Data Collection Survey on Pumped Storage Hydropower Development in Maharashtra

Final Report

October 2012

Japan International Cooperation Agency

Electric Power Development Co., Ltd.

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ABBREVIATION

Abbreviation	Official Name
ACCF	Principal Chief Conservator of Forests
BNHS	Bombay Natural History Society
C/P	Counterpart
CDM	Clean Development Mechanism
CEA	Central Electricity Authority
CERC	Cenrtal Electricity Regulatory Commission
CTU	Central Transmission Utility
DCF	Deputy Conservator of Forests
DRO	District Resettlement Officer
EAC	Expert Appraisal Committee
EC	Environmental Clearance
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ERLDC	Eastern Reginal Load Dispatch Centre
ESA	Ecologically Sensitive Area
ESZ	Ecologically Sensitive Zone
FAC	Forest Advisory Committee
FC	Forest Clearance
FRL	Full Reservoir Level
GOM	Government of Maharashtra
GOMWRD	Government of Maharashtra, Water Resource Department
GPS	Global Positioning System
GSDP	Gross State Domestic Products
IBAs	Important Bird Areas
IEGC	Indian Elecrtricity Grid Code
JICA	Japan International Cooperation Agency
KWDT I	Krishna Water Dispute Tribunal I
KWDT II	Krishna Water Dispute Tribunal II
MAHAGENCO	Maharashtra State Power Generation Co. Ltd.
MAHATRANSCO	Maharashtra State Electricity Transmission Co.Ltd
MDOE	Maharashtra State Department of Environment
MEDA	Maharashtra Energy Development Agency
MERC	Maharashtra Electricity Regulatory Commission
MOEF	Ministry of Environment and Forests
MOP	Ministry of Power
MOSPI	Ministry of Statistics and Programme Implementation
MSEB	MSEB Holding Company
MSEDCL	Maharashtra State Electricity Distribution Co. Ltd
MSLDC	Maharashtra State Load Dispatch Center
NCA	National CDM Authority

Abbreviation	Official Name
NERLDC	North Eastern Regional Load Diapatch Centre
NGO	Non-Governmental Organization
NLDC	National Load Dispatch Centre
NPV	Net Present Value
NRLDC	Northern Regional Load Dispatch Centre
NSDP	Net State Domestic Products
O&M	Operation & Maintenance
PAP	project affected person
PC	Planning Commission
PCN	Project Concept Note
PDD	Project Design Document
PFC	Power Finance Corporation
PGCIL	Power Grid Corporation of India Limited
POSOCO	Power System Operation Corporation Limited
PP	project proponent
R&R	rehabilitation and resettlement
RCCF	Regional Chief Conservator of Forests
RLDC	Reginal Load Dispatch Centre
SAG	State Advisory Group
SCCF	State Chief Conservator of Forests
SEA	Strategic Environmental Assessment
SEAC	State Level Expert Appraisal Committee
SEIAA	State Environmental Impact Assessment Authority
SLAO	Special Land Acquisition Officer
SLDC	State Load Dispatch Centre
SPCB	State Pollution Control Board
SRLDC	Southern Load Dispatch Centre
STU	State Transmission Utility
THDC	Tehri Hydro Development Corporation Limited
tmcf	thousand million cubic feet
TOR	Terms of Reference
UTPCC	Union Territory Pollution Control Committee
WGEA	Western Ghats Ecological Authority
WGEEP	Western Ghats Ecological Expert Panel
WRD	Water Resources Department
WRLDC	Western Regional Load Dispatch Centre
WRPC	Western Regional Power Committee

Chapter 1

Introduction

Chapter 1 Introduction

1.1 Background of Study

Maharashtra state, renowned for Mumbai, the largest market city in India, is located on the western region of India that itself is prominent in economic growth. It has the biggest economic scale as well as the highest growth ratio among the whole India. Among all states in India, Maharashtra state hit the GSDP growth of as high as 16.6% (year 2010) , 11.3%(2011) and yet as high as 8.5% .at Mar. 2012. However, the power supply shortage of the state also hit the highest figure as high as 16.6% (MWH) and 18.1% (peak MW) compared to other states.(In 2011, GSDP11.3% but worsen to 16.7%(MWH) and 22.1%(peak MW)).

The large scale grid failures “Blackouts” on the whole India (3 grid outages out of 5) occurred on 30th and 31st July, 2012 during this study. It is considered the direct causes were due to the over drawl by the northern states utilities from power line, initiating heavy power flow in the line, resulting in the cascade frequency drops, power shutdown, thus successive grid collapses. But the structural causes of the power sector are also discussed. The western grid including Maharashtra state, escaped from falling into “the outage” this time. But it has no reserve power supply and such outage could occur at anytime. Maharashtra state is in the urgent needs for preparing not only the base load power, but also the peaking power as the outstanding state of power shortage.

Maharashtra state has the largest hydropower development potential in terms of Pumped Power Storage plants (27,000MW), and all sites are centralized in Konkan region, the western highland. The Pumped Power Storage plants are considered highly reliable source of peak power supply, and expected to become the powerful supply sources in Maharashtra state with expanding the peak and off-peak power demand gap.

The disadvantage of the Pumped Power Storage plants however, is the site dependency on those geographic and geological conditions. Also the time span for development ranges as long as 10years time. Considering those altogether in mind, let alone the final judges whether they are feasible and competitive enough as other alternative sources or not at the moment, it is highly required to commence the surveys and evaluations as early as possible, and to establish the basic data compilation so as to be able to prepare the best development plans without delay, together with the comparison of other peak power supply sources, when the time comes.

Therefore, “Data Collection Survey on Pumped Storage Hydropower Development in Maharashtra” was planned and commenced.

1.2 Purpose and scope of Study

The Study will collect data and conduct preliminary survey to help develop pumped storage hydro power projects in Maharashtra by focusing on issues in Maharashtra, such as the risks of power

shortage due to the significant economic growth.

The Study aims at verifying the potentiality of pumped storage power project in Maharashtra. The study shall be conducted through focusing on data collection and review on the following aspects:

- Study on Maharashtra power sector including: power demand forecast, power development policy, power system investment plan, etc.
- Environmental and social considerations
- Operation and maintenance including: scheme, present status, capability
- Financial conditions of the State, power companies (MAHAGENCO, MAHATRANSCO etc.)

The scope of the Study is planned:

- To review the existing "Master Plan Study on Pumped Power Storage Hydroelectric Power Development in Maharashtra State (Mar., 1998)"
- Selection of candidate project sites from the existing previous candidate as well as new found candidate sites when required
- Selection of most promising site for next action aiming at formulation of Japanese ODA Loan project, based on the evaluation on economic, technical, and environmental & social considerations.

1.3 Study Schedule

The overall work schedule is shown in the following flow chart:

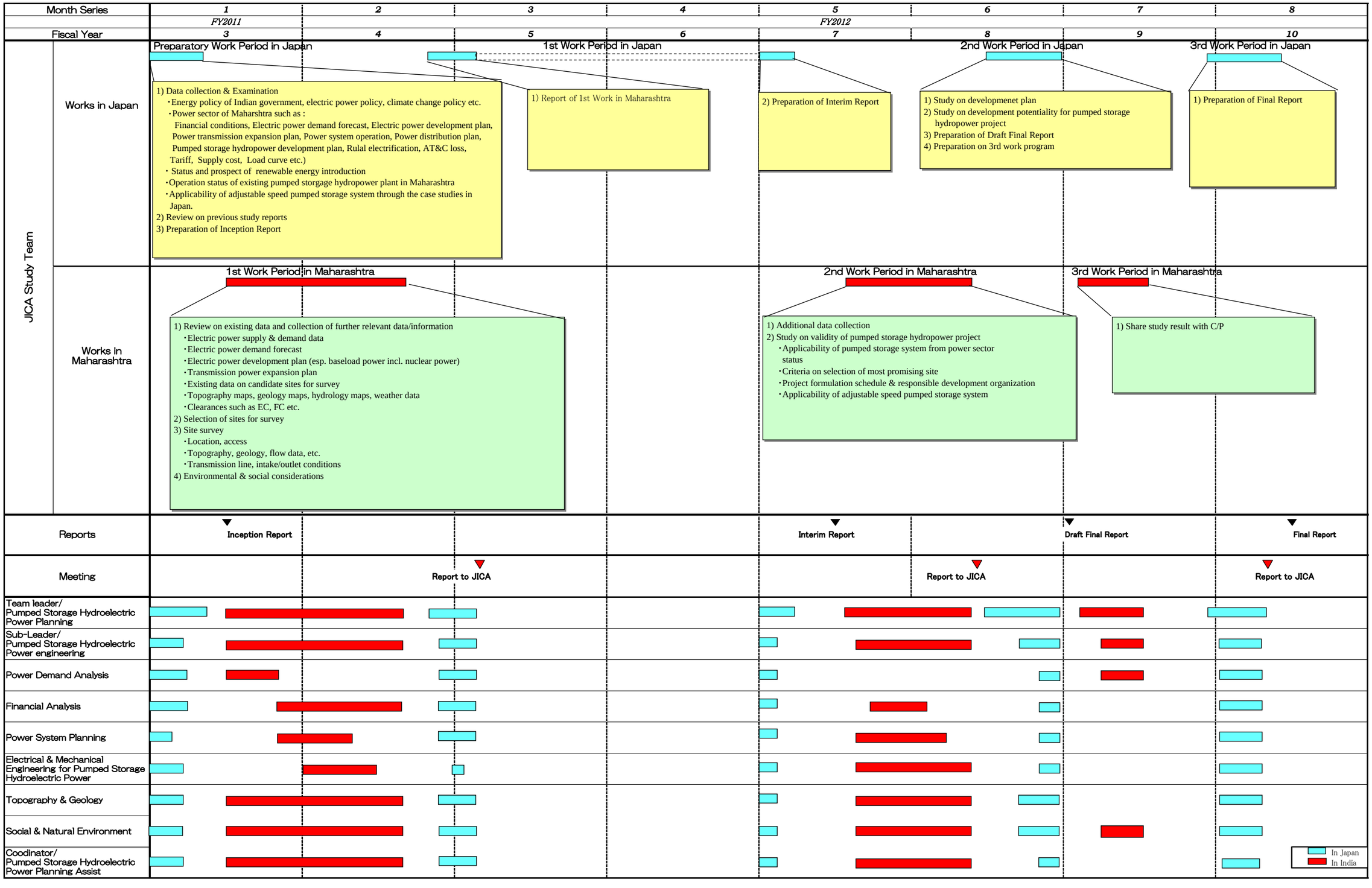


Figure 1.3-1 Work Schedule

1.4 Scope of Studies in Each Stage

1.4.1 Data Collection and Selection of Candidate Sites for Survey

(1) Preparatory Work Period in Japan

1) Data collection and examination

The Study Team will classify, analyze and examine relevant data/information and make detailed work plan and schedule, and also list up necessary data/information. The required data will also be collected in 1st Work Period in Maharashtra. The below are the data/information focused;

- Outline of power sector of Maharashtra such as Financial conditions, Electric power demand forecast, Electric power development plan, Transmission power expansion plan, Power system operation, Power distribution plan, Pumped storage hydropower development plan, Rural electrification, AT&C loss, Tariff, Supply cost, Load curve etc.
- Current situation and prospect of renewable energy introduction in Maharashtra
- Operation status of existing pumped storage hydropower plant in Maharashtra
- Applicability of adjustable speed pumped storage system through the case studies in Japan.

2) Review on previous study reports

- Master Plan Study on Pumped Power Storage Hydroelectric Power Development in Maharashtra State (Mar., 1998)
- JBIC Pilot Study for Project Formation for Identification of Hydro Power Projects for Japanese ODA Funding in INDIA (Aug., 2008)

3) Preparation of Inception Report.

The Study Team will prepare Inception Report. Also the Study Team will prepare and submit questionnaires to the relevant parties.

1.4.2 Selection of Site for Survey, Site Reconnaissance and Study on Promising Site

(1) 1st Work Period in Maharashtra

1) Review on existing data and collection of further relevant data/information

Following existing data will be collected and analyzed.

- Electric power demand and supply balance
- Electric power demand forecast
- Electric power development plan (especially base load power development plan)

- Transmission power expansion plan
- Existing data on candidate sites for survey
- Topography maps, geological maps, hydrology maps, weather data
- Clearances such as Environmental clearance (EC), Forest clearance (FC), etc.

In this Study, counterpart (GOMWRD) will prepare and provide topography data for the Study Team with required approvals for JICA Study Team to accompany them outside of the country.

2) Selection of sites for survey

The Study Team will determine the sites for survey based on the review of data/information.

3) Site survey

The Study Team will confirm the following issues in selected sites for survey and evaluate the possibilities of realization for pumped storage hydropower project.

- Location, access
- Topography, geology, flow data, etc.
- Transmission line, intake and outlet conditions

4) Environmental and social considerations

The Study Team will conduct environmental and social studies on selected sites and surrounding areas with data/information collection including national parks, wild life sanctuaries, land use, populations etc., and evaluate these environmental and social impacts for project realization.

Back in the "Master Plan Study (1998)", it had listed up the total thirty-two (32) candidate sites (Table 1.4.2-1). Among those, three (3) sites were chosen as promising sites for future development.

Table 1.4.2-1 Candidate Sites in "Master Plan Study (1998)"

	Site	Capacity (MW)	Head (m)	Effective reservoir capacity (10^6m^3)	
				Upper	Lower
1	Ulhas	600	548	4.80	4.80
2	Sidgarh	350	649	2.20	2.20
3	Amba	500	541	4.28	4.28
4	Pinjal	30	129	1.34	1.34
5	Kengadi	160	293	2.50	2.50
6	Kalu	300	545	2.50	2.50
7	Jalond	1,000	576	7.50	7.50
8	Kolmanpada	250	450	2.36	2.36
9	Chornai	480	461	4.55	4.55
10	Savitri	1,000	630	6.50	6.50
11	Madhaliwadi	500	508	4.80	4.80
12	Vaitarni	360	466	3.36	3.36
13	Morawadi				
14	Gadgadi	200	632	1.34	1.34
15	Aruna	440	584	3.28	3.28
16	Kharari	420	613	2.94	2.94
17	Kundi	1,200	600	8.92	8.92
18	Jalware	440	552	3.57	3.57
19	Tillariwadi				
20	TillariForebay	720	550	5.83	5.83
21	Marleshwar	1,200	665	8.68	8.68
22	Valvand	1,200	546	9.36	9.36
23	Shemi	60	185	1.6	1.60
24	Kudanbudrak	450	354	5.53	5.53
25	Kaudoshi	400	448	3.95	3.95
26	Kumbhavde	630	363	7.60	7.60
27	Mundirichi	750	659	5.00	5.00
28	Virdi	660	717	4.00	4.00
29	Bamnoli	1,320	662	8.70	8.70
30	Kinjale	420	642	2.93	2.93
31	Khakharwadi	660	505	5.67	5.67
32	Hevale	960	551	7.64	7.63

(No.13 eliminated due to un-accessibility, No.19 eliminated due to small scale)
(Source: Master Plan Study (1998))

However, the further surveys or studies on those sites have been stagnated ever since. The Study Team has noted the following issues as the causes for such delay.

Due to the rapid electric power demand growth, development of base load power projects were put more priorities (GSDP (Gross State Domestic Products) in early 2000s recorded high growth of more or less 10%).

Regarding the selected sites, FC (Forest Clearances) seemed difficult to be obtained. It seems that recently relevant laws such as Forest Conservation Act have been applied strict)

Thus, the consideration onto those issues (Power sector issues, as well as Social & environmental consideration issues) are indispensable in the conduct of this Study.

None the less, the Study Team will collect and review such data previously detailed.

Regarding the social and environmental considerations of the Survey, a scoping exercise will be firstly conducted to clarify expected impacts by the Project. For the exercise, JICA guidelines for environmental and social considerations are referred to as its basis. The following guidelines are also used if necessary.

- Guidelines for confirmation of Environmental and Social Considerations (Japan Bank for International Cooperation)
- Related laws and the EIA guidelines of India

Issues on involuntary resettlement may need to be considered in development of pumped storage hydropower projects. The following guidelines are also referred to in these cases.

- Handbook on Resettlement: A Guide to Good Practice (Asian Development Bank)
- Operation Policy on Involuntary Resettlement (World Bank)

Basic information on natural and social environments will be collected such as location of villages, land use status, current status of protected areas and fauna and flora. And then a scoping table will be drafted considering the scale and range of the impacts induced by the existing dam.

Related information on social and environmental considerations will also be collected from authorities in Maharashtra State such as GOMWRD. The information is used to examine the details of the expected impacts in legislation aspects. Laws and regulations on the following items are especially considered. Procedures in details between the Central Government and the Maharashtra State Government will be examined.

- Protected areas such as national park, sanctuary and forest reserve
- Important cultural heritage/ monument, and their protection and procedure
- Environmental clearance (EC) and its procedure

- Criteria and process of Environmental Impact Assessment (EIA)
- EIA (existing documents and EIAs in process of other similar projects)
- Forest clearance (FC) and its procedure
- Water utilization and water right issues especially acquisition of water right
- Involuntary resettlement and its procedure
- Land acquisition and its procedure
- Compensation of agriculture and fisheries and its procedure
- Protection of ethnic minorities
- Non-governmental organizations on environmental issues and/or social issues

The preliminary studies by the Study Team have identified the following laws and regulations related to EC and FC in India. The Study Team will collect and analyze the specific issues in the Maharashtra related to EC and FC.

(a) The Environmental (Protection) Act, 1986;
(b) The Environment Protection Rules, 1986;
(c) The Indian Forest Act, 1927;
(d) The Forest (Conservation) Act, 1980;
(e) The Forest (Conservation) Rules, 2003;
(f) The Water (Prevention and Control of Pollution) Act, 1974;
(g) The Water (Prevention and Control of Pollution) Rules, 1975;
(h) The Water (Prevention and Control of Pollution) Second Amendment Rules, 1976;
(i) The Air (Prevention and Control of Pollution) Act, 1981;
(j) The Air (Prevention and Control of Pollution) Rules, 1982;
(k) The Wild Life (Protection) Act, 1972;
(l) The Wild Life (Protection) Rules, 1995;
(m) The Public Liability Insurance Act, 1991;
(n) The Public Liability Insurance Rules, 1991;
(o) The Hazardous Wastes (Management And Handling) Rules, 2003.

The preliminary survey has found the following facts and issues:

- Regarding the current status of the protected areas in Maharashtra, there are six (6) national parks and 35 sanctuaries. Within the target area (Konkan district) of the survey, there are one (1) national park and three (3) sanctuaries. Basically these protected areas should be excluded from candidate sites.
- Regarding the forest protection in the state, Recorded Forests are classified as Reserved Forests, Protected Forests and Unclassed Forests (order in conservation priority).

Reserved Forests are classified as the most important ones. Sufficient and adequate reasons for development is required in order to obtain clearance in Reserved Forest even in a project proceeded by central government.. In other two Forests, a clearance is individually examined considering compensation scheme such as an establishment of off-site forest.

In Maharashtra, the area of the Recorded Forests is 62,000km^2 in total which consists of about 20 % of the area of the province (310,000km^2). Although the ratio is not very high comparing the ratio of India, it is important to collect the latest information on the Recorded Forest in order to select the appropriate site for the Project.

Table 1.4.2-2 Areas of Recoded Forests

	State Area (km^2)	Reserved Forests (km^2)	Protected Forests (km^2)	Unclassed Forests (km^2)	Recorded Forests total (km^2)	Forest Ratio (%)
Maharashtra	307,713	49,226	8,195	4,518	61,939	20%
All India	3,287,263	430,582	206,219	132,711	769,512	23%

Source: Forest Survey of India, India State of Forest Report 2009

- Important Bird Areas (IBAs) are internationally recognized areas with high biological diversity conservation priority. In the province, there are 20 IBAs, and some of them are already protected as national park or sanctuary. IBAs shall be excluded from candidate sites for survey.

Candidate sites for survey will be selected based on these information and analysis.

From the technical point of view, existence of faults or other geological problems, and accesses to site for construction and maintenance will be considered as important evaluation criteria.

From economical point of view, a preliminary economic and financial analysis will be conducted based on the other similar projects and their plans.

From social and environmental points of view, sites will be evaluated considering Recorded Forests, protected area such as national park, impacts on endangered species and impacts caused by reservoir construction (area of inundated forest and agricultural land, scale of involuntary resettlement, compensation for fisheries, existence of cultural heritages, ethnic minorities and road).

Table 1.4.2-3 describes an example for evaluation criteria of promising site. The criteria will be utilized in 1st Work Period in Maharashtra after revised if required.

Table 1.4.2-3 Evaluation Criteria (plan)

Technical criteria	Values
Geological conditions	
・Faults near damsites	1
・Thick deposits in damsites	2
・Weak foundation in damsites	3
・Firm & impermeable foundation rocks in damsite	4
Transmission extension	
・>50km	1
・31～50km	2
・11～30km	3
・<10km	4
Access roads extension	
・>50km	1
・31～50km	2
・11～30km	3
・<10km	4

Economical criteria	Values
Construction cost	
・>30,000 Rs/kW	1
・30,000 Rs/kW> >25,000 Rs/kW	4
・>25,000 Rs/kW	8

Social & Environmental criteria	Values
Resettlement	
・Large impact(>500 houses)	1
・Medium impact (100～500 houses)	2
・Small impact (<100 houses)	3
Inundated forest	
・Large (>500 ha)	1
・Medium (100～500 ha)	2
・Small (<100 ha)	3
Recorded forests	
・Reserved Forests	1
・Protected Forests	2
・Unclassed Forests	3
・others	4
Protected areas	
・National Park	1
・Sanctuary	1
・others	4

(2) 1st Work Period in Japan

1) Preparation of Interim Report

The Study Team will prepare the Interim Report including the plan of 2nd Work Period in Maharashtra.

(3) 2nd Work Period in Maharashtra

1) Additional data collection

Based on the collected data/information in 1st Work Period in Maharashtra, additional data/information will be collected. The Study Team will prepare the Interim Report.

2) Study on validity of pumped storage hydropower project

The Study Team will evaluate the validity of pumped storage hydropower project focusing on the following issues.

- Applicability of pumped storage hydropower project from power sector status.
- Criteria on selection of most promising site
- Project formulation schedule and responsible development organization
- Applicability of adjustable speed pumped storage system.

(4) 2nd Work Period in Japan

1) Study on development plan

- Preparation of study plan for the most appropriate site.

2) Study on development potentiality for pumped storage hydropower project

- Schedule, development scale, organization, social & environmental impacts.

3) Preparation of draft Final Report

4) Preparation on 3 rd work program

The Study Team will prepare the plan of 3rd Work Period in Maharashtra.

(5) 3rd Work Period in Maharashtra

1) Share study result with related organizations and collect comments.

(6) 3rd Work Period in Japan

1) Preparation of Final Report

1.5 Study Team

The JICA Study Team members are listed as follows:

Table 1.5-1 Member of the JICA Study Team

Name	Assignment	Company
Madoka HARADA	Team leader/Pumped Storage Hydroelectric Power Planning	Electric Power Development Co., Ltd. (J-POWER)
Yasushi YOSHINO	Sub-Leader/ Pumped Storage Hydroelectric Power engineering	Electric Power Development Co., Ltd. (J-POWER)
Tsuyoshi NAKAHATA	Power Demand Analysis	Electric Power Development Co., Ltd.
Jun KAWASHIMA	Financial Analysis	Electric Power Development Co., Ltd.
Tetsuya HIRAHARA	Financial Analysis	Electric Power Development Co., Ltd.
Masahide KURACHI	Power System Planning	Electric Power Development Co., Ltd.
Satoshi SUZUKI	Electrical & Mechanical Engineering for Pumped Storage Hydroelectric Power	Electric Power Development Co., Ltd. (J-POWER)
Yutaka SHINJO	Topography & Geology	Chuo Kaihatsu Corporation
Shunji USUI	Social & Natural Environment	IC Net Limited
Shigeru KONDO	Coodinator/ Pumped Storage Hydroelectric Power Planning Assist	Electric Power Development Co., Ltd. (J-POWER)
Gaku MATSUOKA	Coodinator/ Pumped Storage Hydroelectric Power Planning Assist	Electric Power Development Co., Ltd. (J-POWER)

The Study Team would like the counterpart (GOMWRD) to provide the following facilities and services for implementing the Study.

Table 1.5-2 Member of the counterpart

Name	Assignment	Comapany
Sharad S DABHADKAR	Team Leader	Water Resource Department, Gov. of Maharashtra
Smita MUNGEKAR	Pumped Storage Hydroelectric Power engineering Social & Natural Environment	Water Resource Department, Gov. of Maharashtra
(S. S. DESHPANDE)	Assistance to Social & Natural Environment	Retired/ Former Deputy Engineer (E&M) of Water Resource Department, Gov. of Maharashtra
R. N. KOSHTI	Electrical & Mechanical Engineering for Pumped Storage Hydroelectric Power	Water Resource Department, Gov. of Maharashtra
S. S. NAIK	Electrical & Mechanical Engineering for Pumped Storage Hydroelectric Power	Water Resource Department, Gov. of Maharashtra
S. K. PATIL	Topography & Geology	Water Resource Department, Gov. of Maharashtra
A. K. DHAWANE	Topography & Geology	Water Resource Department, Gov. of Maharashtra
L. P. NAYAK	Power Demand Analysis Power System Planning Financial Analysis	Water Resource Department, Gov. of Maharashtra Water Resource Department, Gov. of Maharashtra Water Resource Department, Gov. of Maharashtra

1.6 Collected Data

The data collected during the survey was attached below.

Table 1.6-1 List of Collected Data

title	source	year
MAJOR MONETARY POLICY RATES AND RESERVE REQUIREMENTS - BANK RATE, LAF (REPO-REVERSE REPO & Marginal Standing Facility), MSF RATES, CRR, SLR	Reserve Bank of India	2012
Outstanding Guarantees of State Governments	Reserve Bank of India	2012
FACT SHEET ON FOREIGN DIRECT INVESTMENT (FDI)	Department of Industrial Policy & Promotion, Government of	2012
Climate of Maharashtra	India Meteorological Department	2005
India State of Forest Report 1993	Forest Survey of India	1994
India State of Forest Report 1995	Forest Survey of India	1996
India State of Forest Report 1997	Forest Survey of India	1998
India State of Forest Report 1999	Forest Survey of India	2000
India State of Forest Report 2001（re. Maharashtra ）	Forest Survey of India	N/A
India State of Forest Report 2003	Forest Survey of India	N/A
India State of Forest Report 2005（re. Maharashtra）	Forest Survey of India	2008
India State of Forest Report 2009（re. Maharashtra）	Forest Survey of India	N/A
India State of Forest Report 2011（re. Maharashtra）	Forest Survey of India	N/A
India's Fourth National Report to the Convention of Biological Diversity	Ministry of Environment and Forests, India	2009
Prior Environmental Clreance - Notifdication 2006	Ministry of Environment and Forests, India	2006
Report of the Western Ghats Ecological Expert Panel Part I and II	Ministry of Environment and Forests, India	2011
Handbook of Forest (Conservation) Act, 1980 (with amendments made in 1988), Forest (Conservation) Rules, 2003 (with amendments made in 2004) Guidelines and Clarifications (up	Ministry of Environment and Forests, India	no date stated
Model TOR for Hydropower Projects	Ministry of Environment and Forests, India	no date stated
The Draft National Land Acquisition and Rehabilitation & Resettlement Bill (27 July 2011, Minisry of Rural Development)	Ministry of Rural Development, India	2011
Annual Report (2011-12) on The Working of State Power Utilities & Electricity Department	Planning Commission, Government of India	2011
Report of The Working Group on Power for Twelfth Plan (2012-17)	Ministry of Power, Government of India	2012
GUIDELINES FOR FORMULATION OF DETAILED PROJECT REPORTS FOR HYDRO ELECTRIC SCHEMES, THEIR ACCEPTANCE AND EXAMINATION FOR	Central Electricity Authority	2011
CEA Annual Report 2009-10	Central Electricity Authority	2010
17th Electric Power Survey of India	Central Electricity Authority	2007
Operation Performance of Generating Stations in the Country during the Year 2009 - 2010	Central Electricity Authority	2010
eps_18th_agenda_final_rev	Central Electricity Authority	2010
Operation Record of Ghatghar HPS	(obtained from CEA, July 20, 2012)	no date stated
Outage History of Ghatghar HPS	(obtained from CEA, July 20, 2012)	no date stated

title	source	year
Operation Record of Purulia HPS	(obtained from CEA, July 20, 2012)	no date stated
Outage History of Purulia HPS	(obtained from CEA, July 20, 2012)	no date stated
Peak Demand/Peak Met(Provinsional)	(obtained from PGCIL, July 21, 2012)	no date stated
All India & State Wise/UT Wise Peak Electric Load 2009 - 2010 to 2015 - 2016	(obtained from PGCIL, July 21, 2012)	no date stated
Draft National Electricity Plan (Volume 1) Generation	Central Electricity Authority	2012
Draft National Electricity Plan (Volume 2) Transmission	Central Electricity Authority	2012
Growth of Electricity Sector in India(1947-2011)	Government of India, Ministry of Power, Central Electricity	2011
Minutes of the 16th Meeting of the Central Advisory Committee (CAC) of CERC held on 14th March at New Delhi	Central Electricity Authority	2012
18th Electric Power Survey Forecast Table 4.14A & B	(obtained from CEA, Aug.9, 2012)	2012
IEGC	Central Electricity Regulatory Commission	2010
IEGC 1st Amendment 26_12_2011	Central Electricity Regulatory Commission	2012
Report on Short-term Power Marekt in India: 2011-12	Central Electricity Regulatory Commission	2012
Report on Short-term Power Marekt in India: 2009	Central Electricity Regulatory Commission	2009
Mega City Survey for 18th Electric Power Survey Forecast	(obtained from CEA Regional Power Survey Office)	no date stated
POWERGRID ANNUAL REPORT - 2010-11	Power Grid Corporation Ltd	2011
Assumption PoC Charges and Losses 2012-2013	National Load Dispatch Centre	2012
WRPC Annual Report 2009 - 2010	Western Regional Power Committee	2010
WRPC Monthly Progress Report January 2012	Western Regional Power Committee	2012
Power Scenario in Maharashtra	Government of India, Ministry of Power, Central Electricity Authority	no date stated
Economic Survey of Maharashtra 2011-2012	Directorate of Economics & Statistics, Planning Department, Government of Maharashtra	2012
HANDBOOK OF BASIC STATISTICS OF MAHARASHTRA STATE 2008	Directorate of Economics & Statistics, Planning Department, Government of Maharashtra	2010
Economic Survey of Maharashtra 2010-2011	Directorate of Economics & Statistics, Planning Department, Government of Maharashtra	2011
State Grid Code 2006	Maharashtra Electricity Regulatory Commission	2006
MERC (Multi Year Tariff) Regulations 2011	Maharashtra Electricity Regulatory Commission	2011

title	source	year
SLDC Daily System Report for 09/May/2012	State Load Dispatch Centre	2012
SLDC Monthly Progress Report	State Load Dispatch Centre	2012
Frequency graph 29-03-2012	State Load Dispatch Centre	2012
Load curve 29-03-2012	State Load Dispatch Centre	2012
Workshop_20.09.11	State Load Dispatch Centre	2011
Power Flow Diagram in Maharashtra	State Load Dispatch Centre	2012
MAHAGENCO Financial Statements	Maharashtra State Power Generation Co.Ltd	2006-
Generation & Pumping Data of Ghatghar HPS for 2010 - 2011	Maharashtra State Power Generation Co.Ltd	no date stated
Annual Report 2010-2011	Maharashtra State Power Generation Co.Ltd	2011
MAHATRANSCO Financial Statements	Maharashtra State Electricity Transmission Co. Ltd	2008-
Cost data for the year 2011 - 2012 & 2012 - 2013 for the transmission schemes for 220kV and below	Maharashtra State Electricity Transmission Co. Ltd	2012
costdata400kV	Maharashtra State Electricity Transmission Co. Ltd	no date stated
Short cirkuit capacity	Maharashtra State Electricity Transmission Co. Ltd	no date stated
6th Annual Report 2010-2011	Maharashtra State Electricity Transmission Co. Ltd	2011
STU_FIVE_YEAR_PLAN_2010-11 to 2014-15	Maharashtra State Electricity Transmission Co. Ltd	2010
Map-existing&proposed	Maharashtra State Electricity Transmission Co. Ltd	2008
Installed Capacity	(obtained from Maharashtra State Electricity Transmission Co. Ltd)	no date stated
Cost data of Mahatransco	Maharashtra State Electricity Transmission Co. Ltd	no date stated
Key Diagram of 400kV S/C & D/C Tower	Maharashtra State Electricity Transmission Co. Ltd	no date stated
MAHADISCOM Financial Statements	Maharashtra State Electricity Distribution Co. Ltd	2006-
High Tension – Tariff	Maharashtra State Electricity Distribution Co. Ltd	2011
Low Tension – Tariff	Maharashtra State Electricity Distribution Co. Ltd	2011
6th Annual Report 2010-2011	Maharashtra State Electricity Distribution Co. Ltd	2011
Exective Summery	Maharashtra State Electricity Distribution Co. Ltd	no date stated
MSEDCL Material	Maharashtra State Electricity Distribution Co. Ltd	no date stated

title	source	year
Award of turnkey contract for construction of 400kV D/C line from 400kV Jejuri S/S to proposed 400kV Hinjewadi S/S	Maharashtra State Electricity Distribution Co. Ltd	2012
Hourly Demand Curves On Regional Peak Day	(obtained from Government of India, Water Resorce Department)	no date stated
Partial Answer for Questionare	(obtained from Government of India, Water Resorce Department)	no date stated
Drawings of Ghatghar Hydro Electric Project	Water Resorce Department	no date stated
Desired operating voltage as per State Grid Code	(obtained from Government of India, Water Resorce Department)	no date stated
18th Electric Power Survey of India	(obtained from WRD, July, 2012)	2012
Rising to meet challeng	Power Trading Corporation of India Limited	no date stated
Status of Open Access in Maharashtra	(obtained from PTC India, July 20, 2012)	no date stated
Peak Demand/Peak Met (Provisional), April 2012	(obtained from PTC India, July 20, 2012)	2012
All India & State Wise/UT Wise Forecast Peak Electric Load at Power Station Bus Bars (Utilities Only) (U/R) 2009 - 2010 to 2016 - 2017	(obtained from PTC India, July 20, 2012)	2012
Power Supply Position in Maharashtra and Western Region, India	(obtained from PTC India, July 20, 2012)	2012
PUMPED STORAGE SCHEMES IN INDIA	CENTRAL BOARD OF IRRIGATION & POWER	1997.11
Comments on 'generation of Deccan Trap magmas'.pdf	Proc. Indian Acad. Sci. (Earth Planet. Sci.), 110, December 2001, 409{431)	2001
Disaster management in Maharashtra.pdf	Envis Newsletter	2006
Dyke Swarms of the Deccan Traps.pdf	IDC-6, Varanasi Tentative plan for Pre-Conference Field Trip 2	2000
Engineering Geology Concuderations for specifying dam foundation objectives.pdf		2001
Generation of Deccan trap magmas.pdf	Proc. Indian Acad. Sci. (Earth Planet. Sci.), 110, No. 4	2001
Geological Survey if India maps.pdf	Geological Survey of India(GSI),Ministry of Mines (website)	
Geotechnical Report on KASBESHIVTHAR Hydro EP.pdf	Government of Maharashtra, Water Resource Department	2009
List Published Maps GSI Feb 2008.pdf	Geological Survey of India(GSI),Ministry of Mines	2008
Recycling of Flow-Top Breccia Crusts into molten interiors of flood basalt lava flows.pdf		2011
Rockfall and subsidence on Mumbai-Pune Expressway.pdf	International Journal of Geoengineering Case Histories	2010
Role of Engineering Geology in Various Civil Structures - River Linking		

title	source	year
The Feeder System of the Deccan Traps.pdf	JOURNAL OF PETROLOGY at Indian Institute of Technology	2011
The Maharashtra Project Affected Persons Rehabilitation Act, 1999 [Mah. Act XI of 2001] with Allied Laws	CTJ Publications	2009
The Land Acquition Act, 1984 (1 of 1894) with State Amendment & Short Comments	Professional Book Publishers	2012
Forest Laws with with State Amendment & Short Comments	Professional Book Publishers	2012
The Environment (Protection) Act, 1986 (29 of 1986) with Short Comments	Professional Book Publishers	2012
India's Notified Ecologically Sensitive Areas (ESAs): The Story So Far	Kapoor, M., Kohli, K., and Menon, M., Kalpavriksh	2009
Data Collection Survey on Forestry Sector in India	JICA	2011
インドの地方自治-日印自治体間交流のための基礎知識	財団法人自治体国際化協会	2007
Field Training Report for Ghatghar Hydropower Project	A trainee from Water Resources Department	2008
Interstate river water disputes (IRWD) act (1956) and its legal provisions	Sasidhar, N. (articles from website)	2011
Annual Report 2010-2011	Water Resources Depaertment, Karnataka State Government	2011
The Report of the Krishna Water Disputes Tribunal with the Decision, Volume I - IV	Government of India	1973

Chapter 2

General Information on Maharashtra

Chapter 2 General Information on Maharashtra

2.1 General

India has been experiencing the rapid growth of the electric power demand as well as the whole energy recently ever since it has been going through the fast development on economy. The whole capacity of electric power supply in India marked 199,627MW (as of 31/Mar., 2012) and ranked the 4th of the whole nations next to USA, China and Japan. It is proud of the large power supply market already and the growth ratio of the power supply capacity has been increasing. Maharashtra state, renowned for Mumbai, the largest market city in India, is located on the western region of India that itself is prominent in economic growth. It has the biggest economic scale as well as the highest economic growth ratio among the whole India. Among all states in India, Maharashtra state hit the GSDP growth of as high as 16.6% (year 2010), 11.3% (year 2011) that demonstrates the high ratio of the state growth. (In 2012 March, it dropped to 8.5% however it still remains as the top growing state among Indian states).

However, at the same time India has suffered the constant shortage of the power supply as it never has caught up to the greedy power demand. Quite recently the supply of coal to the power utilities and power projects has revealed no longer secured as it could in the past, so the realization of the Power Development Plan is in the midst of insecurity. Again among all states, the power supply shortage of the Maharashtra state also hit the highest figure compared to other states.

It is strongly suggested the importance and necessity of the base load power sources, but not only that, it is being recognized the importance of peak power supply sources, as it has been anticipated the rapid growth of peak power with the growth of peak and off-peak gaps that more value being put on peak power in conjunction with the growth of Power market.

Maharashtra state has the largest hydropower development potential in terms of Pumped Power Storage plants (27,000MW), and all sites are centralized in Konkan region, the western highland. The Pumped Power Storage plants are considered highly reliable source of peak power supply, and expected to become the powerful supply sources in Maharashtra state with its expanding the gap of peak and off-peak power demand.

2.2 Physiography and Geology

2.2.1 Physiography

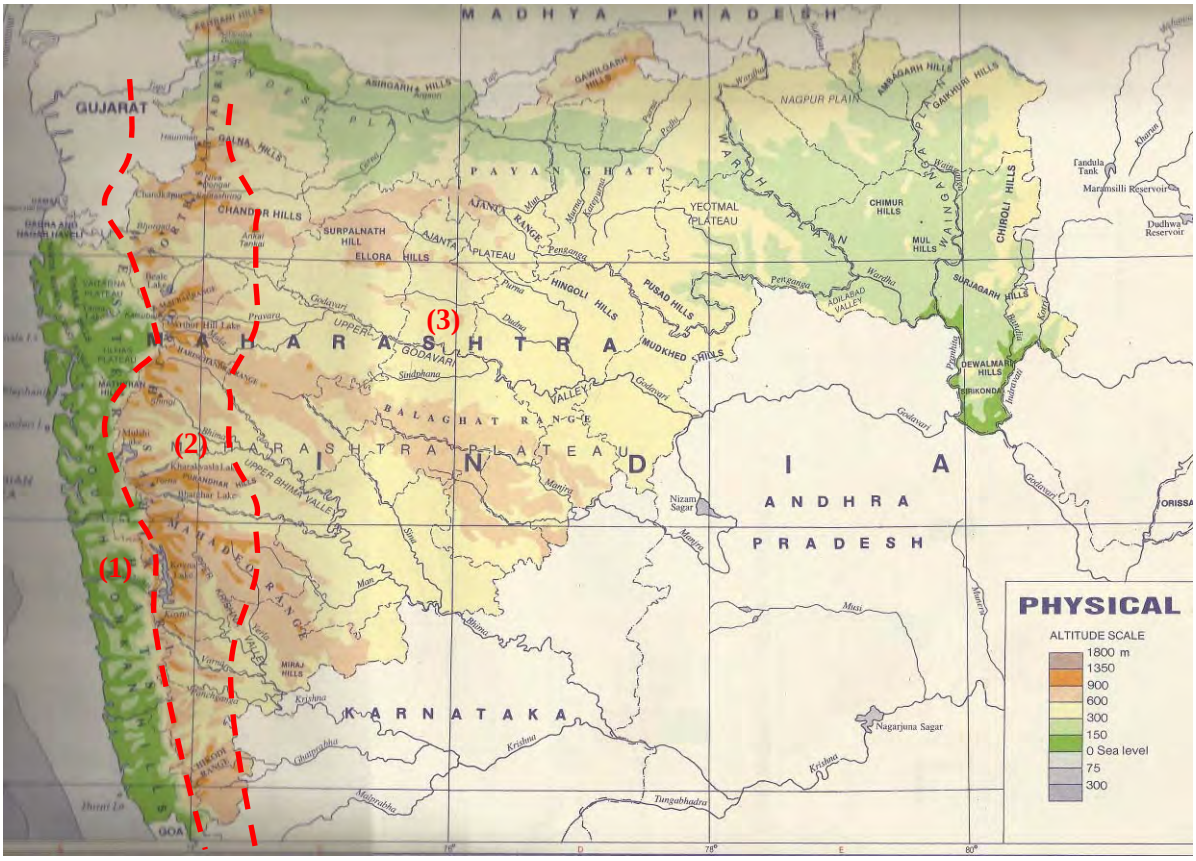
The state of Maharashtra is located in the mid western part of the Indian Peninsula. To the west, the state faces the Arabian Sea, and the length of the coast is about 720 km. The coast is macroscopically linear and stretches nearly in the north-south direction. The shape of the state is more or less trapezoidal, narrowing toward the east.

Maharashtra lies between 16°N and 21°N latitudes, and 72°E and 81°E longitudes. The entire state is located south of Tropic of Cancer, and its figure is elongated in the east-west direction (about 800 km long).

The area of Maharashtra is about 308,000 km^2, the third largest in India, and roughly the same as Japan's Honshu and Hokkaido combined.

Maharashtra is divided in three physiographic provinces listed below by the Western Ghats, which lie nearly parallel to the coast trending north and south.

(1) Konkan Coastal Region
(2) Western Ghats
(3) Maharashtra Plateau



(Base map: An Atlas of India, Oxford University Press 1990)

Figure 2.2.1-1 Physiographic provinces of Maharashtra

Each physiographic province is described below.

(1) Konkan Coastal Region

The Konkan coastal region stretches between the Arabian Sea and the Western Ghats, and its width is about 50 km with the elevation below 200 m. The current pumped-storage hydroelectric project assumes locating lower reservoir in the Konkan coastal region. The Konkan coastal region is a very large consumer of electricity, having the largest city in India, Mumbai.

The Konkan coastal region is not a uniform plain. It consists of numbers of tablelands and terraces lying at different elevations. They show complex shapes and are separated by rivers. The rivers in the Konkan coastal region flow relatively rapidly westward in general. The coastline, fairly linear as a whole, is actually sinuous with many headlands and inlets.

(2) Western Ghats

The Western Ghats, the backbone mountain range of Maharashtra, stretch in the western part of the state from north to south. The Western Ghats lie parallel to the Arabian Sea coastline, separating the Konkan coastal region from the inland Maharashtra plateau.

The Western Ghats macroscopically consist of 2 ~ 3 terrains of different elevations, and show an asymmetrical aspect between east and west. That is, the eastern slope is relatively gentle and the western slope, on the other hand, is very steep and faces the Konkan coastal region with high cliffs that descend all the way. Both eastern and western slopes are characterized by flat-topped ranges and step-like slopes.

The elevations of the Western Ghats are mostly between 1,000 and 1,300 m above the sea level, and the highest point in the state of Maharashtra is 1,646 m (Kalsubai). The current pumped-storage hydroelectric project intends to make use of the big gap between the Western Ghats and the Konkan coastal region, and assumes location of upper reservoir in the Western Ghats.

The Western Ghats constitute a continental divide. The rivers on the western side flow rapidly through the Konkan coastal region to the Arabian Sea. The rivers on the eastern side flow gently eastward to southeastward through the Maharashtra plateau all the way to the distant Bengal Bay.

(3) Maharashtra Plateau

The Maharashtra plateau, east of the Western Ghats, is a vast plateau that takes up 75% of the area of the state. The Maharashtra plateau is the main part of the Deccan plateau, and shows

relatively flat landform as a whole. More detailed look reveals that the plateau is dissected by major rivers into several different terrains, each of which is a few 100 km^2 in area and slightly dipping eastward or southeastward.

The elevation of the Maharashtra plateau decreases from about 600 m near the Western Ghats to about 300 m in the eastern part. The elevation becomes even lower than 300 m along major rivers in the eastern part and near the northern border of the state.

2.2.2 Geology[1]

(1) General aspect

The most distinctive feature of Maharashtra's geology, as shown below, is that the state is widely covered with the Deccan Traps, Cretaceous flood basalts (shown in green). A flood basalt consists of vast amount of lava flows formed by fissure eruptions, and is the largest kind of volcanic activities on the Earth (Flood basalts are also seen in Siberia, Brazil and else).

Outside of the Deccan Traps, very old geological formations from Archeozoic to Carboniferous are distributed. These old geological formations, consist mainly of metamorphic rocks, are limited to the eastern and southern part of the state, and are characteristically rich in minerals such as iron, copper, manganese, and coal. On the contrary, the Deccan Traps are poor in minerals other than bauxite.

Geological formations younger than the Deccan Traps are rarely distributed in abundance. Considerable distribution of unconsolidated sedimentary layers of Quaternary (shown in yellow) are seen in the northern part of the state in a narrow basin along a river.

[1] Reference "Geology of Maharashtra" (Geological Society of India 1998)

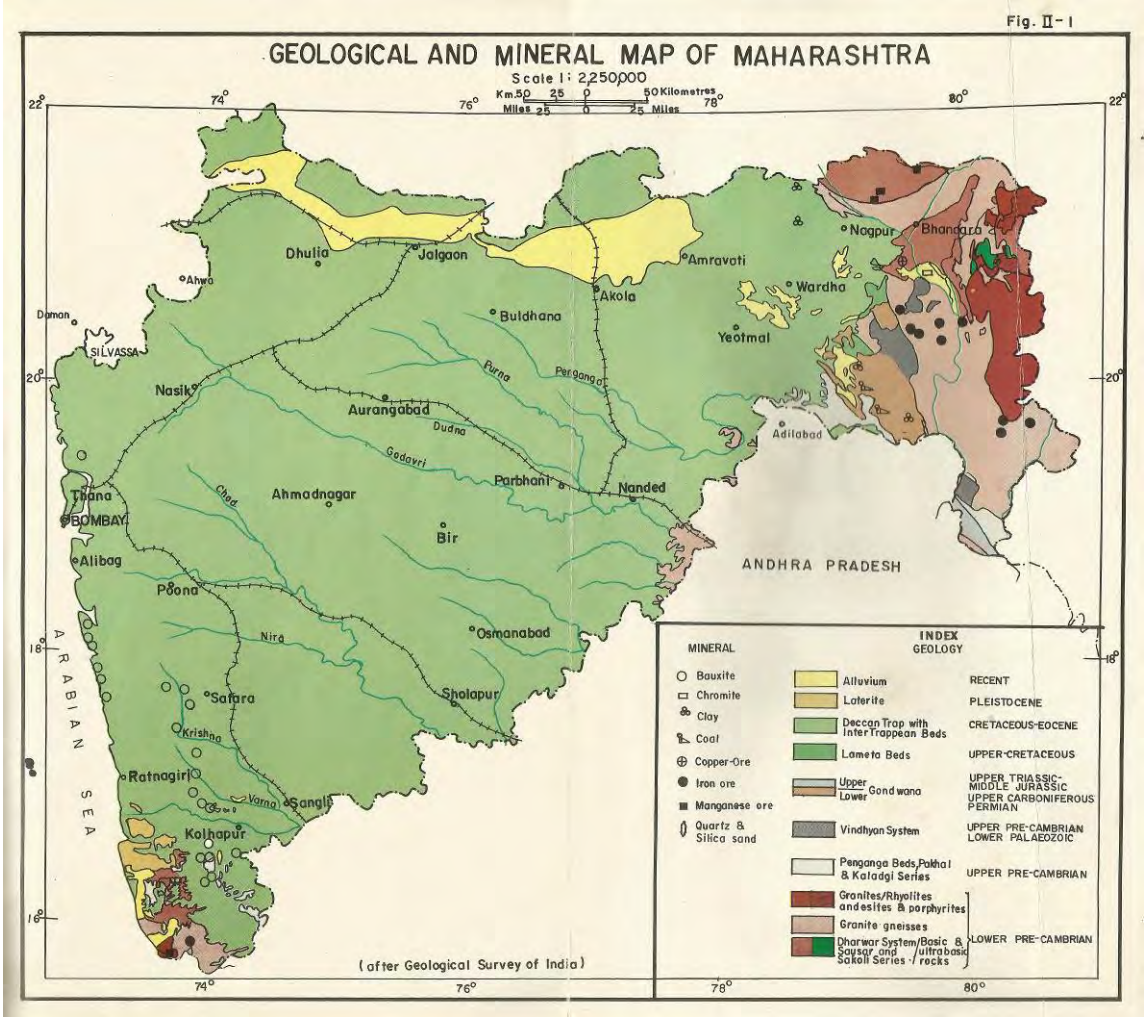


Figure 2.2.2-1 Geological map of Maharashtra

(2) Geological history

Generalized stratigraphic table and geological history of Maharashtra is described below.

Table 2.2.2-1 Generalized stratigraphic table of Maharashtra

Geological period		Name	Formation / Rock type
Quater -nary	Recent	Alluvium	Clay, Sand, Gravel (Unconsolidated)
	Pleistocene	Laterite	Laterite, Bauxite
Paleogene (Tertiary)～ Upper Cretaceous		Deccan Traps Inter Trappeans	Basalt, Dolerite, Rhyolite Cherty Limestone, Shale, Conglomerate, Sandstone Inter Trappean occurs between strata of Deccan Traps
Cretaceous		Infra Trappeans	Cherty Limestone, Shale, Conglomerate, Sandstone
Lower Cretaceous～ Upper Carboniferous		Gondwana group	Shale, Sandstone, Conglomerate, Coal
Proterozoic		Vindhyan system	Limestone, Shale, Sandstone
		Kaladge series	Conglomerate, Quartzite, Sandstone, Shale, Limestone
Archeozoic			Schist, Gneiss, Quartzite, Granulite, Marble, Amphibolite

1) Archeozoic ~ Proterozoic

The oldest geological formations of Maharashtra are metamorphic rocks of Archeozoic (about 3.5 ~ 2.5 billion years ago). These are the subsequent materials of pre-existing igneous and /or sedimentary rocks, which turned into various kinds of schist, gneiss, quartzite, marble, amphibolite, and so on, after repeated intense tectonic activities through a long time

During Proterozoic, several orogenies occurred and the regional geological structures became distinctive due to faulting and folding. Intrusive activities also occurred, and the geological formations of this era were extremely deformed. After those activities ended, a long time of erosion followed.

Later in Proterozoic (about 2.5 ~ 0.54 billion years ago), tectonic basins were formed in the eastern and southern parts of Maharashtra, then conglomerates and limestones etc. were deposited. These Proterozoic layers, scatteringly distributed, covered Archean layers unconformably.

2) Upper Carboniferous ~ Lower Cretaceous

During the period between Proterozoic and Carboniferous, there had been no deposition in South India including the state of Maharashtra. Therefore, layers from Silurian to Devonian are completely absent. The reason for this is thought that South India, which once was a part of Gondwana (the ancient continent consisted of present Antarctica, Australia, South America, and Africa) at that time, was located near the south pole and covered with ice sheets.

Gondwana began to separate in early Carboniferous, and large grabens were formed accordingly. In late Carboniferous, glacial sediments were deposited, and later, normal sediments came to be deposited after the glacier disappeared. This deposition continued until Jurassic, forming the thick layers of Gondwana group.

In Cretaceous, along with sandstones and shales, coal and limestones that indicate climatic warming were deposited. These layers are called the Infra -trappean for they underlie the Deccan Traps directly.

3) Middle Cretaceous to Paleogene

After separating from Gondwana continent, South India continued moving northward. This is thought to be the fastest movement of a continental drift.

In late Cretaceous, a series of gigantic fissure eruptions known as a flood basalt occurred in the middle western part of South India. Vast amount of basaltic lava flowed out and heaped up in hundreds of horizontal layers with various thickness. They exceeded 3,000 m in total thickness and covered most of Maharashtra except the eastern part. The lava layers came to show

step-like landforms due to erosion afterward. These are called the Deccan Traps, with the term Traps meaning steps in Swedish.

The Deccan Trap extends westward off the Arabian Sea coast.

This series of eruptions, one of the Earth's largest lava outflows, took place some 65 million years ago, and were said to have caused mass extinction including dinosaurs (severe climatic change) at the end of Cretaceous. It is currently dominant to think that duration of volcanic activities lasted for a few million years intermittently, although some say much shorter.

Between the lava layers, lacustine and / or fluvial deposits such as cherty limestones are distributed in some places. These were formed during intermissions of lava eruptions, and since they were deposited within the Deccan Traps, they are called the Inter-trappeans. The Inter-trappeans are distributed in small extents with the maximum thickness of about 30 m.

4) Quaternary

The depositional activities were mostly minor, after the volcanic activities of the Deccan Traps ended in early Paleogene. The only Quaternary formation to be displayed in the geological map shown earlier is the east - west trending narrow distribution of alluvium in the northern Maharashtra.

Between late Pliocene and early Pleistocene, due to faulting, grabens were formed and the positions of major rivers were restrained. Also, the distinctive gap (escarpment) between the Western Ghats and the Konkan coastal region was formed. The eastern part was uplifted relative to the western part, and as a result, the Deccan Traps, which were geologically continuous, became geomorphologically discontinuous.

There are faults but is almost no fold within the Deccan Traps, and the layers are nearly horizontal. Quaternary geological activities to note, other than those described above, are forming of laterite and bauxite according to tropical weathering.

2.3 Climate[2]

2.3.1 Climate of Maharashtra

The climate of Maharashtra is classified as the following main types:

(1) Monsoon climate

It is characterized by an annual rainfall of more than 1,000 mms, and is confined to the coastal

[2] The text of this part is extracted and summarised from “Climate of Maharashtra (India Meteorological Department, 2005).

belt and the adjoining Ghats region covering the districts of Thane, Raigad, Ratnagiri, Sindhudurg and the western hilly parts of Pune, Satara and Kolhapur districts. The coastal region has very small annual range of temperature, not exceeding 5°C. The mean daily temperature is above 22°C throughout the year. The mean daily relative humidity is high, generally above 60 %. The coastal belt characterized with as hot and humid weather with plentiful rain during the southwest monsoon season. Regarding the remaining portion of this climate type, the mean daily temperature of the coldest month is between 18°C and 22°C. Relative humidity is reduced, but remains above 50 % for more than eight (8) months in a year.

(2) Dry climate

It covers the semi-arid portions of Jalgaon, Nashik, Aurangabad, Pune, Beed, Satara, Osmanabad and Kolhapur and almost the whole of Dhule, Nandurbar, Ahmednagar, Solapur and Sangli districts. Mean daily temperature is between 18°C and 22°C during winter, and above 22°C during remaining months. Annual rainfall is low from 600 to 900 mms and is confined mainly to the southwest monsoon season. Although mean daily relative humidity is less than 50 % throughout the year, it falls below 30 % for two (2) to three (3) months during summer in the central parts of the region.

(3) Tropical rainy climate

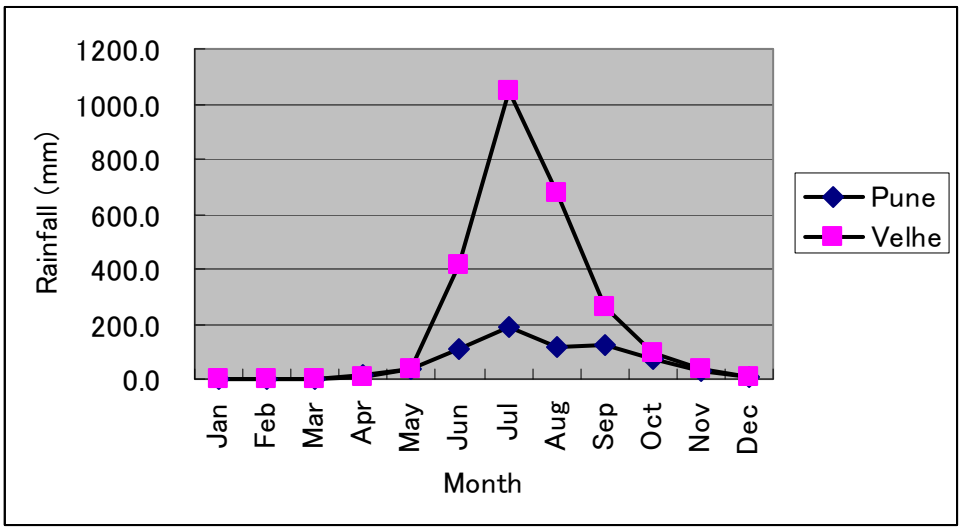
Parts of Nashik, Jalgaon districts, eastern portions of Aurangabad, Jalna, Beed and Osmanabad, as well as the remaining districts of Marathwada (Hingoli, Latur, Parbhani and Nanded) and the entire Vidarbha have the tropical rainy climate. The precipitation is confined to the monsoon season and is above 700 mms. The average relative humidity is above 60 % except during summer when it is even less than 30 % for one (1) or two (2) months. Mean daily temperature is between 18°C and 22°C during winter, and above 22°C during the remaining months.

2.3.2 Climates of Pune and Raigah Districts

(1) Pune

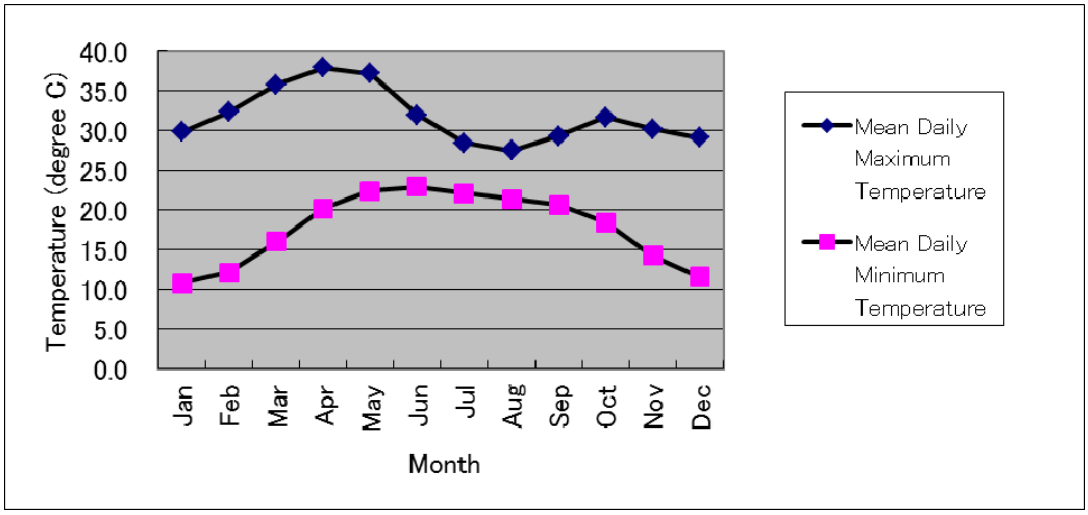
The climate of Pune is mainly dry one except for the western hilly part. The cold season from November to February is followed by the hot season up to early June. The period from early June to the beginning of October constitutes the southwest monsoon season. The succeeding period up to November is the post monsoon or transition season.

Figure 2.3.2-1 shows the rainfall of the two stations in Pune District. Pune station is in the dry zone and Velhe station is located close to Ghats. Figure 2.3.2-2 shows the mean maximum and minimum temperatures of Pune station.



(Source: Climate of Maharashtra (India Meteorological Department, 2005). Prepared by the Study Team)

Figure 2.3.2-1 Rainfall of Pune and Velhe stations, Pune District



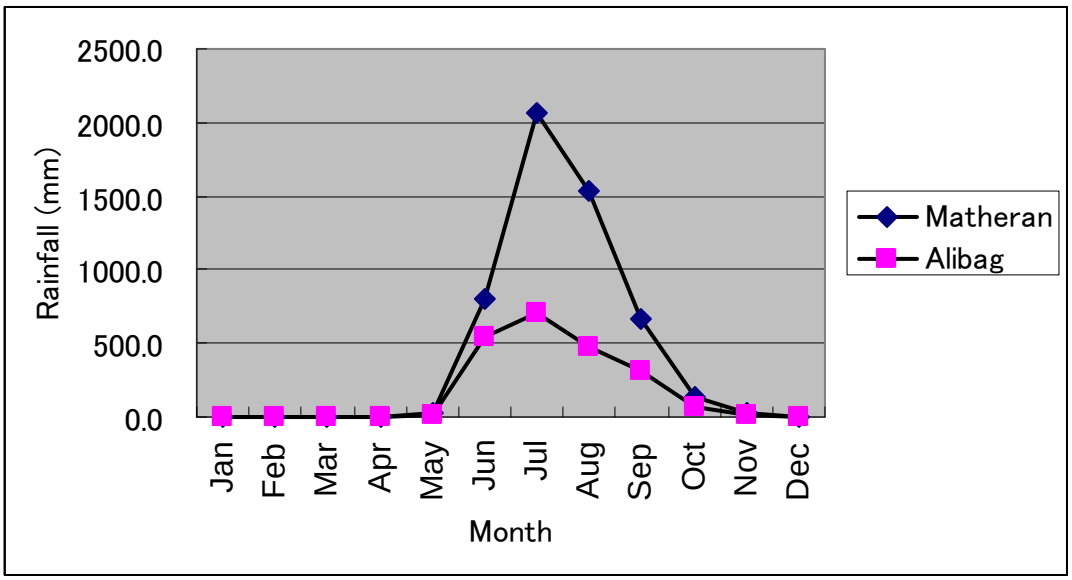
(Source: Climate of Maharashtra (India Meteorological Department, 2005). Prepared by the Study Team)

Figure 2.3.2-2 Mean daily temperatures at Pune station, Pune District

(2) Raigah

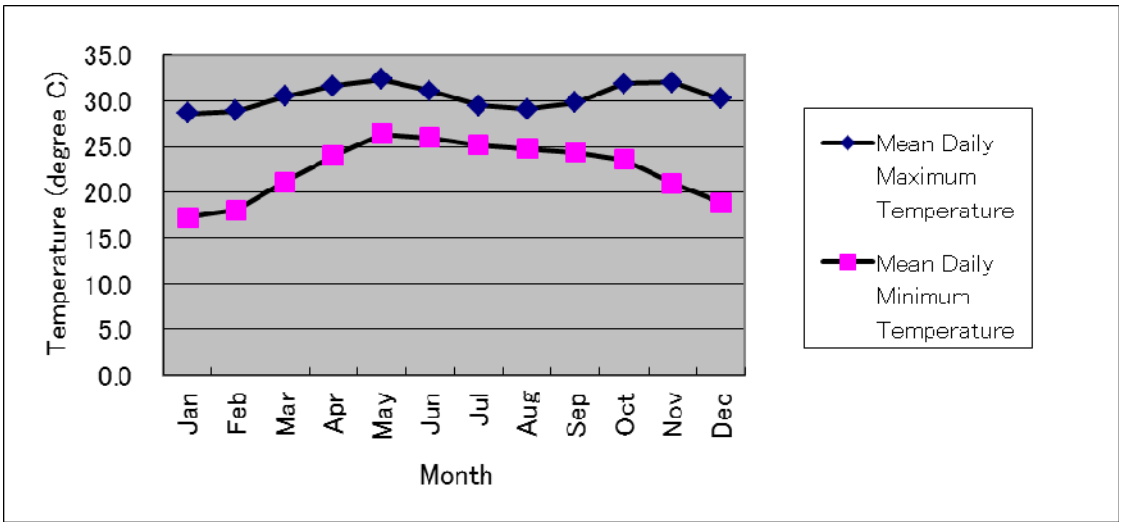
The climate of Raigah is typical of that on the west coast of India, with plentiful and regular seasonal rainfall, oppressive weather in the hot months and high humidity throughout the year. The summer season from March to May is followed by the southwest monsoon season from June to September. October and November form the post monsoon or retreating monsoon season. The period from December to February is the cold season.

Figure 2.3.2-3 shows the rainfall of the two stations in Raigah District. Matheran station is located on Ghats and Alibag station at the northern end of the coast. Figure 2.3.2-4 shows the mean maximum and minimum temperatures at Alibag station.



(Source: Climate of Maharashtra (India Meteorological Department, 2005). Prepared by the Study Team)

Figure 2.3.2-3 Rainfall of Matheran and Alibag stations, Raigah District



(Source: Climate of Maharashtra (India Meteorological Department, 2005). Prepared by the Study Team)

Figure 2.3.2-4 Mean daily temperatures at Alibag station, Raigah District

2.4 Socio-Economic Conditions

2.4.1 Overview on Socio-Economic Conditions in Maharashtra

(1) Population

Maharashtra is the second largest state in India both in terms of population and geographical area (3.08 lakh sq. km.). The State has a population of around 11 crore (Census 2011) which is 9.3 % of the total population of India. During the decade 2001-2011, the population of the State increased by 16 %. This is the lowest rate of growth after 1941, and lower than that of All India.

Higher decadal growth rate is observed in Thane (35.9 %) followed by Pune (30.3 %) and negative growth rates are observed in three districts namely Mumbai city, Ratnagiri and Sindhudurg.

Table 2.4.1-1 Selected Socio-Economic Indicators of Largest 10 States

	Largest 10 States (Population)	Geographical Area (10,000sq. km)	Population (10,000)	Density of population (per sq.km.)	Percentage of urban population to total population	Percentage of State population to all India population	Decennial growth rate of population (per cent)	Sex ratio	Percentage of scheduled castes and scheduled tribes population to total population (2001)
1	Uttar Pradesh	24.1	19,958	828	22.28%	16.49%	20.09%	908	21.21%
2	**Maharashtra**	**30.8**	**11,237**	**365**	**45.23%**	**9.29%**	**15.99%**	**925**	**19.05%**
3	Bihar	9.4	10,381	1102	11.30%	8.58%	25.07%	916	16.64%
4	West Bengal	8.9	9,135	1029	31.89%	7.55%	13.93%	947	28.51%
5	Andhra Pradesh	27.5	8,467	308	33.49%	7.00%	11.10%	992	22.78%
6	Madhya Pradesh	30.8	7,260	236	27.63%	6.00%	20.30%	930	35.44%
7	Tamil Nadu	13.0	7,214	555	48.45%	5.96%	15.60%	995	20.04%
8	Rajasthan	34.2	6,862	201	24.89%	5.67%	21.44%	926	29.72%
9	Karnataka	19.2	6,113	319	38.57%	5.05%	15.67%	968	22.76%
10	Gujarat	19.6	6,038	308	42.58%	4.99%	19.17%	918	21.85%
	All India	328.7	121,019	382	31.16%	100.00%	17.64%	940	24.40%

(Source: JICA Study Team, based on Economic Survey of Maharashtra 2011-12)

Table 2.4.1-2 Trends in Population in Maharashtra

	1961	1971	1981	1991	2001	2011
Population Total (In thousand)	39,554	50,412	62,784	78,937	96,879	112,373
Males	20,429	26,116	32,415	40,826	50,401	58,361
Females	19,125	24,296	30,369	38,111	46,478	54,012
Rural	28,391	34,701	40,791	48,395	55,778	61,545
Urban	11,163	15,711	21,993	30,542	41,101	50,828
Scheduled Castes	2,227	3,177	4,480	8,758	9,882	–
Scheduled Tribes	2,397	3,841	5,772	7,318	8,577	–
Density of population (per Sq. Km.)	129	164	204	257	315	365
Literacy rate (Percentage)	35.1%	45.8%	57.1%	64.9%	76.9%	82.9%
Sex ratio (Females per thousand males)	936	930	937	934	922	925
Percentage of urban population	28.22%	31.17%	35.03%	38.69%	42.43%	45.20%

(Source: JICA Study Team, based on Economic Survey of Maharashtra 2011-12)

As per Census 2011, the population density (persons per sq.km.) in the State is 365 which is lower than that of India (382). Mumbai Suburban and Mumbai city districts top in population density with over 20,000. However population density in most districts is lower than 300 persons.

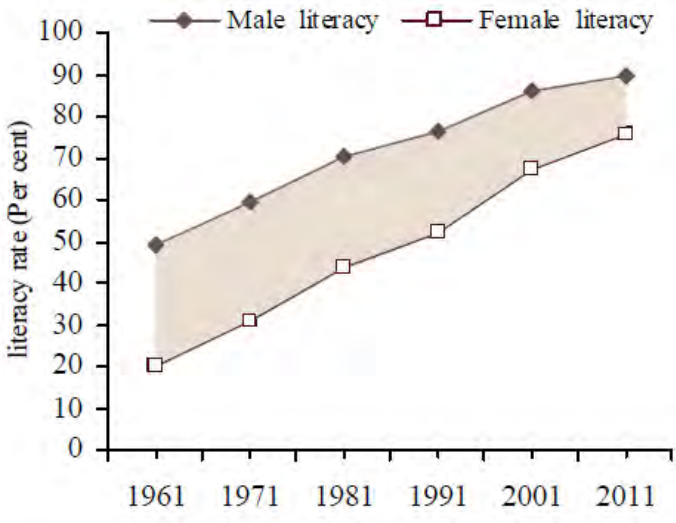
The ratio of urban population has increased gradually and the ratio in 2011 is 45.2% (42.4% in 2001).Population ratio in urban areas is 31.2% in All India, Maharashtra is highly urbanized with 45 % people residing in urban areas. Urban population is about 51 million people in 2011, compared with the urban population of 41 million people in urban areas in 2001, has increased about 9.7 million.

The ratio of rural population has decreased gradually and the ratio in 2011 is 54.8% (57.6% in 2001).Population ratio in rural areas is 68.8% in All India, the ratio in Maharashtra is lower than that in All India. Rural population is about 62 million people in 2011, compared with the urban population of 56 million people in urban areas in 2001, has increased about 5.8 million.

Census 2011 revealed that sex ratio of the State is 925 in 2011 and lower than 940 in All India. The sex ratio in urban area is lower than 900. The ratios in some southern districts are over 1,000.

Census 2011 didn't reveal the population of scheduled castes and tribes. In census 2001, the shares in total population are 10.2% and 8.9% respectively (total 19%), and the share is lower than that of All India (24.4%).

The literacy rate is 82.9% in 2011 increased by 76.9% in 2001. The literacy rates for males and females are 89.8 and 75.5 % respectively. The gap in literacy rates of males and females show decreasing trend. The literacy gap was 29.5 point in 1961 and reduced to 14.3 point in 2011.



(Source: Economic Survey of Maharashtra 2011-12)

Figure 2.4.1-1 Trends in Gender Gap in Literacy Rate in Maharashtra

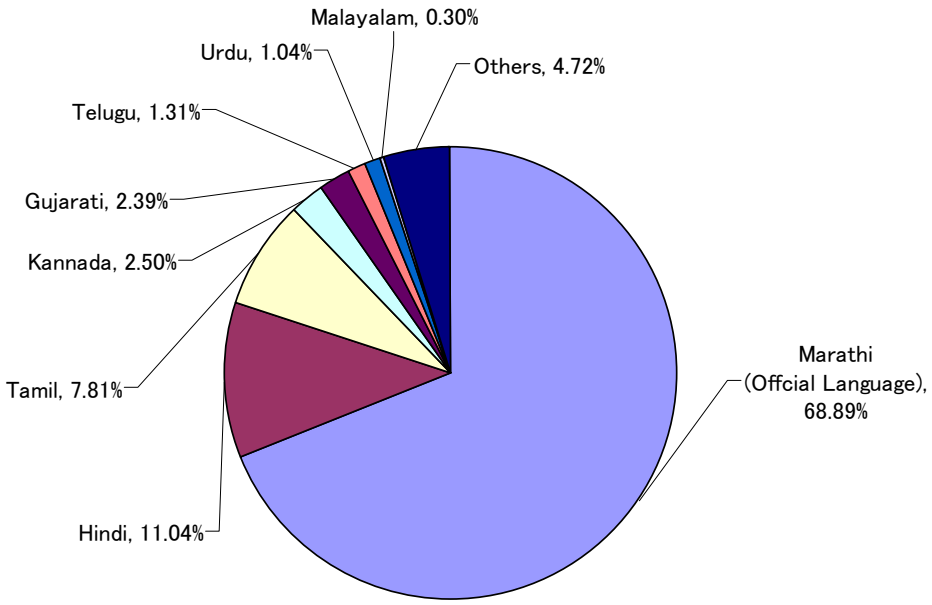
(2) Religions and languages

Census 2011 didn't reveal the data on religions and languages. Therefore the data below is used in census 2001.

The 2001 census reported that Hinduism, with 80.5% of the population, was the largest religion in India; it is followed by Islam (11%), Christianity (2.5%), Sikhism (2%), Buddhism (1.5%), and others (Jainism, Judaism, Zoroastrianism, 0.5%). Major religions in Maharashtra are Hinduism (83.2%) and Islam (10%). Especially Maharashtra has many Sikhism and its population is 1.3 millions of 4.5 millions in All India.

However, there are many scheduled castes that averse the caste system and convert to Buddhism, it is said that there is more than tens of millions of Buddhists throughout India. In order to secure preferential treatment to the caste specified frame, they often do not register with the Buddhists. Therefore, the above figures may not be accurate.

Marathi is the Official language of Maharashtra. According to 2001 census, it is mother tongue of about 70 % of the population. Composition ratio of languages (scheduled by central government) in Maharashtra is presented in Figure 2.4.1-2.



(Source: JICA Study Team, based on Office of the Registrar General & Census Commissioner)

Figure 2.4.1-2 Composition Ratio of Languages in Maharashtra

Others include 100 non scheduled languages other than scheduled languages.

(3) Industries

The percentages of agriculture & allied activities sector, industry sector and services sector in

the year 2010-11 GSDP (at constant (2004-2005) price) are 8.5%, 30.8% and 60.8% respectively. The largest portion in GSDP is services sector's portion.

Mumbai, capital of Maharashtra, is the center of finance in India, and has many headquarters and branches of banks, financial institutes and insurance companies.

SENSEX, also called the BSE 30, is a free-float market capitalization-weighted stock market index of 30 well-established and financially sound companies listed on Bombay Stock Exchange. Bombay Stock Exchange is the oldest stock exchange in Asia, and was established three years earlier than Tokyo Stock Exchange.

Many large banks in India, namely State Bank of India (largest state-owned bank), ICICI Bank (largest second bank), HDFD Bank and Axis Bank are headquartered in Mumbai.

The portion of financial sector in GSDP (at constant price) contributes 24% of service sector and 15% of all sectors. Therefore financial sector is one of main sector in Maharashtra.

Mumbai is also the center of industry and commerce. Of three largest business groups, Tata group and Reliance group are based in Mumbai. Other business group, Birla group was split, but largest group (Aditya Birla) is also based in Mumbai.

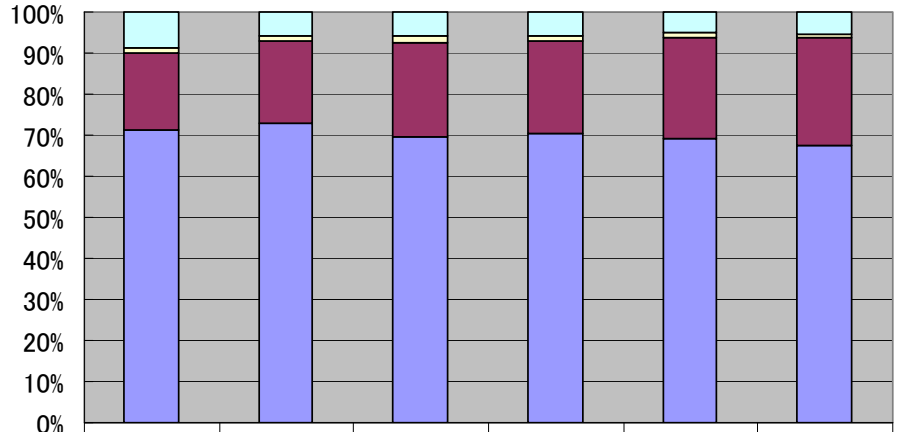
Currently State of Maharashtra is promoting IT industries and established the areas for development of software in Pune, Mumbai, Aurangabad, Nagpur and Nashik. Up to now over 1,200 software companies were established in Maharashtra and contribute annual exports of $ 5.39 billion (30% of software export in India).

The share of Agriculture & allied activities in GSDP is only 8.5%. However the acreages for Jowar (average for years 2006-07 to 2008-09) accounts for 54% of that in All India, and the acreages for cotton also account for 33.8% of that in All India.

(4) Education and Health

Enrollment rate in Maharashtra in 2011 is about 98%, that rate is more than the enrollment rate of all India. Central government is running the policy for school enrollment rate to 100%. Both all India and Maharashtra, the percentage of 'out of school' children has been decreasing gradually.

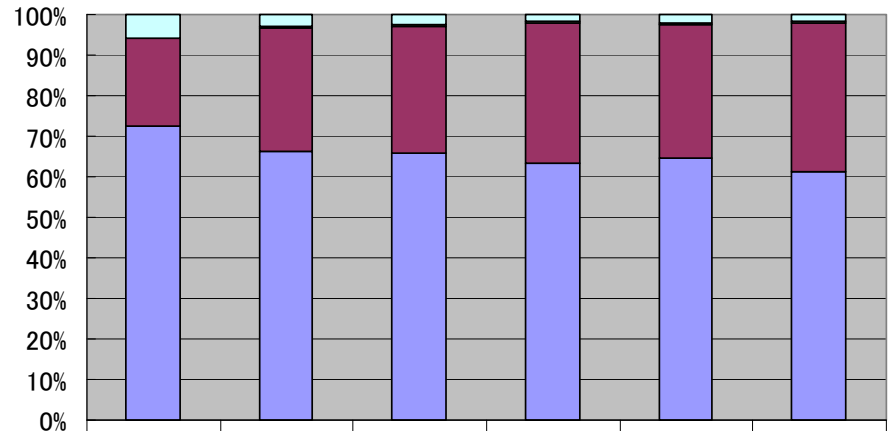
Enrollment rate in rural areas of Maharashtra (age 6 to 14) reached 98.9%.



	2006	2007	2008	2009	2010	2011
Out of School	8.8%	5.7%	6.0%	5.9%	5.1%	5.3%
Other	1.3%	1.2%	1.3%	1.2%	1.0%	1.1%
Private	18.8%	20.2%	23.0%	22.5%	24.6%	26.1%
Governmnet	71.1%	72.9%	69.7%	70.4%	69.2%	67.5%

(Source: JICA Study Team, based on Assessment Survey Evaluation Research Centre)

Figure 2.4.1-3 Enrollment Levels in School - All India



	2006	2007	2008	2009	2010	2011
Out of School	5.7%	3.0%	2.6%	1.6%	2.1%	1.8%
Other	0.3%	0.5%	0.4%	0.3%	0.3%	0.5%
Private	21.5%	30.4%	31.0%	34.7%	33.2%	36.5%
Governmnet	72.6%	66.1%	66.0%	63.4%	64.4%	61.3%

(Source: JICA Study Team, based on Assessment Survey Evaluation Research Centre)

Figure 2.4.1-4 Enrollment Levels in School – Maharashtra

The improvement of sanitary conditions and increase of hospitals contribute to decrease the death rate and infant mortality rate year by year.

However, due to the number of medical institutions have not kept pace with population growth, the number of beds per lakh of population has decreased

Table 2.4.1-3 Trends in Selected Indicators on Health in Maharashtra

	1960	1971	1981	1991	2001	2010
No. of Hospitals	–	299	530	768	1,102	1,264
Beds per lakh of population	–	88	114	144	106	102
Birth Rate	34.7	32.2	28.5	26.2	20.7	17.1
Death Rate	13.8	12.3	9.6	8.2	7.5	6.5
Infant Mortality Rate	86	105	79	60	45	28

(Source: Study Team, based on Economic Survey of Maharashtra 2011-12)

Death rate and infant mortality rate in All India are 7.2 and 47 respectively. The rates in Maharashtra are lower than those in All India.

(5) Electricity

Indicators on electricity in Maharashtra, neighboring states and All India are shown in Table 2.4.1-4.

Per capita consumption of electricity in Maharashtra is 1.47 times of All India. On the other hand, per capita generation of electricity in All India is larger than that in Maharashtra.

In other words, it indicates that Maharashtra can not supply to all the demand in its area.

Thus, for Maharashtra, the power allotment from the central government is essential.

Table 2.4.1-4 Indicators on Electricity in Maharashtra, Neighboring States and All India

	Installed Capacity of Electricity per lakh Population (MW)	Per capita Generation of Electricity (kWh)	Annual Per capita Consumption of Electricity (kWh)	Percentage of Rural Electrification
Andhra Pradesh	14.40	618.74	713.42	100.00%
Goa	5.35	235.79	1572.56	100.00%
Gujarat	21.71	962.46	859.57	99.72%
Karnataka	16.57	638.51	618.25	99.92%
Madhya Pradesh	6.58	268.49	316.29	96.37%
Chhatisgarh	15.78	1030.17	475.27	95.61%
Maharashtra	15.30	658.95	716.29	88.32%
All India	14.35	683.45	486.72	83.90%

(Source: JICA Study Team, based on Economic Survey of Maharashtra 2011-12)

Village Electrification (namely (i) Basic Infrastructure such as distribution transformer and distribution lines are provided, (ii) Electricity is provided to public places, and (iii) The number of households electrified should be at least 10 % of the total number of households in the village.) of Maharashtra is slightly higher than that of All India. However the village electrification rate has been delayed compared to the adjacent states of more than 95%.

(6) Transportation

1) Roads

The total road length maintained by Public Works Department at the end of March, 2011 was 241,712 km of which surfaced road length was about 221,000 km (91.5%).

The past 3 years, the total increase in length of village roads is about 2,800km while the total length of others is unchanged. Road length in Maharashtra is shown in Table 2.4.1-5.

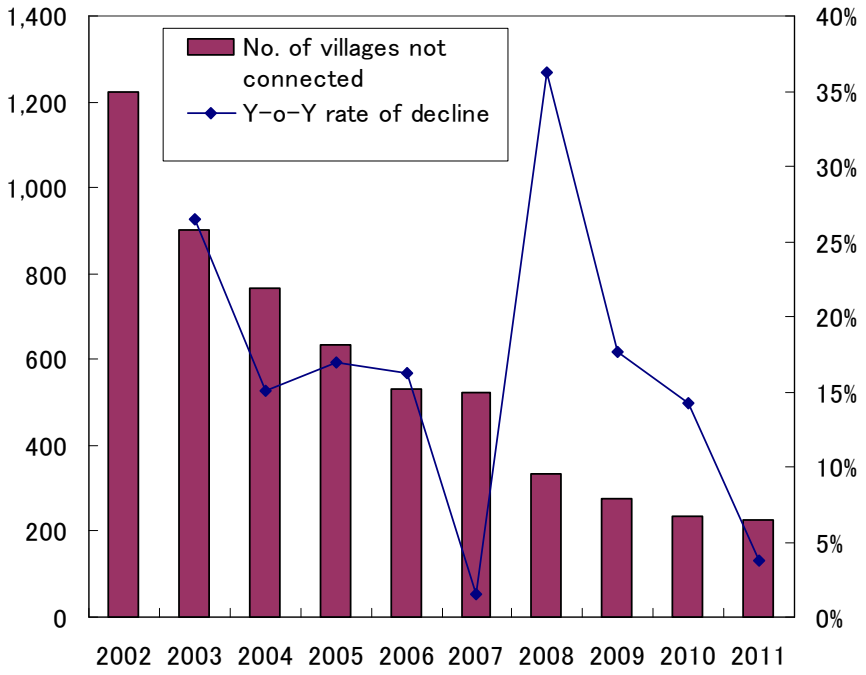
Table 2.4.1-5 Road length maintained by Public Works Department

(Km)

	31 Mar. 2009	31 Mar. 2010	31 Mar. 2011
National Highways	4,367	4,376	4,376
State Highways	33,933	34,102	34,103
Major District Roads	49,621	49,901	49,936
Other District Roads	46,143	46,817	46,897
Village Roads	103,604	104,844	106,400
Total	237,668	240,040	241,712

(Source: JICA Study Team, based on Economic Survey of Maharashtra 2011-12)

As on 31st March, 2011, about 97.8% villages were connected by all-weather roads and 1.6 % villages were connected by fair-weather roads. In all, 227 villages in the State did not have any road connectivity. Only 9 villages have been connected as compared to previous year.



(Source: JICA Study Team, based on Economic Survey of Maharashtra 2011-12)

Figure 2.4.1-5 Trends in No. of Villages not connected by any road in Maharashtra

2) Vehicles

The number of motorcycles and automobiles in Maharashtra, has increased around 10% in one year from January 2011.

Two Wheelers and Light Motor Vehicles (LMV) were increased by more than 1 million and 230 thousands respectively.

Meanwhile, compared to the rate of increase of the vehicle, the rate of increase of the total length of the road is very low. Therefore traffic congestions become serious problems anywhere.

The number of road fatalities each year (2006-2010)has remained at 11,000-12,000 people in Maharashtra. The average of number of deaths from traffic accidents in Japan, has slightly higher population, is about 5,000 in the past five years, in other words, road fatalities rate in Maharashtra is estimated to be more than twice of Japan's.

Table 2.4.1-6 Category wise No. of motor vehicles in Maharashtra

(In thousand)

	1 Jan. 2011	1 Jan. 2012	% of Change
Two Wheelers	12,060	13,477	11.6%
Auto Rickshaws	644	655	1.7%
LMV (Light Motor Vehicles)	2,565	2,795	8.9%
Buses	82	87	6.1%
Goods Vehicles	955	1,048	9.7%
Tractors	358	414	15.6%
Trailers	285	308	8.0%
Ambulances	10	10	0.0%
Others	30	33	10.0%
Total	16,989	18,827	10.8%

(Source: JICA Study Team, based on Economic Survey of Maharashtra 2011-12)

Development and improvement of public transportation is expected to bring an effect of suppressing the occurrence of traffic congestions and accidents in urban cities. However, Maharashtra State Road Transport Corporation (MSRTC) and city passenger transport system as the main public transportation in these cities, have recorded severe deficit. Therefore, due to the tight fiscal situation, the further development of public bus system would not be expected.

2.5 Macro economy of Maharashtra

2.5.1 Overview of Economic Condition in Maharashtra

(1) Gross State Domestic Product (GSDP), as per the advance estimates, is expected to grow at 8.5% during the year 2011-12 as against 11.3% during the previous year. The Agriculture sector is expected to show negative growth of 9.1%, restraining the growth of 'Agriculture & allied activities' sector at (-) 5.1%. Industry sector is expected to grow by 9.1%. Services sector is expected to grow by 10.1% during the year.

(2) Consumer Price Index (CPI) in the State for the period April 2011 to January 2012 for rural and urban areas increased by 9.4% and 7.9% respectively over the corresponding period of the previous year. Wholesale Price Index (WPI) in March 2012 increased by 7.7% over the corresponding the month of the previous year.

(3) Revenue receipts of the State Government are expected to be Rs. 121,504 crore during 2011-12 (BE), as against Rs. 107,159 crore during 2010-11 (RE) and increased by 13.4%.

(4) Revenue expenditure of the State Government is expected to be Rs. 121,446 crore during

2011-12 (BE) as against Rs. 112,847 crore during 2010-11 (RE) and increased by 7.6%.

(5) Revenue surplus of Rs. 58 crore and fiscal deficit of Rs. 22,805 crore (1.8% of GSDP) is projected during 2011-12. Debt stock at the end of 2011-12 is expected to reach at Rs. 226,926 crore.

(6) Production of agriculture & allied activities in 2011-12 is decreased, especially production of food grain and cotton are decreased by 23% and 15% respectively. Production of marine and inland fish is also decreased by about 30%.

(7) During April 2000 to March 2012, the State received Rs. 246,135 crore of Foreign Direct Investment (FDI). This FDI to Maharashtra contributes 32.1% of all FDI to India.

2.5.2 Gross State Domestic Product (GSDP) of Maharashtra

(1) GSDP during 2011-2012

The estimate of GSDP is expected to increase by 8.5% during 2011-12 as against 11.3% during 2010-11. Decline in area under crops and uneven monsoon is likely to reduce foodgrain production, thereby affecting agriculture growth. Overall growth in Agriculture & allied activities sector is estimated at (-) 5.1%. Robust construction sector in the State with 22% growth over previous year is contributing to 9.1% growth in Industry sector. Meanwhile manufacturing sector, losing its momentum due to the price hike and effect of global situation, may be able to maintain its growth at 4.2%. The ever flourishing Services sector will continue its momentum with growth of 10.1% in 2011-12.

The advance estimates of the GSDP at constant (2004-05) prices is expected at Rs. 805,031 crore, registering a growth of 8.5% over the previous year.

(2) GDP during 2011-2012

According to advance estimates released by Central Statistical Office (CSO), the Gross Domestic Product (GDP) at constant (2004-05) prices is Rs. 5,222,027 crore and expected to grow with moderate rate of 6.9% during 2011-12. Growth rate of GSDP of Maharashtra is 8.5% and higher than GDP of All India. Trend in sectoral growth rate at constant prices is shown in Table 2.5.2-1.

Table 2.5.2-1 Trend in Sectoral Growth Rates at Constant (2004-2005) Prices

(Per cent)

Sector	GSDP			GDP $		
	2009-10 *	2010-11 +	2011-12++	2009-10 *	2010-11 +	2011-12++
Agriculture & allied activities	**0.8**	**15.6**	**(-) 5.1**	**1.0**	**7.0**	**2.5**
i) Agriculture	3.9	18.8	(-) 9.1	0.7	7.8	--
ii) Forestry	(-) 10.6	3.1	14.3	2.8	2.9	--
iii) Fisheries	(-) 1.5	2.6	2.6	3.0	3.0	--
Industry	**10.0**	**10.8**	**9.1**	**8.4**	**7.2**	**3.9**
i) Mining & Quarrying	7.1	1.3	(-) 2.9	6.3	5.0	(-) 2.2
ii) Manufacturing	7.2	8.3	4.2	9.7	7.6	3.9
iii) Electricity, Gas & Water Supply	10.9	10.0	11.0	6.3	3.0	8.3
iv) Construction	18.8	18.8	22.3	7.0	8.0	4.8
Services	**10.0**	**11.0**	**10.1**	**10.5**	**9.4**	**9.4**
i) Trade, Hotels & Restaurants, Transport, Storage & Communications	19.8	12.8	8.7	10.3	11.1	11.2
ii) Finance, Insurance, Real Estate & Business Services	3.9	10.3	11.9	9.4	10.4	9.1
iii) Community & personal services	5.0	8.6	9.1	12.1	4.5	5.9
GSDP/GDP	**9.2**	**11.3**	**8.5**	**8.4**	**8.4**	**6.9**

* Provisional + Preliminary ++ Advance estimates $ source : CSO, GoI

(Source: Economic Survey of Maharashtra 2011-12)

Table 2.5.2-2 Trend in GSDP by Industry at Current Prices

(Crore Rs.)

	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Agriculture & Allied Activities	44,927	52,764	67,229	80,684	75,833	91,797	136,540
Industry	123,022	154,683	186,927	221,556	236,089	267,614	323,311
Tertiary Sector/Serveices	247,531	279,318	330,342	382,576	442,047	508,455	608,475
Grand Total	415,480	486,766	584,498	684,817	753,969	867,866	1,068,327
Per capita GSDP (Rs.)	40,509	46,732	55,277	63,810	69,230	78,551	95,351

(Source: JICA Study Team, based on Economic Survey of Maharashtra 2011-12)

Table 2.5.2-3 Trend in GSDP by Industry at Constant (2004-2005) Prices

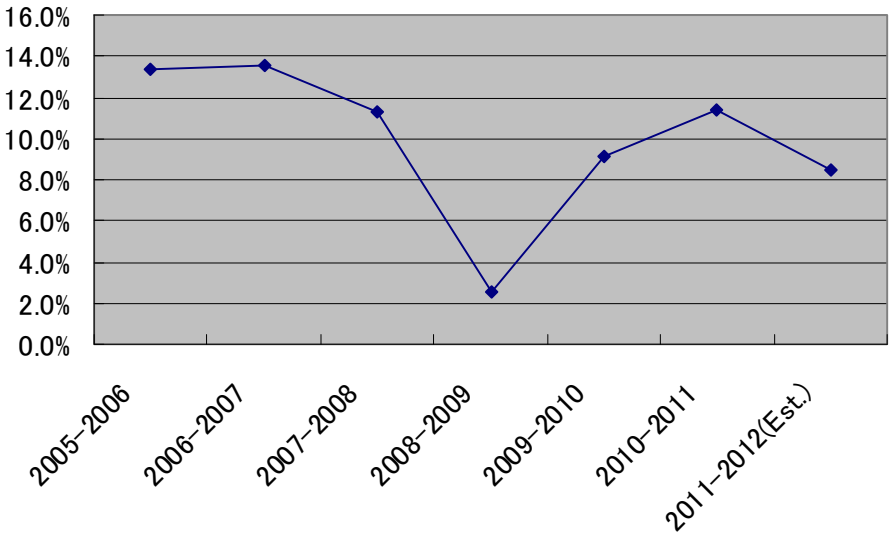
(Crore Rs.)

	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009	2009–2010	2010–2011
Agriculture & Allied Activities	44,927	49,062	55,945	63,641	53,808	54,250	62,709
Industry	123,022	146,308	169,451	189,332	187,322	205,980	228,290
Tertiary Sector/Serveices	247,531	275,559	309,258	341,857	369,062	405,894	450,695
Grand Total	415,480	470,929	534,654	594,831	610,191	666,123	741,694
Per capita GSDP (Rs.)	40,509	45,212	50,563	55,425	56,028	60,291	66,198

(Source: JICA Study Team, based on Economic Survey of Maharashtra 2011-12)

(3) The Growth Trend and Share of GSDP

GSDP recorded more than 10% growth in 2005-06 to 2007-08. Growth rate declined to 2.6% during 2008-09 due to global crisis. Good harvest and recovery from global crisis helped growth rate to reach at 9.2% in 2009-10 and at 11.3% in 2010-2011. Growth rate of GSDP in 2011-2012 is expected at 8.5%.



(Source: JICA Study Team, based on Economic Survey of Maharashtra 2011-12)

Figure 2.5.2-1 Trends in Growth Rate of GSDP at Constant Prices

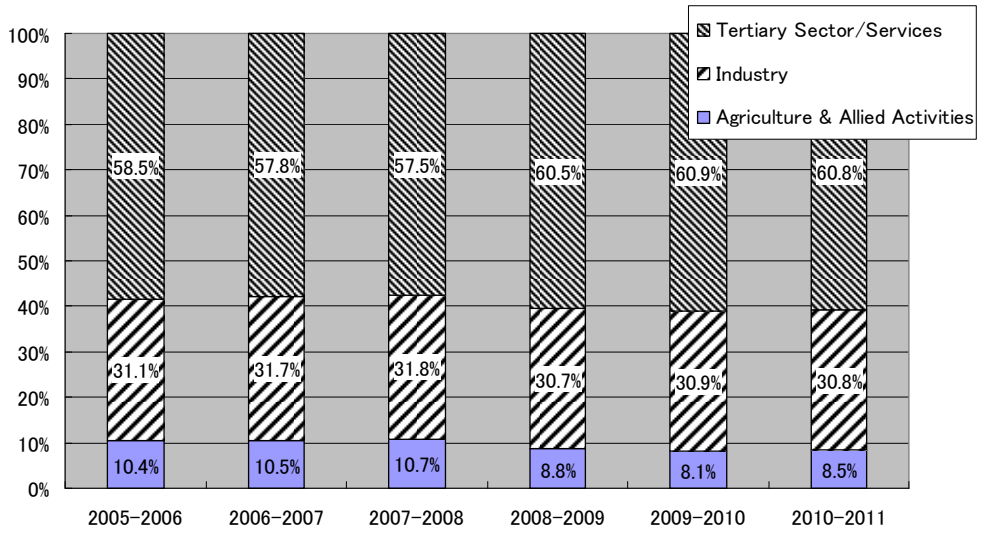
The GSDP of the State (preliminary estimates) during 2010-11 at current prices is estimated at Rs. 1,068,327 crore, which is 23.1% higher than that of 2009-10. The GDP for 2010-11 at current prices is estimated at Rs. 7,157,412. The State share in GDP 2010-11 at current prices is 14.9%.

The Per Capita GSDP at current prices for the year 2010-11 is estimated at Rs. 95,351 as

against that of Rs. 78,551 in 2009-10. The Per capita GDP at current prices for the year 2010-11 is Rs. 60,349 and about 1.6 times higher than that of All India.

(4) Sectoral Composition of GSDP

Sectoral composition of GSDP at constant prices is shown in Figure 2.5.2-2. The share of agriculture & allied activities sector is decreasing slowly and the share of industry sector is flat while the share of services sector is increasing and more than 60% since 2008-2009.



(Source: JICA Study Team, base d on Economic Survey of Maharashtra 2011-12)

Figure 2.5.2-2 Trends in Sectoral Composition of GSDP at Constant Prices

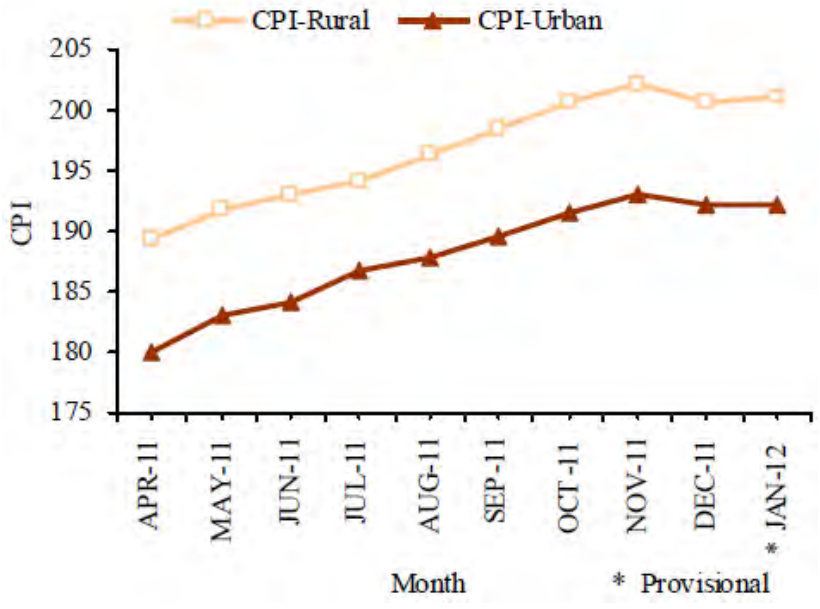
2.5.3 Economic Condition and Public Finance of Maharashtra

(1) Price

1) Consumer Price Index (CPI) in Maharashtra

CPI for rural areas in the State for April, 2011 was 189.4, which increased continuously and reached 202.1 in November, 2011.

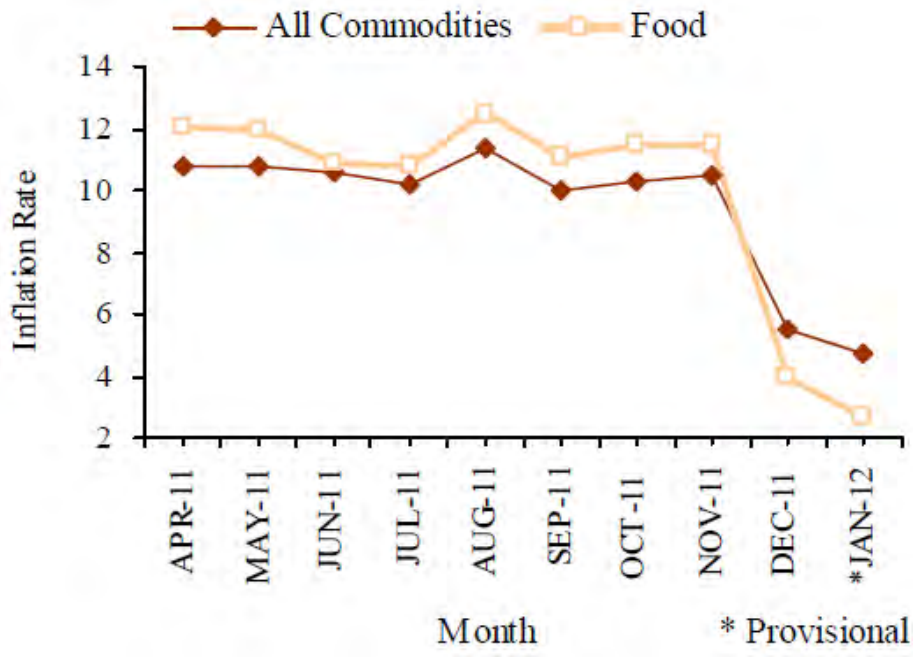
Similarly, CPI for urban areas for April, 2011 was 180.0, which continuously increased and reached to 193.1 in November, 2011. However, in December, 2011, CPI for both rural and urban areas decreased to 200.8 and 192.2 respectively. In January, 2012 CPI for urban areas showed the same trend while CPI for rural areas increased slightly. The average CPI in the State for the period April, 2011 to January, 2012 for rural and urban areas increased by 9.4% and 7.9% respectively over the corresponding period of the previous year.



(Source: Economic Survey of Maharashtra 2011-12)

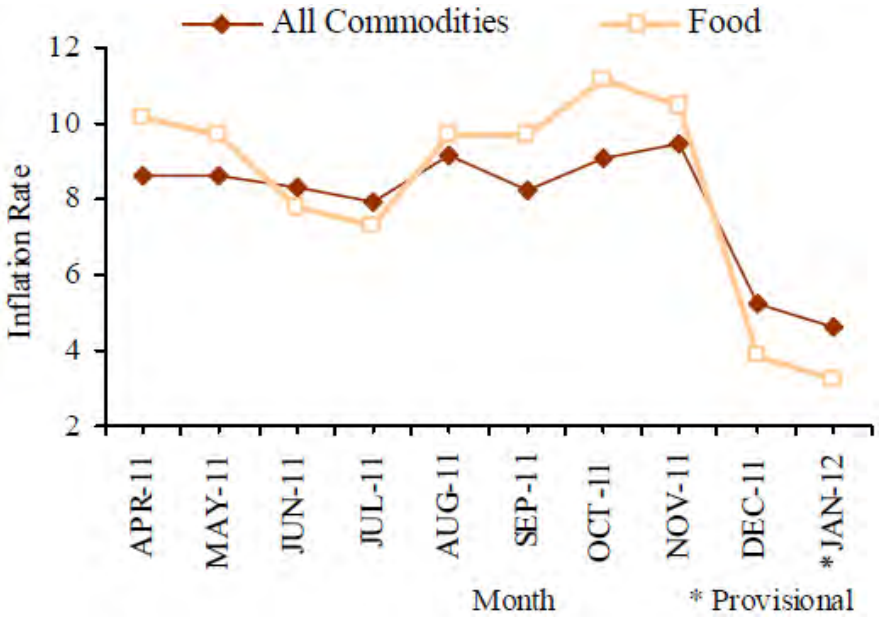
Figure 2.5.3-1 Trends in CPI in Rural and Urban Areas

The year-on-year rate of inflation based on CPI for rural area decreased from 10.5% in January, 2011 to 4.7% in January, 2012 whereas, for urban area it decreased from 10.2% to 4.6% for the same period. Inflation for all commodities and food group are shown in Figure 2.5.3-2 and 2.5.3-3 respectively. The decrease in 'food' inflation is mainly due to 'vegetables and fruits'



(Source: Economic Survey of Maharashtra 2011-12)

Figure 2.5.3-2 Trends in Inflation Based on CPI-Rural

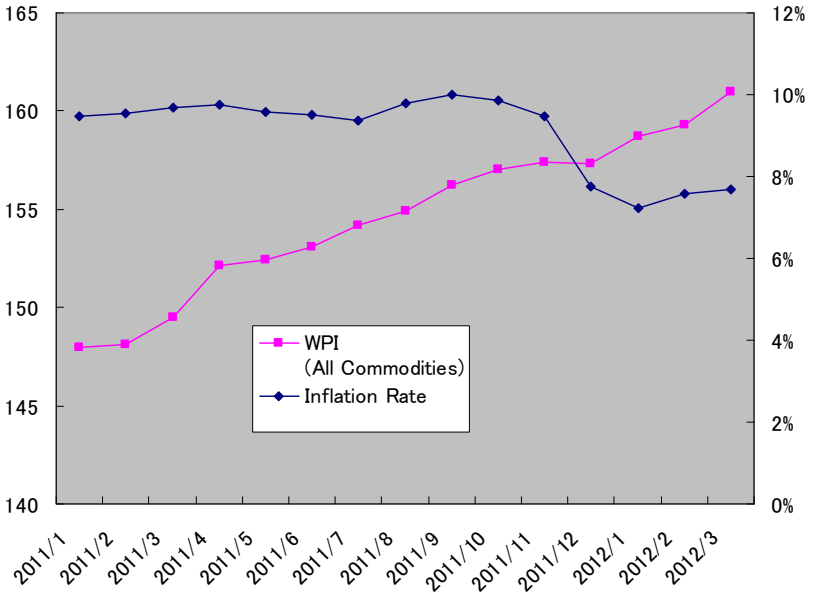


(Source: Economic Survey of Maharashtra 2011-12)

Figure 2.5.3-3 Trends in Inflation Based on CPI-Urban

2) Inflation Rate in All India

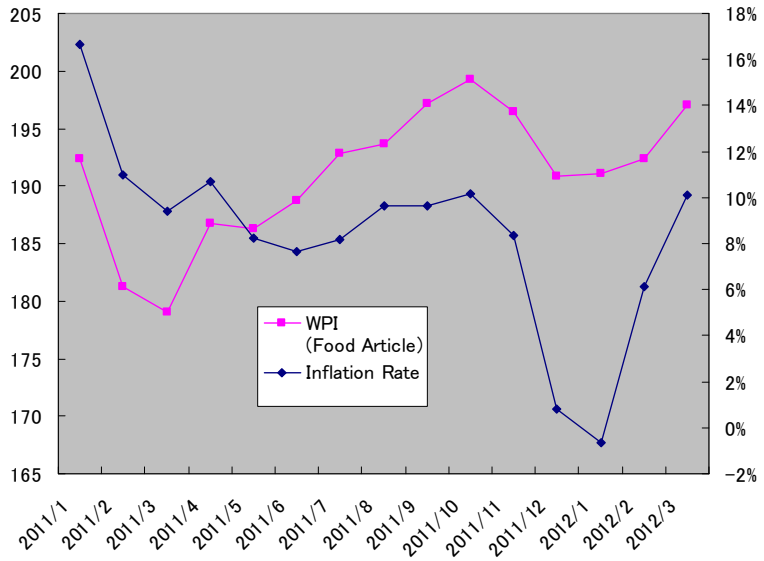
Inflation Rate is released and estimated by Wholesale Price Index (WPI). As shown in Figure 2.5.3-4, Inflation rate was remained at high level of around 10% until November 2011. However it is decreasing by 7.23% in January 2012 and 7.56% in February 2012, both being below 8%.



(Source: JICA Study Team, Based on Materials of Office of Economic Adviser, Ministry of Commerce and Industry)

Figure 2.5.3-4 Trends in Inflation Based on WPI (All Commodities) and Inflation Rate

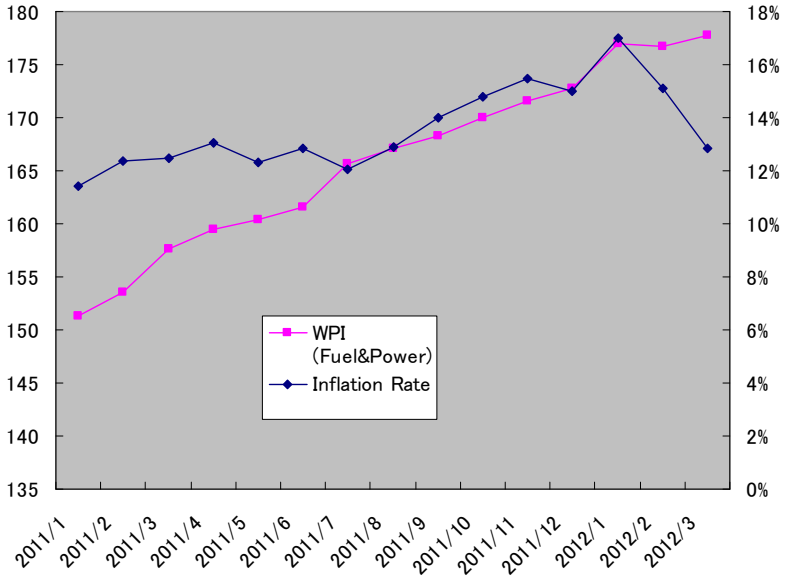
Main factor in decreasing of inflation rate is the falling prices of food article. As shown in Figure 2.5.3-5, in January 2012 the rate of increase has been negative. However, price of food articles will depend on the international grain market and the impact of monsoon compared to the WPI for all products, it can be seen that severe fluctuations. In addition, in February 2012 has started to rise again, there is a possibility of temporary inflation subsided.



(Source: JICA Study Team, Based on Materials of Office of Economic Adviser, Ministry of Commerce and Industry)

Figure 2.5.3-5 Trends in Inflation Based on WPI (Food Article) and Inflation Rate

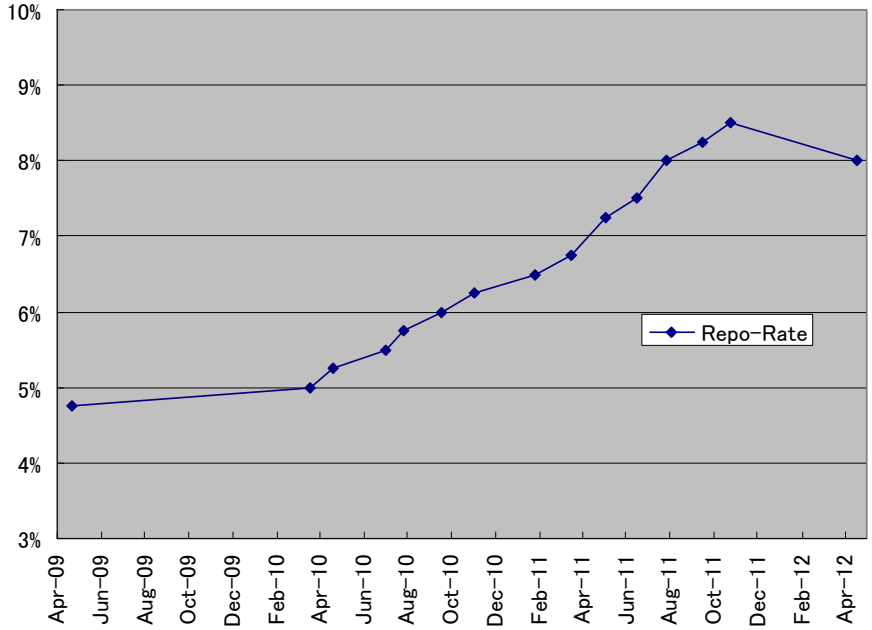
Increasing rate of WPI (Fuel and Power), which depends on international commodity market, is also temporary settled. However it is not less than 10% and one of the factors in high inflation rate.



(Source: JICA Study Team, Based on Materials of Office of Economic Adviser, Ministry of Commerce and Industry)

Figure 2.5.3-6 Trends in Inflation Based on WPI (Fuel & Power) and Inflation Rate

Reserve Bank of India is consistently raising the repo-rate (policy interest rate) and conducting monetary tightening for the suppression of increasing inflation rate. It is seemed that monetary tightening is effective to calm inflation rate. If inflation rate is increased again, it will be also considered raising the repo-rate further. However the business community is also concerned that economic growth is declined due to high repo-rate, Reserve Bank of India cut the repo-rate by 0.5 points on April 17, 2012 The rate of 8% has been maintained since then.



(Source: JICA Study Team, Based on Materials of Reserve Bank of India)

Figure 2.5.3-7 Trends in Repo-Rate

(2) Condition of Public Finance in State of Maharashtra

1) Budget in 2011-2012

State Government developed the budget in 2011-2012 for the surplus of revenue balance and formulated the revenue expenditure within the limit of revenue receipts. The budget of 2011-12 was presented with surplus revenue, after a gap of two years. The main component of revenue i.e. the tax revenue is expected to increase by 14.7% over that of 2010-11(RE) and by 44.6% over that of 2009-10. The budget estimates of 2011-12 indicate that the total expenditure of the government is expected to increase by about 11.2% over the previous year to Rs. 154,125 crore. The fiscal deficit for 2011-12 is expected to Rs. 22,805 crore, as low as 1.8 per cent of GSDP.

Table 2.5.3-1 Trend in Budget of State of Maharashtra

(Crore Rs.)

	2005-2006 (Actual)	2006-2007 (Actual)	2007-2008 (Actual)	2008-2009 (Actual)	2009-2010 (Actual)	2010-2011 (R.E.)	2011-2012 (B.E.)
Revenue Receipts	48,438	62,195	79,583	81,271	86,910	107,159	121,504
(Tax Revenue)	38,522	46,122	55,126	60,049	67,354	84,915	97,404
(Non-Tax Revenue)	9,916	16,073	24,457	21,222	19,556	22,244	24,100
Revenue Expenditure	52,280	61,385	64,780	75,694	94,916	112,847	121,446
(Interest Rayments)	10,523	11,983	12,932	13,027	14,838	16,102	12,561
(Administrative Servicers)	4,207	4,824	5,504	6,560	8,173	10,793	12,561
(Pensions & Misc.)	4,104	4,364	4,215	5,199	6,229	9,177	10,007
Revenue Balance	▲ 3,842	810	14,803	5,577	▲ 8,006	▲ 5,688	58
Capital Receipts	24,176	16,298	1,718	19,065	30,383	31,560	32,676
(Recovery of Loans)	551	51	733	560	515	578	475
(Borrowings & Other Liabilities)	17,883	11,540	▲ 3,717	14,363	26,018	25,208	22,860
Capital Expenditure	20,082	17,121	17,414	24,278	22,865	25,706	32,679
Total Receipt	72,614	78,493	81,301	100,336	117,293	138,719	154,180
Total Expenditure	72,362	78,506	82,194	99,972	117,781	138,553	154,125
Fiscal Balance	▲ 17,631	▲ 11,553	2,824	▲ 13,999	▲ 26,156	▲ 25,042	▲ 22,805
Fiscal Dificit as % of GSDP	3.6%	2.0%	−0.4%	1.9%	3.0%	2.3%	1.8%

(Source: JICA Study Team, based on Materials of Finance Department, Government of Maharashtra)

2) Revenue Receipt in 2011-2012

The expected revenue receipts during 2011-12 are Rs. 121,504 crore, 13.4% higher than that of the previous year. The revenue receipts in 2010-11 were expected to increase by 10.4% over the budgeted figure. Rigorous efforts for tax collection and higher rate of devolution by Thirteenth Finance Commission have resulted in increase in revenue during 2010-11 and 2011-12. Therefore it is an achievable revenue receipt.

Own Tax Revenue (OTR) and share in central taxes contribute to increase the tax revenue in 2011-12 by 14.7 % over the previous year. OTR is expected amount of Rs. 83,686 crore, reaches 85.9% in total receipts and 68.9% in revenue receipt.

The share of Value Added Tax (VAT) reaches to 55% and its increasing rate is higher than other tax items.

Table 2.5.3-2 Trend and Composition of State's Own Tax Revenue (OTR)

(Crore Rs.)

	2006-2007 (Actual)	2007-2008 (Actual)	2008-2009 (Actual)	2009-2010 (Actual)	2010-2011 (R.E.)	2011-2012 (B.E.)
Sales Tax	24,131	26,753	30,680	32,676	40,815	46,000
Stamps and Registration Fees	6,416	8,550	8,288	10,774	14,140	15,677
State Excise Duties	3,301	3,963	4,434	5,057	5,800	8,500
Taxes and Duties on Electricity	1,577	2,688	2,395	3,289	4,686	4,400
Other Taxes on Income & Expenditure	1,246	1,488	1,561	1,612	1,608	1,700
Taxes on Vehicles	1,841	2,143	2,220	2,682	3,471	4,000
Other Taxes & Duties on Commodities & Services	878	1,043	1,015	1,325	1,041	1,099
Tax on Goods and Passengers	224	388	892	977	739	813
Land Revenue	484	512	546	714	1,196	1,497
Total OTR	40,098	47,528	52,031	59,106	73,496	83,686

(Source: JICA Study Team, based on Materials of Finance Department, Government of Maharashtra)

The State receives share from central taxes as per the recommendations of Finance Commission. As per the recommendations of Thirteenth Finance Commission, the State's share in devoluble amount (excluding service tax) from central taxes has increased from 4.997% to 5.199%, the share of service tax has also increased from 5.063% to 5.281%. The State is expected to receive Rs. 13,718 crore as share in central taxes during 2011-12.

Central Grants for specific purposes is Rs. 14.369 crore, 59.6% of total non tax revenue. These grants include grants-in-aid for UID, Improving Delivery of Justice, District Innovation Fund, Improving District & State Statistical System and Employees & Pension Data base.

3) Revenue Expenditure in 2011-2012

As shown in Table 2.5.3-1, from 2006-07 to 2008-09, revenue expenditure was confined to revenue receipts for three consecutive years, resulting in revenue surplus. Thereafter, up to 2010-11(RE), there was revenue deficit. After 2009-2010, revenue deficit was continued due to aggressive fiscal stimulus. To comply with the recommendations of Thirteenth Finance Commission from 2011-12, revenue expenditure must be confined to revenue receipts again.

Table 2.5.3-3 Trend and Composition of State's Revenue Expenditure

(Crore Rs.)

	2005-2006 (Actual)	2006-2007 (Actual)	2007-2008 (Actual)	2008-2009 (Actual)	2009-2010 (Actual)	2010-2011 (R.E.)	2011-2012 (B.E.)
Development Expenditure	30,583	36,279	40,934	49,109	62,845	73,707	77,488
(Social Services)	19,917	23,559	26,773	31,052	41,005	52,281	56,552
(Economic Services)	9,315	11,703	13,237	16,813	20,372	20,495	20,083
(Grants-in Aid & Contributions to Local Bodies etc.)	1,351	1,017	924	1,244	1,468	931	853
Non-Development Expenditure	21,697	25,106	23,846	26,585	32,071	39,140	43,958
(General Services)	11,941	12,925	11,081	13,686	17,129	22,674	25,410
(Interest Payments & Debt Services)	9,756	12,181	12,765	12,899	14,942	16,466	18,548
Total Revenue Expenditure	52,280	61,385	64,780	75,694	94,916	112,847	121,446

(Source: JICA Study Team, based on Materials of Finance Department, Government of Maharashtra)

The largest portion of revenue expenditure is social services which include education, health and employment, its share of revenue expenditure is 46.6%. Its share in 2005-2006 was 38.1% and increasing year by year.

Interest payment is steadily increasing due to increase in debt stock, however its share is decreasing by 15.3% compared to 18.7% in 2005-2006.

4) Subsidies

Certain goods and services are subsidised to make it affordable to the civil society and / or for economic development. The provision for subsidies in 2010-11(RE) was Rs. 7,949 crore, same is estimated at Rs. 7,100 crore during 2011-12.

The major subsidies are (1) Rs. 3,000 crore for compensation to Maharashtra State Electricity Distribution Company Ltd. for subsidised tariffs to agricultural / powerloom users, (2) Rs. 400 crore to industrial units including mega industrial projects, (3) Rs. 505 crore to Maharashtra State Road Transport Corporation for reimbursement of losses of the Corporation for providing concessional fares to certain categories of passengers such as senior citizens, students, freedom fighters etc. and (4) Rs. 281 crore for foodgrain transactions and related schemes such as Antyodaya Anna Yojana.

5) Raised and Realized Tax

One of the mandatory statements to be submitted to legislature as a part of FRBM Act is a statement of tax raised and realized. Accordingly, tax amount of Rs. 27,320 crore has been

raised but not realized till end of 2009-10. Out of undisputed amount of Rs. 9,247 crore, Rs. 4,110 crore is not realized for more than 4 years.

Sales Tax / VAT (including taxes on motor spirits and lubricant) and Central Sales tax, have largest share of 76.0 % in non-realised taxes.

6) Fiscal Balance

The State government has enacted the Fiscal Responsibility and Budgetary Management (FRBM) act in 2005 to discipline the government expenditure and refrain from frequent borrowings. This required the Government to eliminate the revenue deficit by 2008-09 and reduce fiscal deficit to 3 per cent of GSDP. Since 2006-2007, the percentage of revenue deficit to GSDP was at the lowest (-) 2.2% and the percentage of fiscal deficit to GSDP was at the lowest (-) 0.4% in 2007-08. Though the State enjoyed revenue surplus during 2008-09, due to increased salary burden, revenue deficit and fiscal deficit during 2009-10 were 0.9% and 3.0% of GSDP respectively. During 2010-11, with the efforts to increase the tax recovery and plugging the loopholes in the revenue collection, revenue was expected to increase, thereby decreasing the revenue deficit and consequently the percentage of revenue deficit to GSDP to 0.0% and the percentage of fiscal deficit to 1.8%. In 2011-12, the percentage of fiscal deficit to GSDP is again expected to increase to 1.8 per cent which is within the limit of 2.4 per cent, stipulated by Thirteenth Finance Commission.

Thirteenth Finance Commission has laid down the consolidated fiscal reform path for states, for the period 2009-10 to 2014-15 and the same is given in Table 2.5.3-4.

Accordingly, fiscal deficit for the states should be contained to 2.4%, whereas debt stock of the states should be contained to 24.3% of GDP by 2014-15.

Table 2.5.3-4 Fiscal Reform Path for States in India

（% of GDP）

	Fiscal Deficit	Debt Stock
2009-2010	2.8	27.1
2010-2011	2.6	26.6
2011-2012	2.5	26.1
2012-2013	2.5	25.5
2013-2014	2.4	24.8
2014-2015	2.4	24.3

(Source: Thirteenth Finance Commission, Government of India)

Table 2.5.3-5 Trends in Revenue and Fiscal Balances of State of Maharashtra

(Crore Rs.)

	2006-2007 (Actual)	2007-2008 (Actual)	2008-2009 (Actual)	2009-2010 (Actual)	2010-2011 (R.E.)	2011-2012 (B.E.)
GSDP	584,498	684,817	753,969	867,866	1,068,327	1,264,732
Revenue Receipts	62,195	79,583	81,271	86,910	107,159	121,504
Renenue Expenditur	61,385	64,780	75,694	94,916	112,847	121,446
Revenue Balance	810	14,803	5,577	▲ 8,006	▲ 5,688	58
Fiscal Balance	▲ 11,553	2,824	▲ 13,999	▲ 26,156	▲ 25,042	▲ 22,805
Revenue Balance as % of GSDP	0.1%	2.2%	0.7%	-0.9%	-0.5%	0.0%
Fiscal Balance as % of GSDP	-2.0%	0.4%	-1.9%	-3.0%	-2.3%	-1.8%

※ Negative (-) % means dificit.

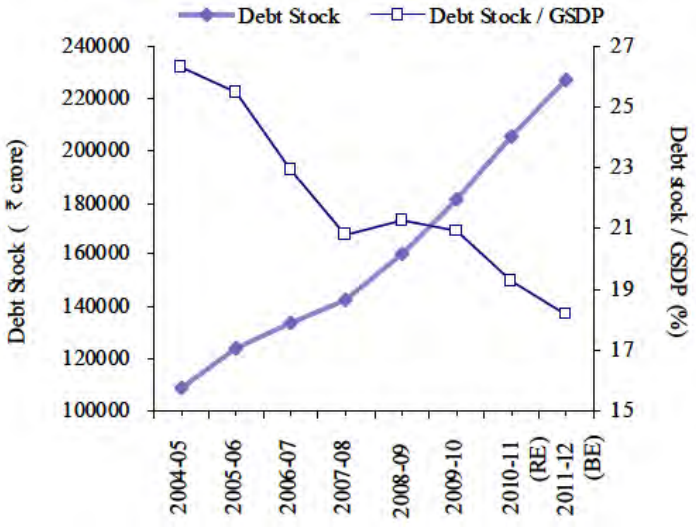
※GSDP in 2011-2012 is estimated by study team based on growth rate and inflation rate.

(Source: JICA Study Team, based on Materials of Finance Department, Government of Maharashtra)

7) Debt Stock

The debt stock of the State is increasing over the year due to increase in internal debt required to finance the development activities and increasing obligatory loan repayment. The debt stock which was Rs. 109,167 crore in 2004-05 is increased to Rs. 226,926 crore by the end of 2011-12. But during the same period, the debt stock to GSDP ratio is likely to decrease from 26.3% to 18.2 %.

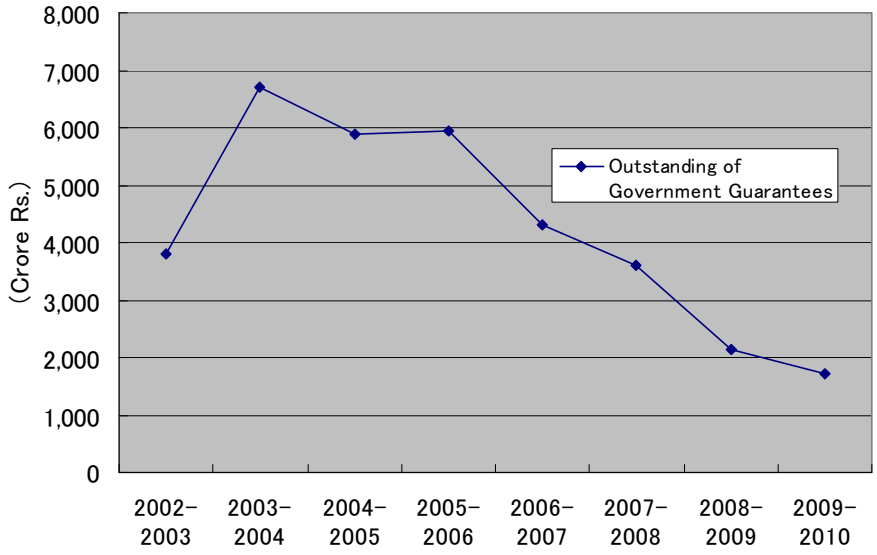
As shown in Table 2.5.3-4, the target is that debt stock of the states should be contained to 24.3% of GDP by 2014-15. Maharashtra's debt stock to GSDP ratio is lower than the target ratio.



(Source: Economic Survey of Maharashtra 2011-12)

Figure 2.5.3-8 Trends in Debt Stock of State of Maharashtra

The outstanding guarantees given by the State Government at the end of 2009-10 amounted to Rs. 1,732 crore. The major guarantees given by the Government were to the Public Works Department (Rs. 363 crore). The outstanding Government guarantee is declining since 2003-2004, and even if the outstanding Government guarantee (based on budget in 2011-2012) is added to the above debt stock at the end of 2009-2010, the sum is estimated to be 19.3%. This figure is still lower than the target ratio by The Thirteen Finance Commission.



(Source: JICA Study Team, based on Materials of Reserve Bank of India)

Figure 2.5.3-9 Trends in Outstanding of Government Guarantees of State of Maharashtra

2.5.4 Situation on Entry into Indian Market by Foreign and Japanese Companies

(1) Foreign Direct Investment (FDI)

1) FDI (All India)

FDI investment to All India (24.8% decrease as compared to FY 2009) was significantly reduced in fiscal 2010. On the other hand, investment from Japan (FY2011) remained steady, it increased by 2.51 times (compared with FY 2009) and 1.90 times (compared with FY 2010).

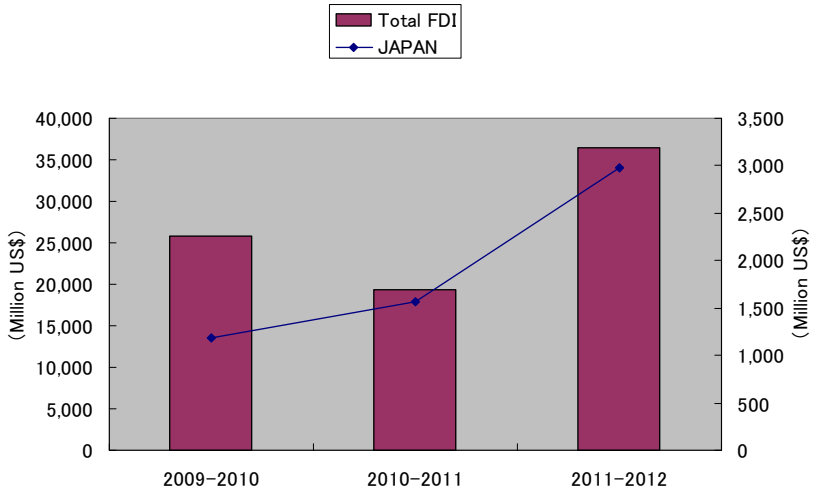
By industry, service sector (including financial) accounts for some 20%. The share of power sector is around 4% of the total.

Table 2.5.4-1 Share of Top Five Countries FDI Inflows in All India

(Million USD)

Countries	2009-2010	2010-2011	2011-2012	Cumulative Inflows(Apr. 2000-Mar.2012)	% to Total Inflows (USD)
Mauritius	10,376	6,987	9,942	64,169	37.7%
Singapore	2,379	1,705	5,257	17,153	10.1%
UK	3,094	755	9,257	15,896	9.3%
Japan	1,183	1,562	2,972	12,313	7.2%
USA	1,943	1,170	1,115	10,564	6.2%
Total FDI Inflows	25,834	19,427	36,504	170,407	

(Source: JICA Study Team, based on Materials of Department of Industrial Policy & Promotion)



(Source: JICA Study Team, based on Materials of Department of Industrial Policy & Promotion)

Figure 2.5.4-1 Trends in Total FDI and FDI from Japan to India

Table 2.5.4-2 FDI Equity Inflows to All India by Sectors (April 2000 - February 2012)

	Services Sector	Telecommunications	Construction Activities	Computer Software & Hardware	Housing & Real Estate
Cumulative Inflows (million USD)	32,351	12,552	11,433	11,205	11,113
% to Total Inflows (million USD)	19.0%	7.4%	6.7%	6.6%	6.5%

	Drugs & Pharmaceuticals	Power	Automobile Industry	Metallurgical Industries	Petroleum & Natural Gas
Cumulative Inflows (million USD)	9,195	7,299	6,758	6,041	3,339
% to Total Inflows (million USD)	5.4%	4.3%	4.0%	3.5%	2.0%

(Source: JICA Study Team, based on Materials of Department of Industrial Policy & Promotion)

Western companies are investing in India via Mauritius, Japanese companies are also investing via Singapore, Netherlands and Thailand. Therefore figures in Table 2.5.4-1 do not reflect the actual situations. The reason that western companies are investing via Mauritius, is the tax treaty signed between both countries. About 70% of people living in Mauritius is NRI (Non-Resident Indian) and NRI's companies are preferential treatment in taxation.

The biggest investment by Japanese companies was the acquisition of Ranbaxy Laboratories Limited.

2) Situation on FDI and Japanese companies to Maharashtra

Maharashtra has received FDI amounting to US$ 54.6 billion during April 2000 to March 2012. The share of its amount of investment is the largest and 32% in that for All India.

Delhi is the second largest in 19.2%. However, the project of "Region Not Indicated" accounted for 25.2% of the total investment (included by a major Japanese telecommunications company, entry into the telecommunications services industry).

Amounts of FDI of selected states are shown in Table 2.5.4-3. Total amount of investment of the top five states and "Region Not Indicated" reach more than 90% of the total.

Table 2.5.4-3 FDI Equity Inflows to Selected States by RBI's Regional Offices

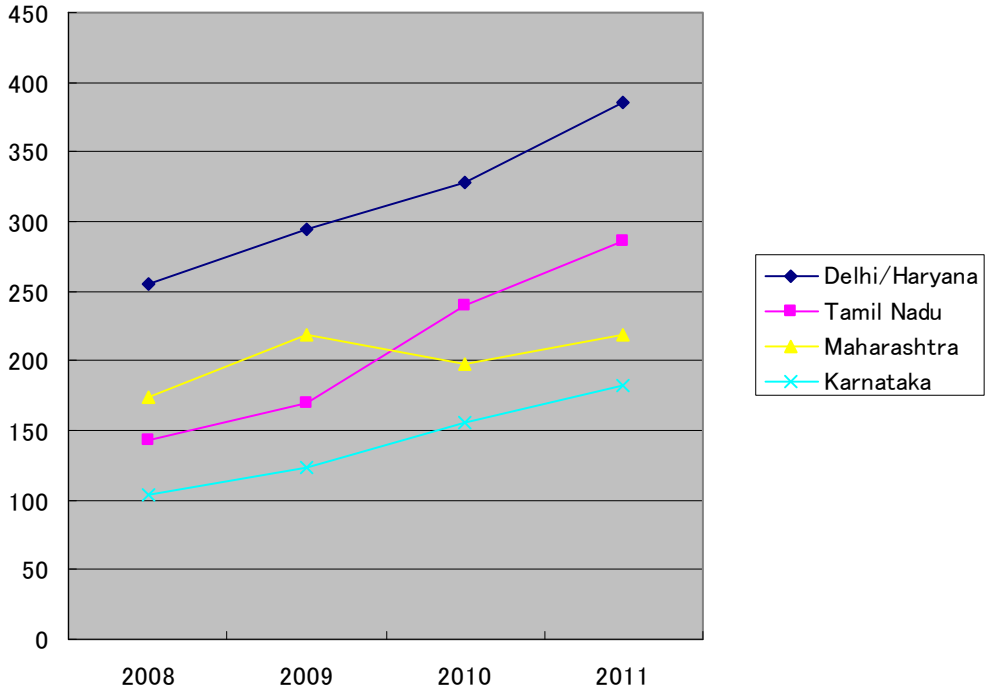
(Million USD)

RBI's Regional Office	State Covered	2009-2010	2010-2100	2011-2012	Cumulative Inflows (Apr. 2000-Mar. 2012)	% to Total Inflows (million USD)
Munbai	Maharashtra, etc.	8,249	6,097	9,553	54,620	32.1%
New Delhi	Delhi、Part of Uttar Pradesh and Haryana	9,665	2,677	7,983	33,071	19.4%
Bangalore	Karnataka	1,029	1,332	1,533	9,761	5.7%
Chennai	Tamil nadu, etc.	774	1,352	1,422	8,273	4.9%
Ahmedabad	Gujarat	807	724	1,001	8,157	4.8%
Hyderabad	Andhra Pradesh	1,203	1,262	848	6,809	4.0%
Kolkata	West Bengal, etc.	115	95	394	1,882	1.1%
Chandigarh	Chandigarh、Punjab, Haryana, Himachal Pradesh	224	416	130	1,154	0.7%
Bhopal	Madhya Pradesh, Chattisgarh	54	451	123	777	0.5%
Kochi	Kerala, etc.	128	37	471	839	0.5%
Region Not Indicated		3,148	4,491	12,782	42,918	25.2%

(Source: JICA Study Team, based on Materials of Department of Industrial Policy & Promotion)

In recent years, many Japanese companies established their headquarters, branches and factories in Tamil Nadu and Karnataka that actively attract foreign companies and is attracting attention from Japanese companies. On the other hand, since 2009, the number of Japanese companies expand into Maharashtra is almost flat.

The number of Japanese companies in district-wise of Maharashtra is shown in Table 2.5.4-4. More than 96% of companies are concentrated in Mumbai or Pune. In terms of sectors, Japanese companies in various sectors viz. industry, services and finance sectors, entered into Maharashtra.



(Source: JICA Study Team, based on Materials of Embassy of Japan)

Figure 2.5.4-2 Trends in no. of Japanese Companies in Selected States

Table 2.5.4-4 Number of Japanese Companies in Maharashtra (Dstrict-wise)

Munbai	Pune	Thane	Aurangabad	Nagpur	Raigad
154	56	4	2	1	1

Total	218

(Source: JICA Study Team, based on Materials of Embassy of Japan)

2.6 General Description of the Environment

2.6.1 Natural environment

(1) India's Ecosystem[3]

India, known for its rich heritage of biological diversity, has so far documented over 91,200 species of animals and 45,500 species of plants in its ten bio-geographic regions. India ranks among the top ten species-rich nations and shows high endemism. India has four global biodiversity hot spots (Eastern Himalaya, Indo-Burma, Western Ghats & Sri Lanka, and Sundaland). The varied edaphic, climatic and topographic conditions and years of geological stability have resulted in a wide range of ecosystems and habitats such as forests, grasslands, wetlands, deserts, and coastal and marine ecosystems.

[3] The text of this section is extracted and summarized from "India's Fourth National Report to the Convention on Biological Diversity (Ministry of Environment and Forests, 2009)"

The total forest and tree cover of the country constitutes 23.39 % of the geographical area with most north-eastern states maintaining more than 75% of the forest cover. Against the prevailing global trend of decreasing forest cover, India has been successful in stabilizing its area under forests over the years.

The mountain ecosystems of India are largely described under two global hot-spots, such as the Eastern Himalaya, and the Western Ghats & Sri Lanka. They contribute prominently in geographic extent, biophysical and socio-cultural diversity and uniqueness. At present, there are 137 Protected Areas (PAs) (47,208 km^2) in the Indian Himalayan Region and 88 PAs (13,695 km^2) in Western Ghats. Human interventions, including developmental activities and rampant poverty are leading to change in land use patterns, habitat loss and fragmentation in the Indian Himalayan Region. Similarly, in Western Ghats, in the past, selective logging, and conversion to agriculture and cash crop plantations, river valley projects have contributed to the decline of biodiversity. Of late, mass tourism, unsustainable land use practices, excessive subsistence dependence on forests are major challenges.

Arid and semi-arid regions spread over ten states, cover 38.80% of the geographical area. About 140 species of birds are known, and the flora of the Indian desert comprises 682 species with over 6% of total plant species as endemics. India's Third National Report on the implementation of United Nations Convention to Combat Desertification indicates that most of arid, semi-arid and dry subhumid areas of India are either identified as drought prone, or considered wastelands.

India has a variety of wetland ecosystems ranging from high altitude cold desert wetlands to hot and humid ones in coastal zones with their diverse flora and fauna. The major threats to wetland ecosystems include uncontrolled siltation, weed infestation, discharge of waste effluents, surface run-off, habitat destruction, encroachment and hydrological perturbations.

(2) Ecosystem of Maharashtra

General: Maharashtra occupies the western and central part of the country and has a long coastline stretching nearly 720 km along the Arabian Sea. Ranges of Sahyadri Mountain provide a physical backbone to the State on the west, while the Satpuda hills along the north and Bhamragad- Gadchiroli-Gaikhuri ranges on the east serve as natural borders[4].

According to the Forest Research Institute, the forest area of the State is 6.38 million ha, constituting 20.75% of its geographical area. Reserved forest constitutes 76%, protected forest 14% and unclassified forest 10%. In the Forest Research Institute 1999 report, six forest types are mentioned in Maharashtra, (1) Tropical Semi-Evergreen; (2) Tropical Moist Deciduous; (3)

[4] "Economic Survey of Maharashtra 2011-2012 (Directorate of Economics & Statistics, Planning Department, Maharashtra, 2012)"

Tropical Dry Deciduous; (4) Tropical Thorn; (5) Subtropical Broadleaf Hill and (6) Littoral and Swamp Forests. Extensive tracts of forests are still present in the Vidarbha region and some patches in the Northern Western Ghats. Some endemic and highly endangered plants are found in the evergreen and semi-evergreen patches of the Western Ghats[5].

Biodiversity Hotspots: Conservation International, international nature conservation NGO, has identified high biodiversity areas with high conservation priority as "Biodiversity Hotspots" in the world. Western Ghats & Sri Lanka is one of the four (4) hotspots in India. Because of is climatic (yearly monsoons) and physical (high mountains) conditions, it has a rich endemic assemblage of plants, reptiles, and amphibians. The forests of the hotspot have been dramatically impacted by the demands for timber and agricultural land due to tremendous population pressure. Remaining forests of the Western Ghats are heavily fragmented; in Sri Lanka, only 1.5 % of the original forest remains[6.]

Figure 2.6.1-1 shows the map of the Hotspot, and the northern part of the Hotspot belongs to the State.

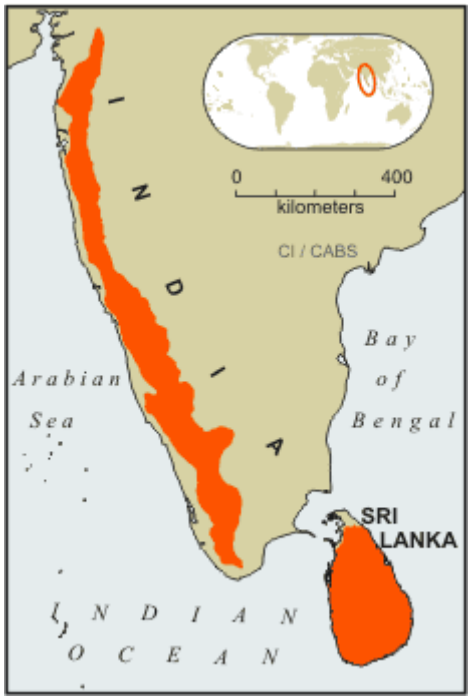


Figure 2.6.1-1 Hotspot: Western Ghats & Sri Lanka[7]

Ecologically Sensitive Areas[8]**:** Ecologically Sensitive Areas (ESAs) have been identified and notified by the Ministry of Environment and Forests (MOEF) since 1989. Notifications declaring areas as ESAs are issued under the Environment (Protection) Act 1986 (EPA). ESAs

[5] Important Bird Areas In India: Priority sites for conservation (Bombay Natural History Society, 2005)
[6] Conservation International web site.
http://www.conservation.org/where/priority_areas/hotspots/asia-pacific/Western-Ghats-and-Sri-Lanka/Pages/default.aspx
[7] The map is also from the Conservation International web site.
[8] India's Notified Ecologically Sensitive Areas (ESAs): The Story So Far (Kapoor, M., Kohli, K. and Menon, M., 2009).

can realize landscape-level conservation based on the act. 14 EBAs have been identified and declared (or proposed) in India; Murud-Janjira, Doon Valley, Dahanu, The Aravallis, Numaligarh, The Taj Trapezium, Mahabaleshwar-Panchgani, Matheran, Mount Abu, Sultanpur, Pachmarhi, The Himalayas, Hill Stations, and Sahyadri. Kodachadri in Karnataka and Kerala is considered as a proposed ESA by MOEF.

In Maharashtra, Matheran is located at about 50 km east of Munbai with the area of about 214 km^2. The hill is about 20 km from the main range. Sahyadri is part of the Western Ghats located in the area which comprises of contiguous segments from north Karnataka (Uttara Kannada and Belgaum Districts), East Goa (Canacona, Sanguem and Sattari administrative areas) and south Maharashtra (Sindhudurg and Kolhapur Districts).

Important Bird Areas[9]**:** BirdLife International, international bird conservation NGO, has identified "Important Bird Areas (IBAs)" in the world (including India) since the areas usually have one (or more) of the following features:

- significant numbers of one or more globally threatened species;
- one of a set of sites that together hold a suite of restricted-range species or biome-restricted species ; and,
- exceptionally large numbers of migratory or congregating species.

IBAs are considered to be key sites for conservation – small enough to be conserved in their entirety and often already part of a PA network in the concerned country.

India has 464 IBAs, and Maharashtra does 20 IBAs, of which list is attached as Appendix 1.

(3) Current status of species including threatened species

General[10]**:** Inventories of faunal diversity in India are being progressively updated and analyzed with several new discoveries. So far, nearly 91,212 of faunal species (7.43% of the world's faunal species) have been recorded in the country. Endemic richness in the fauna is recognized most prominently in Reptiles and Amphibians. Indian fish fauna includes two endemic families and 127 monotypic genera.

New species have been being discovered – 41 plant species in 2007 by Botanical Survey of India alone. The unique features of the plant diversity include 60 monotypic families and over 6,000 endemic species.

Table 2.6.1-1 shows the current status of globally threatened species in India.

[9] BirdLife International web site. http://www.birdlife.org/action/science/sites/

[10] The text of this section is extracted and summarized from "India's Fourth National Report to the Convention on Biological Diversity (Ministry of Environment and Forests, 2009)".

Table 2.6.1-1 Globally threatened species (number of species) in India[11]

	Critically Endangered	Endangered	Vulnerable	Near Threatened
Mammals	10	39	45	25
Birds	14	12	51	64
Reptiles	6	9	15	5
Amphibians	18	32	21	9
Fishes	19	77	116	78
Plants	60	142	110	34

Conservation of species[12]**:** Considering the high biodiversity and needs of conservation of these species, the Government of India has been positively implementing actions to conserve them. Mainly based on the Wildlife (Protection) Act, 1972, the wild species and their habitats are protected.

Regarding the threatened species, the Government also has been paying strong commitments to conserve them with special conservation programs; namely Tiger *Panthera tigris* (Project Tiger), Asian Elephant *Elephas maximus* (Project Elephant), Indian Lion *Panthera leo persica*, Greater One-horned Rhinoceros *Rhinoceros unicornis*, and Nilgiri Thar *Hemitragus hylocrius*. Regarding birds species, special protected areas have been set up for Jerdon's Courser *Rhinoptilus bitorquatus* and Great Indian Bustard *Ardeotis nigriceps*. These programs have been successful.

Current status of species in Maharashtra[13]**:** Regarding the bird species, 540 species of birds from the State, and about 450 bird species from Western Maharashtra are reported. Threatened species are shown in Table 2.6.1-2.

Table 2.6.1-2 Threatened bird species in Maharashtra

Status	English name	Scientific name
Critically Endangered	Oriental White-backed Vulture	Gyps bengalensis
	Long-billed Vulture	Gyps indicus
	Forest Owlet	Heteroglaux blewitti
Endangered	Great Indian Bustard	Ardeotis nigriceps
	Lesser Florican	Sypheotides indica
	Spotted Greenshank	Tringa guttifer
Vulnerable	Lesser Adjutant	Leptoptilos javanicus
	Lesser White-fronted Goose	Anser erythropus
	Pallas's Fish-Eagle	Haliaeetus leucoryphus
	Greater Spotted Eagle	Aquila clanga
	Eastern Imperial Eagle	Aquila heliaca

[11] The table is prepared based on the information from IUCN Red List of Threatened Species (February 2011 Version: http://www.iucnredlist.org/) by the JICA Study Team.

[12] Data Collection Survey on Forestry Sector in India (JICA, 2011)

[13] Important Bird Areas In India: Priority sites for conservation (Bombay Natural History Society, 2005). Regarding other fauna and flora, reports are limited.

Status	English name	Scientific name
	Lesser Kestrel	Falco naumanni
	Sarus Crane	Grus antigone
	Indian Skimmer	Rynchops albicollis
	Nilgiri Wood-Pigeon	Columba elphinstonii
	Purple Wood-Pigeon	Columba punicea
	Broad-tailed Grass-Warbler	Schoenicola platyura
	Green Munia	Amandava formosa
Near Threatened	Darter	Anhinga melanogaster
	Painted Stork	Mycteria leucocephala
	Oriental White Ibis	Threskiornis melanocephalus
	Lesser Flamingo	Phoenicopterus minor
	Ferruginous Pochard	Aythya nyroca
	Pallid Harrier	Circus macrourus

(Note: English names with under lines are threatened species for which Maharashtra is regarded as important state in India.)

The following activities are identified as threats to the wildlife conservation in Maharashtra;

- Large dams: Unplanned water management systems have led to creating of large dams, directly resulting in habitat destruction and fragmentation;
- Encroachment: With increasing population, encroachment on forestland is a common practice in India and in Maharashtra .This has resulted in massive degradation of forest and illegal exploitation of resources; and,
- Mining: Over exploitation of minerals, oil and stone, has left most of the remaining resources in the protected areas of India.

(4) Protected areas

Protected areas[14]**:** *In-situ* conservation in India has its strength in its PA network, which currently comprises 661 PAs under the Wildlife (Protection) Act, 1972: 99 National Parks; 515 Wildlife Sanctuaries; 43 Conservation Reserves;, and 4(four) Community Reserves.

The network covers approximately 4.8% of the total geographical area of the country. India's PAs have increased by 15% since the adoption of the Programme of Work on Protected Areas in 2002.

In Maharashtra, there are six (6) National Parks, 35 Wildlife Sanctuaries, and one (1) Conservation Reserve, and there is no Community Reserve[15]. The list of the National Parks and Wildlife Sanctuaries in Maharashtra is attached as Appendix 2.

Biosphere Reserves: The concept of Biosphere Reserve was established based on "Man and Biosphere Programme" by United Nations Educational, Scientific and Cultural Organization

[14] "India's Fourth National Report to the Convention on Biological Diversity (Ministry of Environment and Forests, 2009)".
[15] Wildlife Institute of India: http://www.wii.gov.in/

(UNESCO). The concept was introduced to India and 17 Biosphere Reserves have been established. The reserves have vast area of conservation at landscape level which include one or a couple of PAs. The reserves are not designated based on the Wildlife (Protection) Act, 1972[16]. The list of the reserves is attached as Appendix 3.

There is no Biosphere Reserve in Maharashtra.

Important wetlands: The Government of India has been implementing the National Wetlands Conservation Programme in close collaboration with the State / Union Territory Governments since the year 1985-86. Under the programme, 115 wetlands have been identified by MOEF (as of 26 June 2009). These wetlands require urgent conservation and management interventions. The aim of the programme is defined as "Conservation of wetlands in the country so as to prevent their further degradation and ensuring their wise use for the benefit of local communities and overall conservation of biodiversity". In Maharashtra, the following three (3) wetlands are identified under the programme; Ujni, Jayakawadi and Nalganga wetlands.

The Government of India is a member of "Convention on Wetlands of International Importance Especially as Waterfowl Habitats (Ramsar Convention)" and has registered 25 wetlands (Appendix 4). There is none in Maharashtra.

World Natural Heritage sites: The Government of India is a member of "Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention)", and has registered six (6) natural heritages (Appendix 5).

Western Ghats has recently been inscribed as a World Natural Heritage site. Sahyadri area in Maharashtra is one of the seven (7) sub-clusters of the Western Ghats World Natural Heritage site[17].

(5) Forests

General: The geographical area of India is legally divided into "recorded forest area" and "outside of recorded forest area". The recorded forest areas are divided into "reserved forests", "protected forests", and "unclassed forests" under the Indian Forest Act, 1927. The forestry of India heavily depends on trees outside of forests (trees from outside of the recorded forest areas), almost all of which grow in private lands[18].

Table 2.6.1-3 shows the areas of each forest in India and Maharashtra.

[16] Data Collection Survey on Forestry Sector in India (JICA, 2011)

[17] The seven sub-clusters are Sahyadri, Kudremukh, Talacauvery, Nilgiri, Anamalai, Periyar and Agasthyamalai. Information are from UNESCO World Heritage Centre (http://whc.unesco.org/pg.cfm), accessed on 13 August 2012.

[18] Data Collection Survey on Forestry Sector in India (JICA, 2011)

Table 2.6.1-3 Areas of recoded forest area in India and Maharashtra in 2011 (in km^2)[19]

	recorded forest			Total
	reserved forest	protected forest	unclassed forest	
India	422,536	213,982	133,020	769,538
Maharashtra	49,226	8,195	4,518	61,939

Forests in Maharashtra: Table 2.6.1-4 shows the change of areas of the recorded forest in Maharashtra from 1993 to 2011, which indicates that the change in area of reserved forest has been little throughout the period.

Table 2.6.1-4 Areas of recoded forest area in Maharashtra from 1993 to 2011 (in km^2)[20]

Year	Recorded Forest			Total
	Reserved Forest	Protected Forest	Unclassed Forest	
2011	49,226	8,195	4,518	61,939
2009	49,226	8,195	4,518	61,939
2005	49,217	8,194	4,528	61,939
2003	49,217	8,196	4,526	61,939
2001	49,217	8,196	4,526	61,939
1999	4.85 M ha	0.89 M ha	0.64 M ha	6.38 M ha
1997	48,373	9,350	6,119	63,842
1995	48,373	9,350	6,119	63,842
1993	-	-	-	63,842

(Note: In 1999, the figures are shown in million hector (M ha))

2.6.2 Social environment[21]

(1) General

Maharashtra is the second largest state in India both in terms of geographical area and population. Its area is 307,713 km^2, and the population is 112,373,000 (male: 58,361,000 female: 54,012,000) The State is highly urbanized with 45.2 % of its population residing in urban areas as against 31.2 % at all India level. Population of each district of the State is shown in Appendix 6.

(2) Administration

Mumbai, the capital of Maharashtra and the financial capital of India, houses the headquarters of most of the major coorporates and financial institutions. India's main stock exchanges and capital market and commodity exchanges are located in Mumbai.

[19] India State of Forest Report 2011 (Forest Survey of India, 2011)
[20] India State of Forest Report 1993 to 2011 (Forest Survey of India)
[21] The texts of this section are extracted and summarized from "Economic Survey of Maharashtra 2011-2012 (Directorate of Economics & Statistics, Planning Department, Maharashtra, 2012)" unless otherwise indicated.

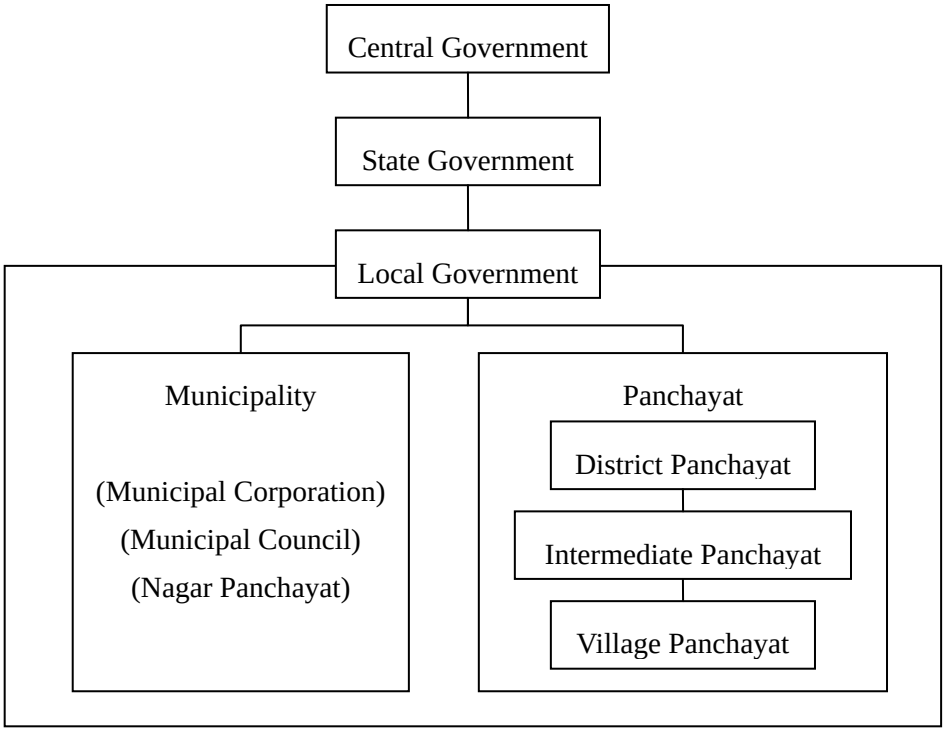
The State has 35 districts which are divided into six (6) revenue divisions (i.e. Konkan, Pune, Nashik, Aurangabad, Amravati and Nagpur) for administrative purposes. There are 535 Towns, 355 Takukas (Tahsils), and 43,663 Villages (including un-inhabited ones). Figure 2.6.2-1 shows the administrative map of the State.

Figure 2.6.2-1 Administrative map of the State of Maharashtra[22]

Figure 2.6.2-2 shows the institutional organization of the central and local governments stipulated in the Indian Constitution[23].

[22] http://www.grandeurmaharashtra.com/

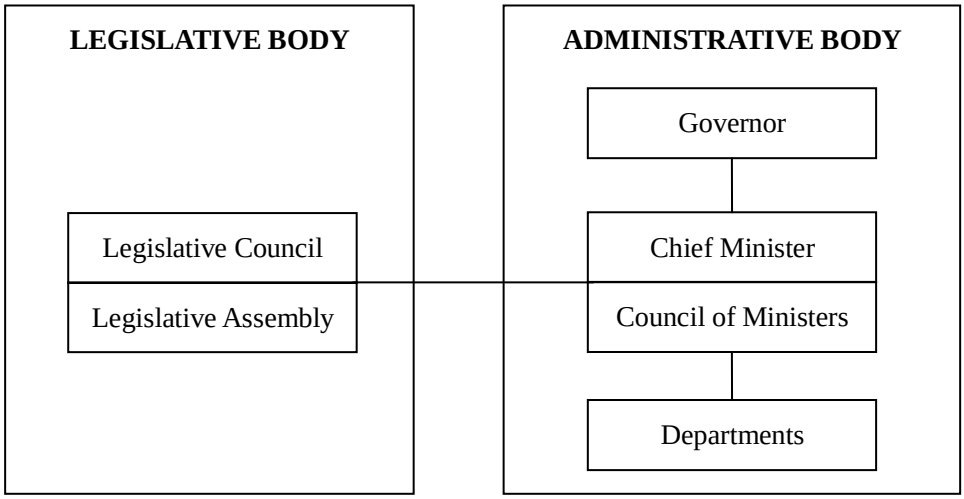
[23] Local Governments and their current status (Council of Local Authorities for International Relations, 2007, in Japanese)



(Source: Local Governments and their current status (Council of Local Authorities for International Relations, 2007, in Japanese). Prepared by the JICA Study Team.)

Figure 2.6.2-2 Institutional organization of the governments

The institutional organization of the State Government is shown in Figure 2.6.2-3[24].



(Source: Local Governments and their current status (Council of Local Authorities for International Relations, 2007, in Japanese). Prepared by the JICA Study Team.)

Figure 2.6.2-3 Institutional organization of the State Government

[24] Modified based on "Local Governments and their current status (Council of Local Authorities for International Relations, 2007, in Japanese)".

The State Government has 27 departments such as Home, Revenue and Forest, Finance, Water Resources Departments, of which headquarters are located in Mumbai.

(3) Economic sectors

The share of Agriculture & allied activities' sector in the gross state domestic product (GSDP) of the year 2010-11 (at current price) is estimated at 12.8 %. The share of the Industry sector is estimated at 30.3 %. The Services sector is consistently growing by more than 10 %, and the share of it is estimated at 56.9 %.

Agriculture and allied activities' sector: The State is about to achieve the XI Five Year Plan target of 4 (four) % growth in this sector. However, the ratio of gross irrigated area to gross cropped area for 2008-09 in the State was 17.7 %, which was much below the national level ratio of 45.3 %. This and low productivity of soil are the major concerns in this sector in the State.

Fishery sector generates employment, especially in coastal areas. The share of fisheries in GSDP of the Agriculture & allied activities sector during 2010-11 was 1.7 %. Fish production of marine sector was 44.700 million metric ton (MT) (2010-11) and 31.2 million MT (2011-12, provisional), and those of inland sector was 13.0 million MT (2010-11) and 10.0 million MT (2011-12, provisional).

Forest is the second largest land use sector after agriculture in the State. The share of the forest sector in GSDP of the Agriculture & allied activities sector during 2010-11 was 13.9 %. The total forest area of the State is 61,939 km^2 (provisional), about 20 % of geographical area of the State. Forest and Revenue Department and Forest Development Corporation of Maharashtra are mainly in charge of the forest area.

Industry and Services sectors: Maharashtra has rich natural resources, skilled manpower and quality education facilities to harvest the Industry sector. The State adopted first industrial policy in the year 1993 which was revised in 1995 and 2001. Latest industrial policy was introduced in 2006, which aimed at 10 % growth in the Industry sector, 12 % growth in the Service sector and generation of additional 2,000,000 employments by 2010. State has nearly achieved these growth targets.

(4) Infrastructure

Energy: Refer to Chapter 3.

Road network: The total road length maintained by Public Works Department (PWD) of the State Government, Zilla Parishads (ZP) (excluding internal road length maintained by local bodies) at the end of March, 2011, was 241,712 km, 91.5 % of which is surfaced. The total increase in road length for 2011 as compared to 2010 is 1,672 km.

As on 31 March 2011, 97.8 % of the villages were connected by all-weather roads and 1.6 % by

fair-weather roads. However, 227 villages in the State did not have any road connectivity. Only nine (9) villages had been connected as compared to 2010.

Railways: Indian Railways is the life-line of India's transport infrastructure with its network of 65,202 km and provides connectivity to most parts of the country. The railway route length in the State as on 31 March 2011 was 5,984 km, which is 9.2 % of the total railway route length in the country. Total railway route length in the State has marginally increased by 18.4 % over the last 51 years. The railway route length per 1,000 km^2 of geographical area as on 31 March 2011 was 19.43 km in the State as against 19.83 km in the country.

Water transport: The State has 720 km long coastal line with two major ports, namely Mumbai Port Trust and Jawaharlal Nehru Port Trust. The State Government has taken a policy decision to develop 48 non-major ports.

Air transport: There are three (3) international (Mumbai, Nagpur and Pune) and five (5) domestic airports (Mumbai, Nagpur, Pune, Aurangabad and Kolhapur) in the State.

Communications: The Communications sector is growing rapidly due to private sector contribution. In the State, private sector operators hold 91.7 % of wireless market share whereas the two "private sector undertaking" operators Bharat Sanchar Nigam Limited and Mahanagar Telephone Nigam Limited together hold 8.3 % market share.

The total number of landline connections at the end of December 2011 in the State was 5,669,000. The number of cell phone users per 100,000 persons at the end of December, 2011 in the State was 94,181.

(5) Social sectors

Employment: According to the Census 2001, percentage of main workers to total workers was declined from 91.4 % in 1991 to 84.3 % in 2001 which is mainly due to declining work force in agriculture and allied activities. Total number of the workers has been increased from 33.9 million (1991) to 41.2 million (2001).

Education: Number of schools and number of enrolment in education are shown in Table 2.6.2-1.

Table 2.6.2-1 Number of schools and enrolment

Category	2010-11	2011-12
Number of schools and Junior Colleges		
(1) I to VII grades	75,695	76,625
(2) I to X grades	15,762	15,955
(3) I to XII grades	4,626	4,676
(4) XI and XII (Junior Colleges)	969	969
Enrolment (estimated, in '000)		
(1) Primary (I to VII) Total	10,626	10,728
of these, girls	4,935	4,989

Category		2010-11	2011-12
(2) Secondary (VIII to X)	Total	5,603	5,656
	of these, girls	2,602	2,630
(3) Higher Secondary (XI to XII)	Total	4,291	4,332
	of these, girls	1,993	2,014
(4) Junior Colleges (XI to XII)	Total	817	823
	of these, girls	379	384

The literacy rate is 82.9 % in the Census 2011 comparing 76.9 % in the Census 2001.

Public health: During 2010-11, expenditure incurred by the State on public health services was 0.81 % of GSDP. The State is having a three-tier public health infrastructure. Under the primary tier, three types of health-care institutions are covered: (1) Sub-Centre, (2) Primary Health Centre, and (3) Community Health Centre. The district level hospitals serve as a secondary tier, whereas, tertiary health care is provided by hospitals in urban areas, which are equipped with technology for diagnostic and investigative facilities. Table 2.6.2-2 and 2.6.2-3 respectively show the public health institutes of the State Government and the status of selected health indicators of the State.

Table 2.6.2-2 Public health institutes of the State Government (as of 31 October 2011)

Type of institution	Number
State level hospital	498
District hospital	23
Sun district hospital with capacity with 50 beds	56
100 beds	24
200 beds	3
Community health centre	458
Rural hospital / cottage hospital	386
Primary health centre	1,809
Sub centre	10,580
Primary health unit	172
Mobile health unit	13
Women hospital	10
Mental hospital	4
Dental hospital	3

Table 2.6.2-3 Status of selected health indicators

Health indicator (in percentages)	Targets under XI Five Year Plan	2007	2008	2009	2010
Crude birth rate	18	18.1	17.9	17.6	17.1
Crude death rate	6.4	6.6	6.6	6.7	6.5
Total fertility rate	2.1	2.0	2.0	1.9	not available
Infant mortality rate	25	34	33	3	28

Women and child welfare: The State Government is implementing many important schemes for welfare of women such as Government Hostels / Supportive Homes (*Sudharit Maher Yojana*); Protective homes (*Mahila Sanrakshan Gruha*); Financial Assistance to *Mahila Mandal* for organizing vocational training.

To achieve the objectives set by the Child Development Policy, 2002, the State Government is implementing schemes such as Foster Care Scheme (*Bal Sangopan Yojana*) to provide care, protection and rehabilitation of children.

Poverty: The percentage of Below Poverty Line (BPL) families for rural and urban areas in the State is given in Table 2.6.2-4.

Table 2.6.2-4 Percentage of Below Poverty Line Families in the State

Area	1997		2002	
	Total families ('000)	% of BPL families	Total families ('000)	% of BPL families
Rural	11,053	34.6	12,593	35.7
Urban	8,489	8.8	7,819*	18.2*

(*Information for year 2005)

The Jawaharlal Nehru National Urban Renewal Mission is a massive city modernization program. Under this mission, Basic Services to Urban Poor Programme and Integrated Housing and Slum Development Programme are being implemented in the State through Maharashtra Housing & Area Development Authority as the nodal agency for monitoring.

Indira Awas Yojana has been being implemented in the State since April 1989 to construct the houses for houseless BPL families in the rural areas.

Water supply and sanitation: The Central and State Government are implementing various schemes for providing drinking water and proper sanitation. According to the Census 2011, 67.9 % households of the total households in the State had tap water as drinking water facility; and 34 % households had no latrines.

Scheduled Caste: Scheduled Caste Sub-Plan comprises of six (6) sectors. Of the total expenditure, the major share of expenditure is on Social and Community Services both at State and district level schemes. Social and Community Services cover sub sectors such as education, health, housing, water supply, women and child development, and welfare of backward classes.

Scheduled Tribe: The tribal population in the State is largely concentrated in the hilly districts such as Dhule, Nandurbar, Jalgaon, Nashik, Thane and in the forest districts such as Chandrapur, Gadchiroli, Bhandara, Gondia, Nagpur, Amravati and Yavatmal.

Population of the Scheduled Tribes in Maharashtra is 8,577,276 (male: 4,347,754, female: 4,229,522), which consists of 8.85 % of the total population[25].

The major share of the expenditure of Tribal Sub-plan was on Social and Community Services (57 %), followed by Agriculture and allied services (13 %).

(6) Environment conservation

General information on pollution: The industrial pollution is one of the major concerns for environment. The Maharashtra Pollution Control Board (MPCB) acts as the nodal agency for implementation of pollution related acts.

MPCB was established in 1970 under the provisions of Maharashtra Prevention of Water Pollution Act, 1969. The Water (Prevention and Control of Pollution) Act, 1974, was adopted in Maharashtra in 1981. MPCB advises the State on environment related issues and monitors ambient air quality, water quality, industrial effluent, and noise levels.

Of the total 75,080 industries under the purview of MPCB, 17 % were air pollution prone, 18 % were water pollution prone and seven (7) percent were hazardous waste prone industries at the end of March 2011. Apart from issuing directions based on the acts by MPCB, bank guarantee was taken from certain industries, and electricity and water supply of few polluting industries was disconnected until pollution control measures were implemented.

Air Pollution: Under National Air Quality Monitoring Programme, State Air Quality Monitoring Programme and Continuous Ambient Air Monitoring Stations, MPCB, with the help of various educational institutes, is operating air quality monitoring system at 82 stations spread in 17 districts.

Water Pollution: At present, MPCB monitors 250 stations of which 200 locations are for surface water and 50 locations are for ground water.

Noise Pollution: As per the Noise Pollution Act 2000, areas have been classified as industrial, residential, commercial and silence zones and thereby restricting the noise level to a certain decibel for that particular zone.

Soil Pollution: Leading soil pollution causes in the State are insecticides and pesticides, industrial wastes such as harmful gases and chemicals, unfavorable and harmful irrigation practices, improper septic system and management, acid rains, fumes released from industries getting mixed with rains, fuel leakages from automobiles, unhealthy waste management techniques which are characterized by release of sewage into the large dumping grounds and nearby streams or rivers.

Hazardous Waste: There are 5,428 hazardous waste generating industries in Maharashtra. The

[25] Directorate of Economics & Statistics, Planning Department, Maharashtra. Data is from the Census 2001.

volume of hazardous waste generated is estimated to be around 1.80 million MT per year. A total of 5,969 industries have taken membership to treat common hazardous waste and its disposal. Various steps are being taken by MPCB for proper waste management. Common facilities for management of hazardous waste have been set up at four (4) stations across the State, the major stations being at Taloja & T.T.C. Industrial areas of Maharashtra Industrial Development Corporation in Thane district, Ranjangaon in Pune district and Butibori in Nagpur district. As per the Hazardous Waste Management, Handling and Transboundary Rules, 2008, MPCB has directed 59 industries to pay fine for unlawful storage and disposal of large quantities of hazardous waste in their premises. They were also directed to send hazardous waste lying in their premises to Common Hazardous Waste Treatment, Storage and Disposal Facility. Since implementation of the rules, MPCB has received a total fine of Rs. 433 million from these defaulting industries up to September 2011.

The State Government has made mandatory to install Global Positioning System (GPS) in all the containers carrying the hazardous waste which allows tracking whether the waste is disposed properly or not. At present 200 hazardous waste transporters have installed GPS.

Major Accident Hazard Factories: If storage or use of hazardous substances given under Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989, and Chemical Accidents (Emergency, Planning, Preparedness and Response) Rules, 1996, is more than the threshold limit, these factories are recognized as being prone to Major Accident Hazard. The management gives information and assurance regarding the safety and health measures taken. Disclosure of information regarding hazards of chemical used and training about handling is given to the workers. To prevent accident occurring in factories, Internal Crisis Prevention Plan has to be followed. The effect of some accidents is not limited to the factories but to the neighboring area also. For this reason External Crisis Prevention Plan is brought into existence.

e-Waste: e-Waste contains harmful components like halogenated compounds, heavy metals besides radioactive substances that can spell danger to health and the environment. MPCB has identified e-waste management as a priority area and has taken certain initiatives to create awareness among its stakeholders.

Bio-Medical Waste: In the State of Maharashtra, MPCB is implementing national Bio-Medical (Management & Handling) Rules, 1998. There are 35 Common Bio-Medical Waste Treatment and Disposal Facilities in the State, out of which 29 facilities are operating on incineration basis and remaining on deep burial basis. About 31,205 kg per day of bio-medical waste is collected and treated by these facilities.

Climate Change: The State Government has signed Memorandum of Understanding with The Energy and Resources Institute to tackle the issue of climate change. This institute will prepare action plan for climate change within a period of two years. This action plan includes study of key sectors like hydrology and water resources, agriculture and food system, coastal areas

marine ecosystem and biodiversity, livelihood associated sectors like human health, forests and disaster management.

National River Action Plan: The main objective of National River Action Plan is abatement of pollution of main rivers in the country. Under the plan, 70 % of funds are received from the Central Government and 30 % from concerned council/ municipality/ State Government. Under this scheme, the work of cleaning the rivers at Tryambakeshwar, Nashik, Nanded, Karad and Sangli cities have been completed successfully while the works of cleaning the rivers at Kolhapur and Prakasha are in progress.

National Lake Conservation Plan: National Lake Conservation Plan is a centrally sponsored scheme with 70 : 30 pattern as described in National River Action Plan. Under this scheme, the works of 12 lakes have been completed while the works of Varaladevi Lake in Bhiwandi and Siddheshwar Lake in Solapur are in progress.

State Lake Conservation Plan: The State Government provides funds for conservation of degraded lakes. The conservation and restoration works of Yamai Lake (Pandharpur), Hanuman Lake (Katol), Charlotte Lake (Matheran), Jaysingrao Lake (Kagal), Dedargaon Lake (Dhule), Gandhisagar and Sonegaon Lakes (Nagpur), Peer Lake (Nandurbar), Moti Lake (Sawantwadi), Ganesh and Aitwade Khurd Lakes (Sangli) are in progress.

(7) Religious and cultural heritages

Religious heritages: The main religion of the State is Hinduism, and there are significant Muslim, Christian, Buddhist, Zoroastrian and Jainism minorities[26]. There are many temples of these religions in the State.

Cultural heritages: There are 23 World Cultural Heritage sites in India (refer to Appendix 5). In the State, there are the following four (4) World Heritage sites; Chhatrapati Shivaji Terminus (Mumbai), Elephanta Caves (Mumbai), Ajanta Caves (Aurangabad District) and Ellora Caves (Aurangabad District).

[26] Maharashtra Road Guide (TTK HealthCare limited, 2011)

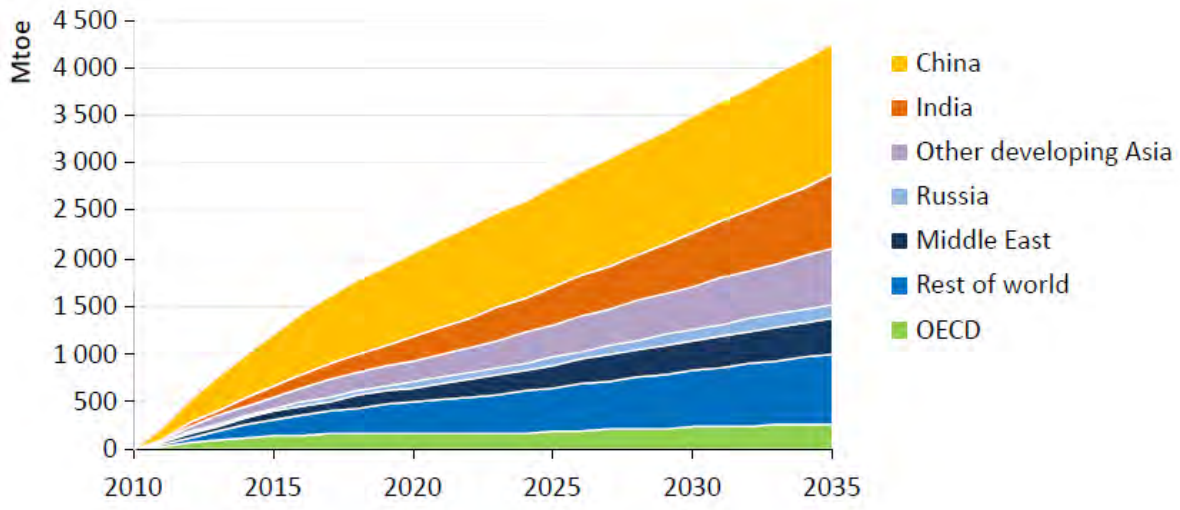
Chapter 3

Power Sector in Maharashtra

Chapter 3 Power Sector in Maharashtra

3.1 Energy sector in India

The energy consumption for the world is expected to increase by 1/3 (one third) between 2010 and 2035. Since 1990, the energy consumption in India and China has increased significantly and together accounted for 10% of the share of the world total consumption in 1990 reached 21% in 2008, moreover the 2 nations were among the least affected nations by the economic recessions like Lehman shock since 2008 and have been continuing to lead the economic growth. These 2 nations occupy the 50% of the energy consumption growth upto 2035, and considered to keep leading the world economic growth and energy demand.



(Source: World Energy Outlook 2011, Nov., 2011)

Figure 3.1-1 Increase of World Total Primary Energy Consumption by region

India has been experiencing the rapid growth of the electric power demand as well as the whole energy recently ever since it has been going through the fast development on economy. The expected electric power infrastructure growth and demand for India are shown below. In this estimate India's GDP growth averages 5.5% per year from 2008 to 2035. In fact, India was affected far less than other nations by the global economic recession in conjunction with the fact that India is oriented as domestic consumption oriented and enjoys the stable foreign investment growth resulting the steady GDP growth of India of 6.8% in 2008 and 8.4% in 2010.

In the short term range, India has the problems of high inflation thus causing monetary entightening, moreover has the issues of depreciation of Rupee caused by European capital shrinkage, however in the long run India still receives strong expectation of the steady growth as long as such structural reforms continue (regulatory reforms, change of labor intensive industries, agricultural reforms).

In such circumstances, India just experienced two large blackouts with 3 out of 5 grids shutting down.

The outages have been investigated for the causes. It was pointed out that the direct causes are mixture of

- No reserved power in India especially in peak time
- 30% of normal rainfall this year in monsoon causing dam water level lowered
- Some states overwithdrawing power from regulated amount from transmission lines

But structural causes are also discussed like

- Power supply shortage with delay of enhancement
- Transmission capability restriction with delay of enhancement
- Structural deficit on distribution companies
- High transmission loss, theft of power
- Fuel procurement shortage

Table 3.1-1 Projections for electricity capacity by fuel (reference case) (Gigawatts),

generation by fuel	2008	2015	2020	2025	2030	2035	av. growth (2008-35)	composition % as at 2025
Coal fired	99	111	116	131	149	171	2.0%	39.5%
Liquids fired	4	4	3	3	3	3	-1.0%	0.9%
Natural gas fired	19	42	52	62	65	67	4.9%	18.7%
Hydroelectric	39	56	80	85	96	106	3.8%	25.6%
Nuclear	4	9	16	21	25	28	7.4%	6.3%
Wind-powered	10	14	16	20	22	24	3.3%	6.0%
Solar	0	1	3	6	7	8	35.6%	1.8%
other renewable energy	2	3	3	3	3	4	2.6%	0.9%
total	177	240	290	332	371	411	3.2%	

(Source: International Energy Outlook 2011, EIA, Sep 2011)

Table 3.1-2 Projections for electricity generation by fuel (reference case) (Billion kWh),

generation by fuel	2008	2015	2020	2025	2030	2035	av. growth (2008-35)	composition % as at 2025
Coal fired	537	637	681	800	938	1111	2.7%	47.0%
Liquids fired	26	24	23	22	21	20	-1.0%	1.3%
Natural gas fired	81	242	311	374	399	410	6.2%	22.0%
Hydroelectric	113	174	260	279	319	356	4.3%	16.4%
Nuclear	13	66	119	157	187	211	10.8%	9.2%
Wind-powered	13	24	31	44	50	56	5.5%	2.6%
Solar	0	2	6	13	15	16	28.5%	0.8%
other renewable energy	2	11	11	12	14	15	8.0%	0.7%
total	786	1181	1444	1701	1942	2196	3.9%	

(Source: International Energy Outlook 2011, EIA, Sep 2011)

In meeting the strong energy demand, India as a whole government level tries to secure the fuels.

3.1.1 Coal sector

In Asia coal always continues to be the most important source of fuel. India is no exception and depends much of its source of energy on domestic coal resource which it has plenty. India is the world's 3rd coal producing countries in with 500Mtpa, but also is the world's 2nd largest consumer of coal, and with the demand exceeding the production India has fallen to one of net-Import coal nations. Majority of coal fields in India are located in the eastern region, and the government owned coal company (Coal of India, CIL) has been engaged in most of the production and supply to the consumers (through "Coal Linkage"), but gradually some private companies become engaged in some portions of coal productions to consumers (through "Coal Block Allocations").

70% of power capacities in India come from coal thermal power, and this dependency on coal is expected to remain unchanged, that 50% of the projected growth in coal consumption is in the electric power sectors. Coal use of electricity generation in India grows by 2% annually, resulting coal thermal power capacity to increase from 99GW in 2008 to 171 GW in 2035. However such increase will decline the share of coal power from 68% in 2008 down to 51% in 2035 due to even higher growth of power generations from nuclear power, natural gas and renewable energy sources.

There arise various hurdles to meet the growth of coal demand, like not only coal production capabilities, but also transportation, import or environmental restrictions etc. The coal production constantly increased in the past bur nowadays the enhancements or new developments have decreased their pace as the stricter of the environmental restrictions have become such as MOEF labeled some coal mines as "No Go Area (though it was formally abandoned)". Nonetheless the consumption demand for coal from new power projects even has been escalating, CIL no longer affords itself to secure the Fuel Supply Agreements (FSA) to its customers. The new schemes as acquiring "Coal Block Allocation" by competitive bidding may become the major stream but still development of coal has to face the environmental hurdles harder. Infrastructures impede the movement of unevenly distributed domestic coal to customers, thus major coastal coal powers are expected to become the fueled with imported coal packaged with expansion of port infrastructures.

India, with preparation of port facilities, increase of overseas coal investments by governmental level as well as privates has surpassed Japan's coal import level, ranking it the 2nd largest importer of coal. However the restriction policy of export from Indonesia has impacted the price of import coal, and is making new coal power projects (ex. UMPP) unstable.

3.1.2 Power sector

Electricity demand in India is the fastest growing in the Asian countries (the power growth rises by 4.0% annually whereas the worldwide growth by 2.3% from 2008 to 2035). At the present India's power capacity ranks at 4th largest among the whole nations. At the same time India suffers many issues (ex. environmental issues, fuel security, land acquisition, complex approval procedures, inter

state issues, structural imbalance of distributing companies, etc.) has been causing persistent power shortages by delaying power developments. The new schemes of various improvements (opening to private companies, introduction of power trade market, Open Access, Multi Year Tariffs (MYT), Unscheduled Interchange (UI), etc.) in ways proceeding the reforms of power industries after New Electricity Act (2003) came into effect, but have not resolved the shortage. The ongoing power development of large scale is no doubt indispensable considering the lasting economic growth.

The power industries are composed of:

- Central governmental & state governmental authorities in charge of "Power policies", "Regulatory approvals", "Power managements"
- Power Utilities players of Central government, State government, and Private enterprises

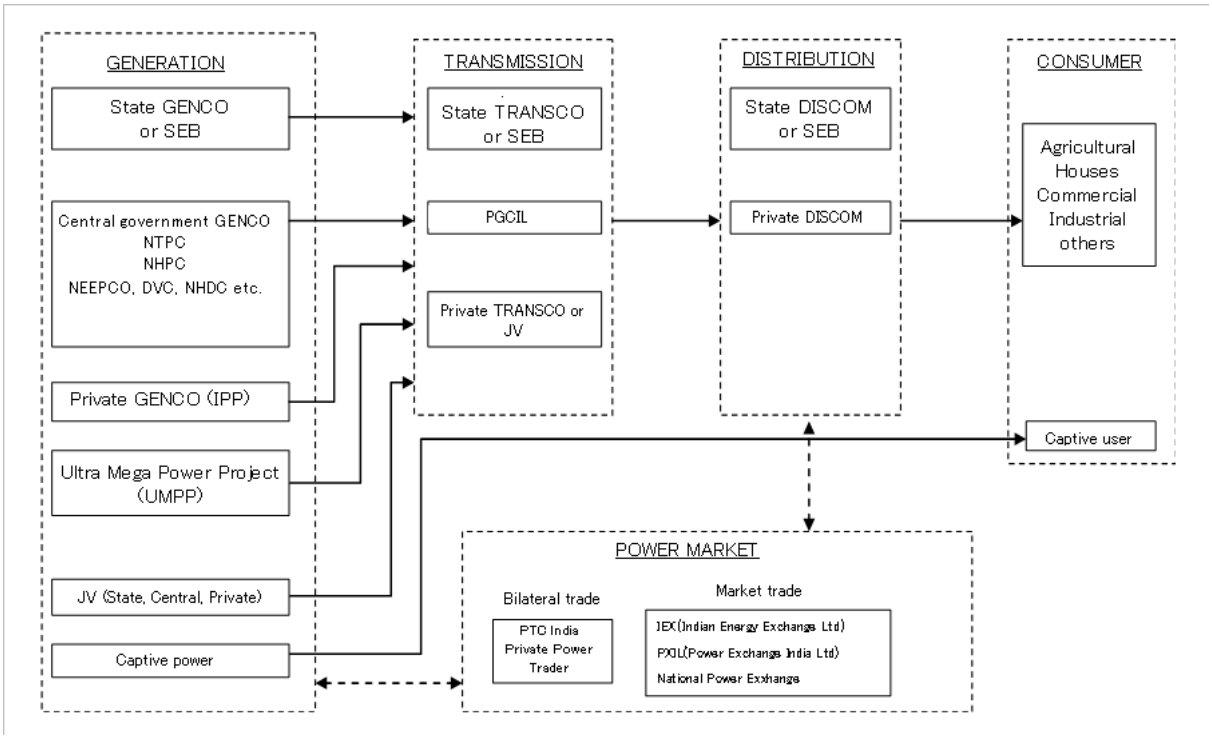


Figure 3.1.2-1 Electric Power Sector in India

3.1.3 Nuclear power

In India, Nuclear power is solely and exclusively managed and operated by Nuclear Power Corporation of India Ltd., NPCIL). From historical background, India has long time taken the independent PHWR policy after the nuclear arms tests in 1990s and the continued imposed punishments everafter. Now India owns about 20 nuclear power stations.

Recently, India was released from nuclear sanctions from USA and other nations, came into U.S.-India Nuclear Agreement (2008), French-India Nuclear Deal, and Russia-India Nuclear cooperation, and thus has turned the rudder to the introduction of foreign nuclear technologies. At

present India has Russian nuclear power (4 units) in Tamil Nadu, French nuclear power (2-6 units) in Maharashtra, thus targeting "20GW in 2020" policy as the nation. It is still unknown for the world wide nuclear developments, India has expressed its steady development in nuclear power, and is expected to develop 63GW in 2035.

3.1.4 Natural gas

In India, natural gas consumption doubles between 2008 and 2035 with many LNG terminals but largely relying on the commencement of production in Krishna Godavari (KG) field in Bengal (2009). Natural gas production use grows by 4.6% annually and much of the expected growth comes from the Krishna Godavari Basin (Dhirubhai-6 block). It will rise most of production by 2020. In the longer term as the KG basin is not sufficient enough for the demand growth India's import requirement is expected to continue to increase with constructions of LNG terminals (ex. Kochi), but in shorter term the evaluation of production growth from KG basin and price comparison with LNG gas is likely to occur.

It has been recognized that the production from KG basin has dropped 50% of the approved production at 2006. They speculate the development has not been going well.

The production of natural gas increased in India to 146MCM per day at 2010/11, with 18% shortage to the demand. It may reach to 473MCM (2.6 times) at 2016/17.

The price of gas at the moment, is higher in LNG than in natural domestic gas (LNG CIF at 10-11 US$/mmBTU (2012/Aug.) where KG gas at 4.2US$ or 7US$ including transport). The future trend is hard to see as shale gas may be increased in the future, or the pool price may be introduced.

Indian government does not have comprehensive laws regulating the whole Indian natural gas industries, Ministry of Petroleum and Natural Gas (MoPNG India) manages the industry. India issued the New Exploration Licensing Policy (NELP) in 1998, since then through licenses issued new discoveries of gas fields were made. Gas Authority of India (GAIL) operates and manages the downstream including the constructions of gas pipelines inland.

In the long term, other unconventional gas resources are expected to come. In 2008 Coal Bed Methane (CBM) was commenced production and the explorations continue. India owns some prospective Shale gas resources and in 2010 Indian State Oil and Natural Gas Company (ONGC) commenced the exploration. Petronet LNG Ltd. also carries out LNG import and LNG base constructions.

In the future it is estimated that India develops non- conventional gas. CBM production sarted in 2008, shale gas exploration started in 2010 by ONGC. The government announced to introduce international biddings on the shale gas permits. The first bid may start in 2013, possibly allows foreign 100% investment.

3.1.5 Renewable Energy

India settled the "National Action Plan on Climate Change" noting the encouragement of the Renewable Energy. In India, Ministry of New and Renewable Energy (MNRE) is in charge of the Renewable Energy except the large scale Hydropower Energy.

In the 11th Electricity Development Plan raised the target of 12.5% share of Renewable Energy in all the installed generation capacity. Accordingly Indian government introduced the Feed In Tariff (FIT) for the Renewable Energy onto the gridded generation power systems of 5 sources (i.e. Wind, Small scale Hydropower, Biomass, Cogeneration, Solar Power), including tariff, tax benefits, subsidiary, etc.

As the result of such policies by the government, India has reached its Renewable Power to 14 % of all the Installed Capacity.

MNRE proposed in the 12th Electricity Development Plan (draft) to increase Renewable Power up to 30GW (including solar 10GW, wind 15GW). However CEA's draft of 12th plan just proposed to have Renewable Power raised to 11GW of wind and 4GW of solar as a Base Case. In CEA, MNRE proposal was treated as High Case.

(1) Wind Power

The total output of Wind Power 2011 reached over 16,000 MW with the various incentives offered by states and central government including tax holiday, tariff etc.

The 70% of the Renewable Power in India is by the Wind Power, and India has boosted its position in 5 th rank among the world for its Wind Power installed capacity. In 2011, the increased capacity in India was the 3 rd largest of all the Nations. The potentiality of Wind Power is estimated to be 120GW. It has such merits of the short installation time, speedy investment return with strong wind density, low environmental impact. On the contrary majority of the Wind power still remains on the captive (self consumption) off grid.

Recently it was reported that the total potentiality of Wind Power in India is raised as much as 20 or 30 times than previously reported. The present estimate of 120GW will raise the share of Wind Power to 8% at 2022 and 5% at 2032. In the revised estimate however, the potential will be 2006GW when the turbine is set at 80m high and 3121GW at 120m. the report also notes Wind Power is a matured commercialized technology with the highest cost efficiency among all Renewable Powers. 95% of suitable areas are located in 5 southern states including Maharashtra. The tariff is said to be able to be lowered below 5 Rs/kWh.

(2) Solar Power

India also has an encouragement policy on the Solar Enegry. The Policy called "Jawaharlal Nehru National Solar Mission (JNNSM) authorized in 2009 targets its scale to 20GW in 2022,

though it is still 900MW. The government expects the private investment on the field. However, Reverse Auction on the bidding system is said to be the large hurdle for the private companies to enter this sector. It is envisaged that the government aims private investors to participate more into the Solar Power.

But Indian government said "the target can be reachable as many plants can be constructed near the consumption areas with the fact many consumers areas are still non electrified in India. No transmission lines are needed in such cases".

Hitachi or other manufactures already began entering in to India establishing their factories of solar panels.

3.2 Power Sector Regulation

3.2.1 EA 2003

It is EA 2003 (Electricy Act 2003) that power sector. It was authorized integrating previous the Indian Electricity Act (1910), the Electricity (Supply) Act (1948) and tthe Electricity Regulatory Commission Act (1998).

It is intended to reorganize (unbundling) SEB which was mandated created by previous laws into independent generation, distribution and transmission utilities.

(Previous scheme allows SEB's exclusive power supply over 40 years time that huge accumulation of debt in SEBs was made and that the task for power supply meeting power demand was not accomplished. Also the power system became inefficient with losses. The constant power shortages had been a hurdle for smooth economic growth. The monopoly of SEB had interrupted private investors to participate into the power sector)

The EA 2003 regulates:

- Unbundling of SEB
- No license required for generation except hydro power generation
- Open access in distribution and transmission
- Abolish after decrease of subsidy
- Power trade market
- Rural electrification
- Metering of all electricity and stringent provision on theft of electricity

The table 3.2.1-1 shows main features of EA 2003.

Table 3.2.1-1 Main Features of EA 2003.

	features
Part III GENERATION OF ELECTRICITY	No licence is required for Generation and captive generation has been freely permitted. Hydro projects exceeding the capital cost notified by Central Government however, need concurrence of the Central Electricity Authority. A generating company may supply electricity to any licensee and to any consumer subject to the regulations.
PART IV LICENSING	No person shall transmit electricity; or distribute electricity; or undertake trading in electricity, unless he is authorised to do so by a licence issued.
PART V TRANSMISSION OF ELECTRICITY	Central Government may establish National Load Despatch Centre for optimum scheduling and despatch of electricity among the Regional Load Despatch Centres. The State Government shall establish a State Load Despatch Centre for the purposes of exercising the powers and discharging the functions.Central Transmission Utility shall not engage in the business of generation of electricity or trading in electricity.
PART VI DISTRIBUTION OF ELECTRICITY	It shall be the duty of a distribution licensee to supply electricity in the area. The State Commission shall introduce open access.
PART – VII TARIFF	The Commission shall determine the tariff for – (a) supply of electricity by a generating company to a distribution licensee (b) transmission of electricity (c) wheeling of electricity (d) retail sale of electricity.
PART – VIII Works of licensees	A licensee may, within his area of supply or transmission permitted to lay down or place electric supply lines
PART – IX CENTRAL ELECTRICITY AUTHORITY	The Authority shall perform such functions and duties as (a) advise the Central Government on the matters relating to thenational electricity policy (b) specify the technical standards for construction of electrical plants, the safety requirements, the Grid Standards for operation and maintenance of transmission lines (c)specify the conditions for installation of meters for transmission and supply of electricity (d)promote and assist completion of schemes and projects for improving the electricity system; (e)promote measures for advancing the skill of persons engaged in the electricity industry (f)collect and record the data concerning the generation, transmission, trading, distribution
PART X REGULATORY COMMISSIONS	The Central Commission shall discharge the following functions, (a) to regulate the tariff of generating companies owned by the Central Government; (b) to regulate the tariff of generating companies for generation and sale of electricity in more than one State (c) to regulate the inter-State transmission and tariff (d) to issue licenses for transmission licensee and electricity trader with respect to their inter-State operations
	The State Commission shall discharge the following functions, (a) determine the tariff for generation, supply, transmission and wheeling of electricity,wholesale in the state (b) the State Commission shall determine only the wheeling charges and surcharge (Cross subsidy surchargs) (c)regulate electricity purchase and procurement process of distribution licensees (d) issue licences to persons seeking to act as transmission licensees, distribution licensees and electricity traders within the State
CHAPTER XI APPELLATE TRIBUNAL FOR ELECTRICITY	The Central Government shall establish an Appellate Tribunal to be known as the Appellate Tribunal for Electricity

Based on EA 2003, CERC authorized each regulations and guidelines as under

- Open access in intra state transmission regulations 2004
- National Electricity Policy 2005
- National Tariff Policy 2006

- UI (Unscheduled Interchange charge regulation 2009
- Power Market Regulations 2010

Thus, the purpose of EA 2003 has been being realized. As for hydropower, New Hydto Policy 2008 was initiated to accelerate hydropower development.

Electricity tariff was based on CERC's National Tariff Policy 2006, and each SERC defines state tariff regulation after auditing financial status of each state generation, transmission, and distribution companies. SERC initiates Tariff Regulation and Tariff Order from time to time.

The achievements of power sector's improvements are

- Most of SEBs have been unbundled.
- Competitive bidding scheme has been introduced after Competitive Bidding Guidelines- 2004/5 and National Tariff Policy 2006, where case1 and case2 bidding started.
- Open access. It made generation companies to directly sell power to consumers.
- Many private generation companies realized. Hydropower requires, by transparent bidding processes, CEA approval for projects above 2,500 crores, and 2,500 Crores unless otherwise..
- UI (Unscheduled Interchange) was introduced. It is used originally as grid ancillary function against frequency variations under the power shortage circumstances. It provides incentives to those players of underdrawal and oversupply in case of lower frequency, and penalties to those of ovedrawal and undersupply. It turns vise versa in higher frequency phase.
- SERC established in each state.
- Power market commencement. PTC India initiates its trading business.

So far, the restructuring of the power sector has been successful to a large extent. But still, politically lowered tariff set on to the agricultural category has been left. Electricity A ct amendment 2007 changed the "abolishment of subsidy" into the "decrease of subsidy".

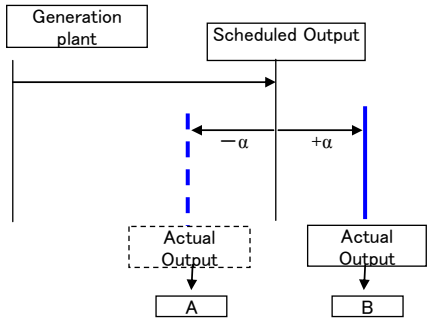
The deficit on the distribution companies inevitably remains. The debt account on the companies has increased significantly.

3.2.2 UI

UI has been introduced by CERC so as to provide frequency adjustment function through supply and demand control in short term. It provides incentive to those companies of underdrawal and oversupply at peak hours and those of undersupply and overdrawal at off peak hours. Incentive is defined on the basis of power frequency (called UI).

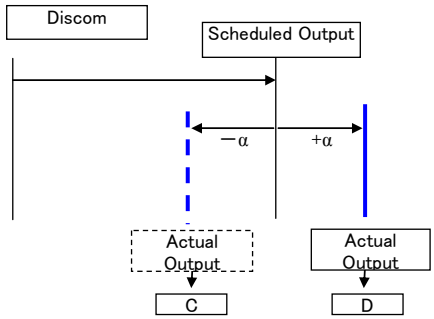
This was first introduced into western grid system under WRLDC. Now all 5 grids have UI system.

The figure shows the mechanism of UI transaction.



Geneation Company

A	Actual supply < Scheduled supply (Undergeneration) 1） >50Hz→UI=0 （No penalty, Genaration compnany receivables are "all tariffs for scheduled output" No need to generate planned scheduled output. That triggers incentive for decreasing output. 2) <50Hz→UI cash （Penalty arises. Actual receivables are "all tariffs for scheduled output + UI* differential output (actual-shceduled)" Cash incentivises the increase of generation
B	Actual supply > Scheduled supply (Overgeneration) 1） >50Hz→UI=0 （No bonus, Genaration compnany receivables are "all tariffs for scheduled output" No need to generate excess planned scheduled output. That triggers incentive for decreasing output. 2) <50Hz→UI cash （bonus arises. Actual receivables are "all tariffs for scheduled output - UI* differential output (actual-shceduled)" Cash incentivises the increase of generation



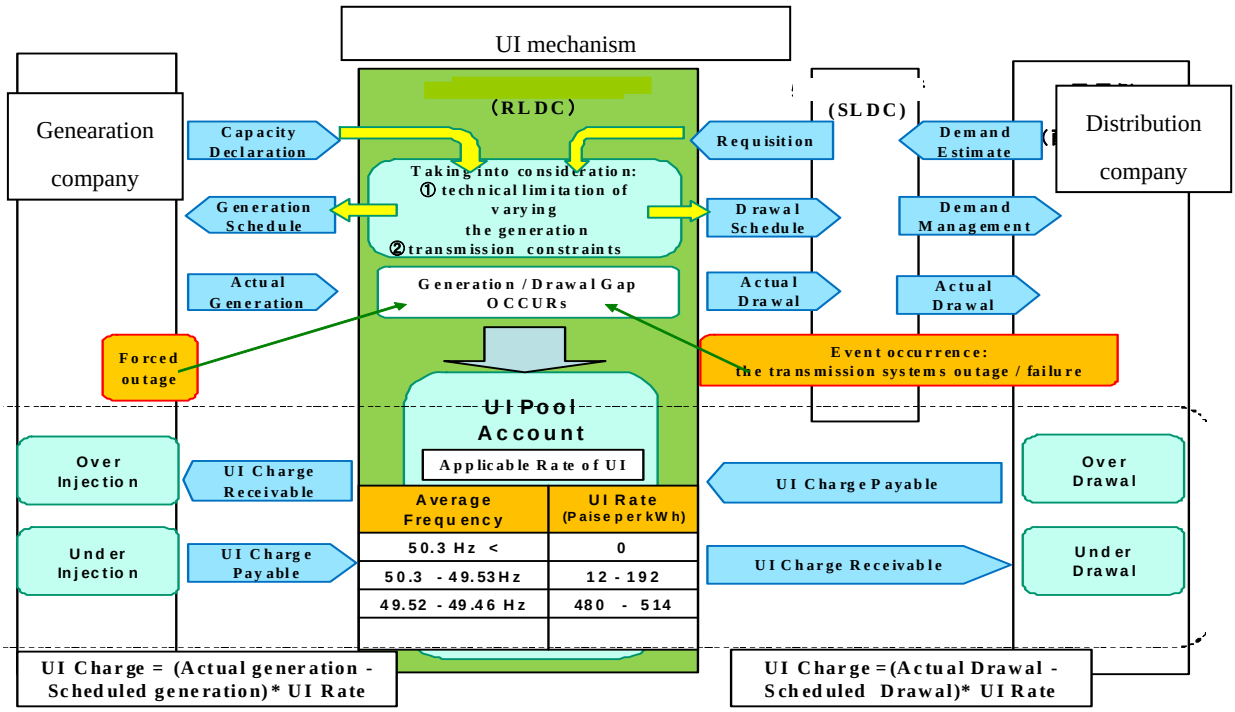
Distribution company

C	Actual withdrawal < Scheduled drawal (Underdrawal) 1） >50Hz→UI=0 （No bonus, Distribution compnany payables are "all tariffs for scheduled input" No need to decrease planned scheduled input. That triggers incentive for increase input. 2) <50Hz→UI cash （bonus arises. Actual payables are "all tariffs for scheduled input - UI* differential input (actual-shceduled)" Cash incentivises the decrease of withdrawal
D	Actual withdrawal > Scheduled drawal (Overdrawal) 1） >50Hz→UI=0 （No penalty, Distribution compnany payables are "all tariffs for scheduled input" No need to decrease planned scheduled input. That triggers incentive for increase input. 2) <50Hz→UI cash （penalty arises. Actual payables are "all tariffs for scheduled input + UI* differential input (actual-shceduled)" Cash incentivises the decrease of withdrawal

(Source: JICA Study Team)

Figure 3.2.2-1 Mechanism of UI Transaction

LDC is to determine the next day's input and output in one day advance by generation companies and distribution companies. The actual output and input differ from the scheduled output and input. LDC provides opportunities for both parties to sell and buy powers outside of the schedule by "charges" dependent upon frequency (higher in lower frequency). This encourages the voluntary sales and purchase by the companies, and also gives the self control function of frequency stabilization UI charge is paid from the pool offered by both generation and distribution companies.

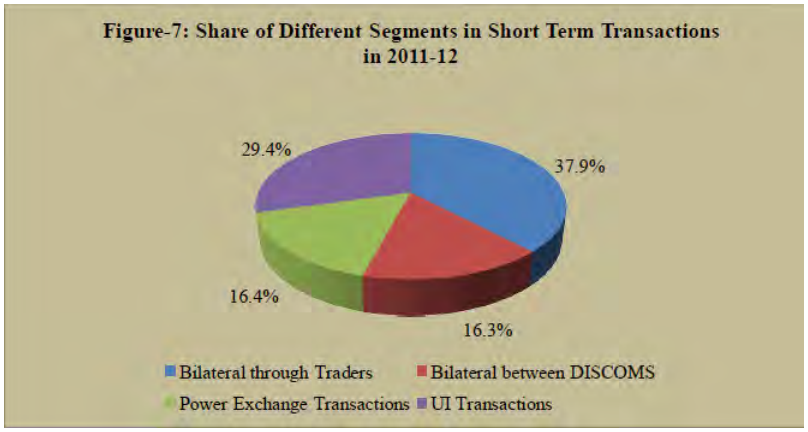


(Source: JICA Study Team)

Figure 3.2.2-2 Demand Supply Control by UI Transaction

Initially introduced UI charge price has been revised repeatedly as some participants declared less in scheduled output/input, thus transact available differential powers by UI transaction with higher price. The limit of transaction volume, the ceiling on the UI charge, severer penalty, nwwarrower the frequency band for UI, etc. were made to restrict such transaction, then now Frequency- UI charge curve becomes more and more complex.

In reality, there physically exist two types transactions in short term power market, except bilateral transaction. Those are “short term power market price” and ”UI transaction price”. The recent outcome shows UI volume exceeds the market transaction volume.



(Source: Report on Short-term Power Market in India 2011-12, CERC, 2012/7)

Figure 3.2.2-3 UI Volume in Power Market

3.2.3 Hydropower from EA 2003

The Act itself focuses the encouragement of power development as a whole (ex. trading, open access).

The points relating to hydropower are that the CEA approval process (TEC) is still formalized in the law. It is explained as “hydropower depends on the local geographical conditions in nature, it involves issues of optimized river development or even issues of inter-state water treaties”. However the applications to TEC is limited to large projects with over 2,500Crores or projects having inter state problems.

Thus, hydropower developments need three approvals.

- TEC :Techno Economic Clearance
- EC and FC :Environmental Clearance and Forest Clearance
- CCEA :Cabinet Committee on Economic Affairs Clearance (but omitted for central projects)

3.2.4 Hydropower from New Hydropower Policy 2008

This was authorized by MOP in 2008, dictates the encouragement of private entities into hydropower. Specifically it says “state government shall take selection of private entities through transparent methods, with guaranteeing royalty>13%, upfront payment, etc. defined by each state on a single manner.

In hydropower generation entity must contract with Discom by long term PPA, but guaranteed ROE. Also it can sell energy max 40% to the market.

3.2.5 Recent Hydropower Policy (including PSPP)

CERC now considers a new tariff regulation for storage type hydropower and PSP with some privileges. It formally published a Public Notification (Draft Amendment to Central Electricity Regulatory Commission (Terms and Conditions of Tariff) Regulations, 2009、2012/6/13).

According to this, it gives a new ROE to storage type hydropower and PSP of 16.5%, 1% higher than previous hydropowers. The basis on this are

- Hydropower is renewable type of energy, clean without air pollution
- Advantageous in quick stop/resume capability with stable supply that are beneficial meeting a wide range of power fluctuation.
- Cost of generation is escalation free. It depreciates annually.
- It mainly plays as peaking power source that the value of such power must be granted.
- The higher tariff must be set onto these types of power source, as they contribute the energy security, and meets the acceleration of renewable energy.

This regulation is at the draft at the moment, but the fact CERC proposed this, as well as that it is included in the 12th power development plan suggests central government admits the value of such peaking powers as storage type or PSPP, and decides to include these values into a regulatory framework.

3.3 Power Companies

3.3.1 Organization

(1) State Electricity Companies

Maharashtra State Electricity Board (MSEB) was established in June 1960, based on Electricity (Supply) Act of 1948, in charge of electricity supply in Maharashtra State. Electricity Act of 2003, aiming at restructuring electric power sector, stipulates the framework of liberalization of electric power market and reorganization of electric power sector. This resulted in unbundling of State Electricity Board, as well as introduction of an Open Access to the power transmission and distribution system. Thus, MSEB was unbundled to the following companies in charge of power generation, transmission and distribution in June 2005, headed by MSEB Golding Company Limited.

- Maharashtra State Power Generation Co. Ltd. (MSPGCL)

  MSPGCL, also known as MAHAGENCO, took over power generation plants from MSEB. MSPGCL was established as a state company in charge of power generation business in the State of Maharashtra. MSPGCL owns and operates seven (7) coal fired power plants (7980MW), two (2) gas power plants (672MW) as well as 12 hydro power plants (2885MW), as of March 2011.

- Maharashtra State Electricity Transmission Co. Ltd. (MSETCL)

  MSETCL, also know as MAHATRANSCO, took over power transmission lines and substations from MSEB. MSETCL was established as a state company in charge of power transmission from the generation end to the receiving end of distribution companies in the State of Maharashtra. MSETCL owns and operates 39,871 cct-km of transmission lines, as well as 559 EVH substations (89,178MVA), as of March 2012. It also plays a role as Maharashtra State Transmission Utility (MSTU) and State Load Dispatch Centre.

- Maharashtra State Electricity Distribution Co. Ltd. (MSEDCL)

  MSEDCL, also know as MAHADISCOM or MAHAVITARAN, took over power distribution facilities from MSEB. MSEDCL was established as a state company in charge of power distribution in the State of Maharashtra. It supplies electricity to a staggering 1.93 crore

consumers in Maharashtra excluding the city of Mumbai. There are about 1.43 crore residential, 31.70 lakh agricultural, 13.79 lakh commercial and 3.63 lakh industrial consumers. It operates a network comprising of 33 kV, 22 kV and 11 kV lines, sub-stations and distribution transformers spread over 3.08 lakh sq.kms geographical area of Maharashtra.

(2) Private Companies

In addition to the state utilities unbundled by MSEB, a few private companies go into the electric power business in the area of power generation, transmission and distribution.

Tata Power Company (TATA) is a company in charge of power generation, transmission and distribution. It owns and operate Trombay Thermal Power Plant (1330MW) and hydropower plants (447MW). TATA delivers 12,000GWh of annual energy to 1.5 lakh customers. The company has bulk supply clients such as another distributor BEST, railways, port, and refineries

Reliance Infrastructure Limited（RINFRA）also sets out power business from generation to distribution. RINFRA owns and operates Dahanu Coal-fired Power Plant (250MW x 2), 460kV transmission lines, 7500cct-km HV/LV undergraund calbes, and supplies electricity to the licensed area of 384km^2 including a customer of some 27.52 lakhs, with an annual energy sale of 6930GWh.

In addition to these, there operate power generators such as Ratnagiri Gas and Power Pvt Ltd, JSW Energy (Jaigad Power); power transmitters as Jaigad Power Transco Ltd (JPTL), Adani Power Maharashtra Ltd - Transmission (APML-T), Maharashtra Eastern Grid Power Transmission Co Ltd (MEGPTCL); power distributor in Mumbay as The Brihan Mumbai Electric Supply & Transport Undertaking (BEST) .

Power supply organization in Maharashtra is shown in Figure 3.3.1-1.

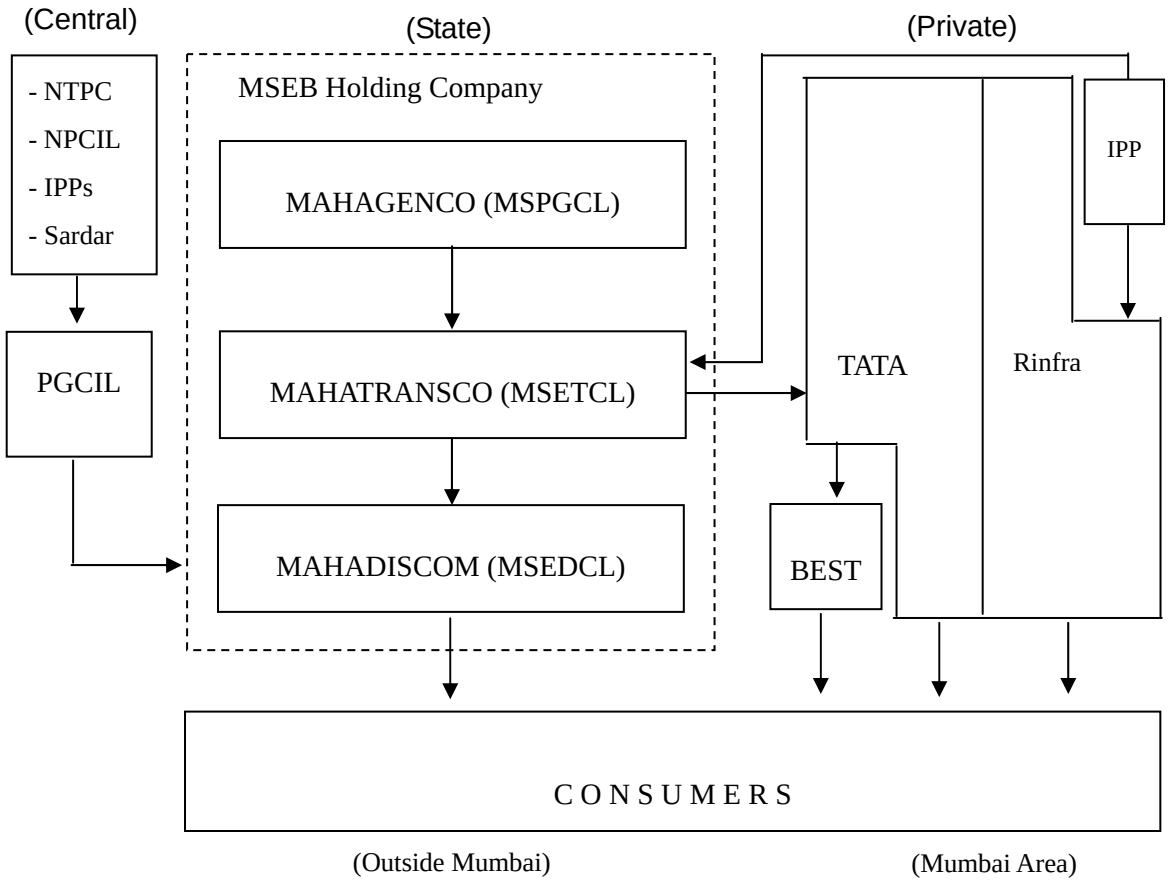


Figure 3.3.1-1 Electric Power Supply in Maharashtra State

3.3.2 Financial Status on Power Companies

(1) Policy of Financial Analysis

In considering the financial status, using the latest materials obtained in the survey and the websites, financial status was evaluated from several points of view. Its evaluation method and criteria is shown below.

Indicators of Financial status is composed of five viewpoints namely, (1) Profitability, (2) Efficiency (Turnover), (3) Stability, (4) Growth Potential and (5) Overall Profitability.

In terms of profitability, by analyzing how much it can make a profit for turnover, we assessed the ability of company profitability. In terms of Efficiency, by analyzing turnover rate of assets and receivables, we evaluated the efficiency of company's operation. As for Stability, by analyzing short-term or long-term financial status and the ability of repayment, we evaluated company's financial stability. Growth Potential was evaluated degree of company's growth by analyzing increasing trend in turnover and income. Overall Profitability was evaluated company's comprehensive ability to generate profit by analyzing how much equity or assets earn.

1) Profit & Loss Account Overview

In this overview, by comparing income and expenditure in each year, we analyzed the trends in income and growth rudimentarily.

2) Balance Sheet Overview

We analyzed the trends in growth or balance of equity, current liabilities and non-current liabilities in their balance sheet.

3) Profitability Evaluation

We evaluated the profitability by using three indicators, namely Operating Income Ratio, Ordinary Income Ratio and Net Profit Ratio. The details of these indicators are shown in Table 3.3.2-1

Table 3.3.2-1 Indicators on Profitability Evaluation

Indicators	Formula	Reference	Comparative Figure(1) (TATA Power)	Comparative Figure(2)
Operating Income Ratio (%)	Operating Income / Turnover * 100	Profitability of Operating Income to Turnover	23.6%	6.29%
Ordinary Income Ratio (%)	Ordinary Income / Turnover * 100	Profitability of Main Business (including non-operating Revenue) to Turnover	16.2%	4.43%
Net Profit Ratio (%)	Net Profit / Turnover * 100	Profitability obtained as a result of the activities of the entire company	10.7%	2.80%

Comparative Figure (1): Created by Study Team Based on Annual Report of The Tata Power Company Limited

Comparative Figure (2): per power utility company in Japan (source: METI, Japan)

(Source: JICA Study Team)

4) Turnover Evaluation

We evaluated the Efficiency by using two indicators, namely Total Assets Turnover and Receivable Turnover Rate. The details of two indicators are shown in Table 3.3.2-2.

Table 3.3.2-2 Indicators on Turnover Evaluation

Indicators	Formula	Reference	Comparative Figure(1) (TATA Power)	Comparative Figure(2)
Total Assets Turnover (times)	Turnover / ((Beginning Total Assets + Closing Total Assets) / 2)	Turnover Ratio to Total Assets	0.67	0.38
Receivable Turnover Rate (times)	Turnover / ((Beginning Receivables + Closing receivables) / 2)	Ability to Recover Receivables	4.48	–

Comparative Figure (1): Created by Study Team Based on Annual Report of The Tata Power Company Limited

Comparative Figure (2): per power utility company in Japan (source: METI, Japan)

(Source: JICA Study Team)

5) Stability Evaluation

We evaluated the Stability by using six indicators, namely Current Ratio, Quick Ratio, Fixed Assets Ratio, Fixed Assets to Fixed Liability Ratio, Debt Equity Ratio and Interest Coverage Ratio. The details of six indicators are shown in Table 3.3.2-3.

Table 3.3.2-3 Indicators on Stability Evaluation

Indicators	Formula	Reference	Comparative Figure(1) (TATA Power)	Comparative Figure(2)
Current Ratio (%)	Current Assets / Current Liabilities * 100	Measures whether or not a Company Has Enough Resources to Pay its Debts in Short-term	116.66%	-
Quick Ratio (%)	Quick Assets / Current Liabilities * 100	The Ability of a Company to Use its Near Cash or Quick Assets to Extinguish or Retire its Current Liabilities Immediately	23.21%	-
Fixed Assets Ratio (%)	Fixed Assets / Equity * 100	Ratio Raised in Equity Capital of the Fixed Ass	239.51%	390%
Fixed Assets to Fixed Liability Ratio (%)	Fixed Assets / (Fixed Liabilities + Equity) * 100	Ratio Raised in Equity Capital and Fixed Liabilities of the Fixed Assets	82.88%	-
Debt Equity Ratio (%)	Debt / Equity * 100	Long-term financial stability	2.65	-
Interest Coverage Ratio (%)	(Operating Income + Financial Revenue) / (Financial Expenditure) * 100	Measure of a Company's Ability to Honor its Debt Payments	4.64	-

Comparative Figure (1): Created by Study Team Based on Annual Report of The Tata Power Company Limited

Comparative Figure (2): per power utility company in Japan (source: METI, Japan)

(Source: JICA Study Team)

6) Evaluation of Growth Potential

We evaluated the Stability by using two indicators, namely Growth Rate in Turnover and Growth Rate in Ordinary Income. The details of two indicators are shown in Table 3.3.2-4.

Table 3.3.2-4 Indicators on Evaluation of Growth Potential

Indicators	Formula	Reference	Comparative Figure(1) (TATA Power)	Comparative Figure(2)
Growth Rate in Turnover (%	(Turnover - Prior Turnover) / Prior Turnover * 100	Evaluation of increase in turnover	1.46%	-11.6%
Growth Rate in Ordinary Income (%)	(Ordinary Income - Prior Ordinary Income) / Prior Ordinary Income * 100	Evaluation of increase in ordinary income	14.10%	-

Comparative Figure (1): Created by Study Team Based on Annual Report of The Tata Power Company Limited

Comparative Figure (2): per power utility company in Japan (source: METI, Japan)

(Source: JICA Study Team)

7) Evaluation of Overall Profitability

We evaluated the Stability by using two indicators, namely Return on Equity (ROE) and Return on Assets (ROA). The details of two indicators are shown in Table 3.3.2-5.

Table 3.3.2-5 Indicators on Evaluation of Overall Profitability

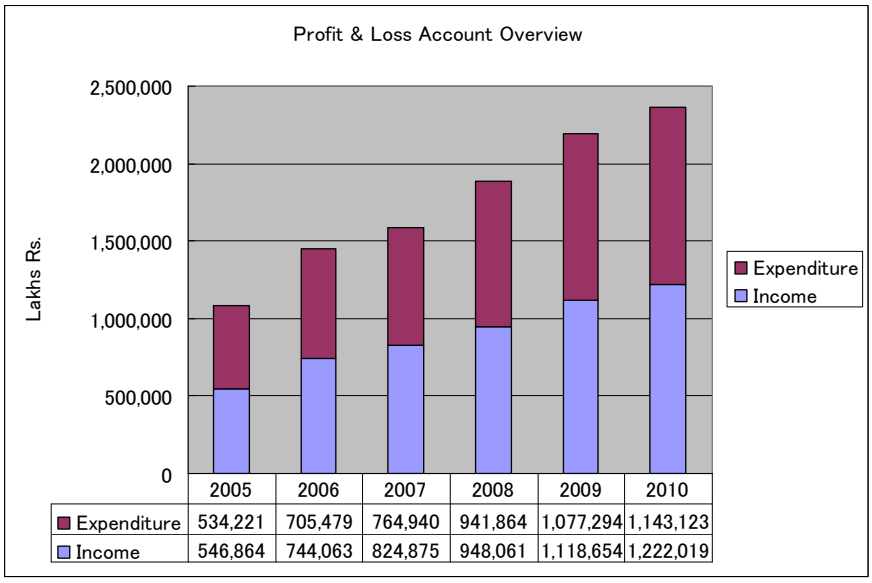
Indicators	Formula	Reference	Comparative Figure(1) (TATA Power)
Return on Equity (ROE, %)	Net Profit / ((Beginning Equity + Closing Equity) / 2) * 100	The Rate of Return on the Ownership Interest (shareholders' equity) of the Common Stock Owners	17.04%
Return on Assets (ROA, %)	(Operating Income + Financial Revenue) / ((Beginning Total Assets + Closing Total Assets)/2) * 100	Overall Corporate Profitability Evaluation	6.91%

Comparative Figure (1): Created by Study Team Based on Annual Report of The Tata Power Company Limited

(Source: JICA Study Team)

(2) Financial Status on Maharashtra State Power generation Co., Ltd (MAHAGENCO)

1) Profit & Loss Account Overview



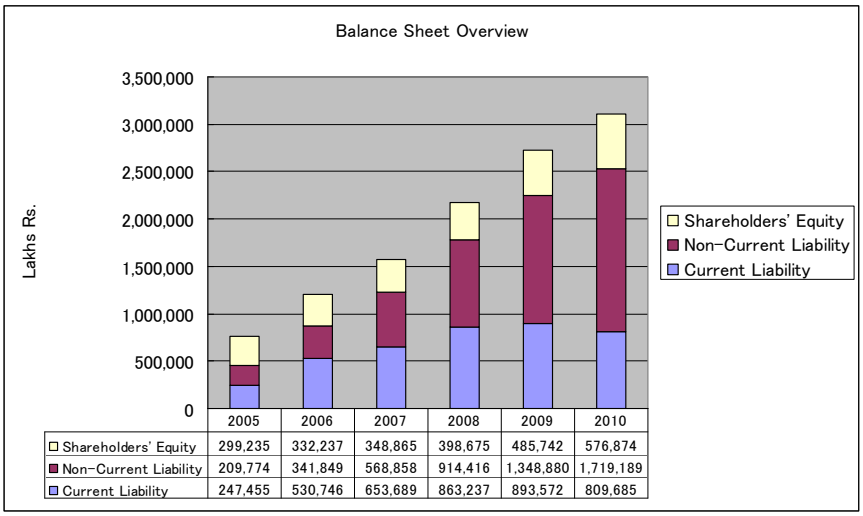
	2005	2006	2007	2008	2009	2010
Expenditure	534,221	705,479	764,940	941,864	1,077,294	1,143,123
Income	546,864	744,063	824,875	948,061	1,118,654	1,222,019

(Source: JICA Study Team, based on Annual Report of MAHAGENCO)

Figure 3.3.2-1 Profit & Loss Account Overview on MAHAGENCO

MAHAGENCO, operating income has remained in surplus, have shown strong income growth (an increase of 123.5%) during FY 2005 to FY 2010. However, its expenditure has also been an increase (an increase of 114.0%) as well as growth of income.

2) Balance Sheet Overview



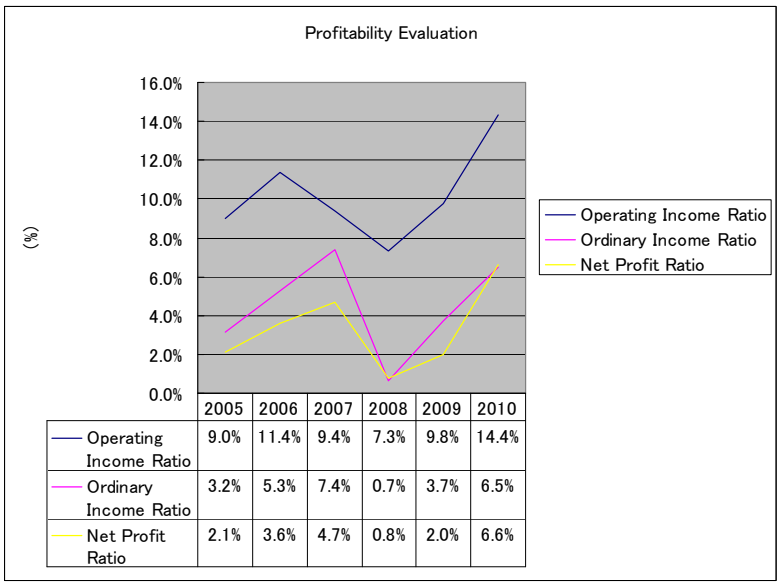
	2005	2006	2007	2008	2009	2010
Shareholders' Equity	299,235	332,237	348,865	398,675	485,742	576,874
Non-Current Liability	209,774	341,849	568,858	914,416	1,348,880	1,719,189
Current Liability	247,455	530,746	653,689	863,237	893,572	809,685

(Source: JICA Study Team, based on Annual Report of MAHAGENCO)

Figure 3.3.2-2 Balance Sheet Overview on MAHAGENCO

Total assets have increased significantly MAHAGENCO during FY 2005 to FY 2010. Shareholders' equity is increasing by 92.8% because of investment from the State of Maharashtra and MESB. As well as shareholder's equity, current liabilities and non-current liabilities are also significantly increased in 3.27 times and 8.20 times respectively.

3) Profitability Evaluation



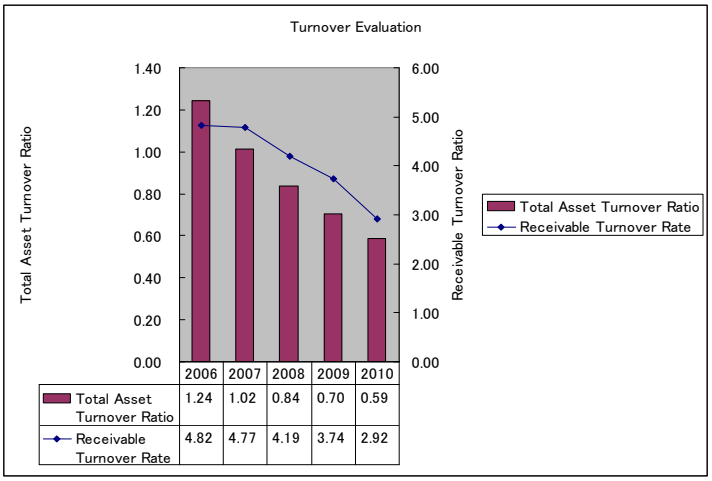
	2005	2006	2007	2008	2009	2010
Operating Income Ratio	9.0%	11.4%	9.4%	7.3%	9.8%	14.4%
Ordinary Income Ratio	3.2%	5.3%	7.4%	0.7%	3.7%	6.5%
Net Profit Ratio	2.1%	3.6%	4.7%	0.8%	2.0%	6.6%

(Source: JICA Study Team, based on Annual Report of MAHAGENCO)

Figure 3.3.2-3 Profitability Evaluation on MAHAGENCO

Operating Income Ratio of MAHAGENCO, since 2005, has remained around 10%. Ordinary Income Ratio and Net Profit Ratio has not been negative, while not high. Their figures have remained at almost the same level as the average of power utility companies in Japan.

4) Turnover Evaluation

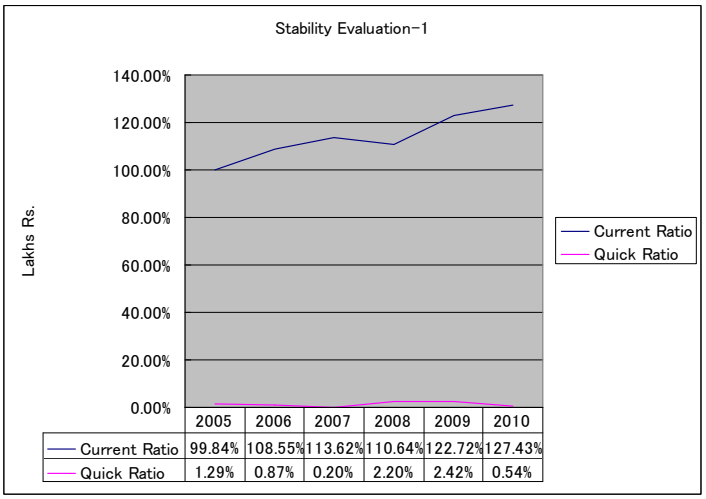


(Source: JICA Study Team, based on Annual Report of MAHAGENCO)

Figure 3.3.2-4 Turnover Evaluation on MAHAGENCO

The total asset turnover ratio has decreased during FY 2005 to FY 2010 due to the increase in total assets. In equipment-intensive industries such as power sector in general, some low figures tend to be calculated, however MAHAGENCO is higher than average of power utility companies in Japan. In addition, receivable Turnover Rate is about 3.0 to 5.0, there is no problem in general. Therefore, Turnover Evaluation has kept in general level.

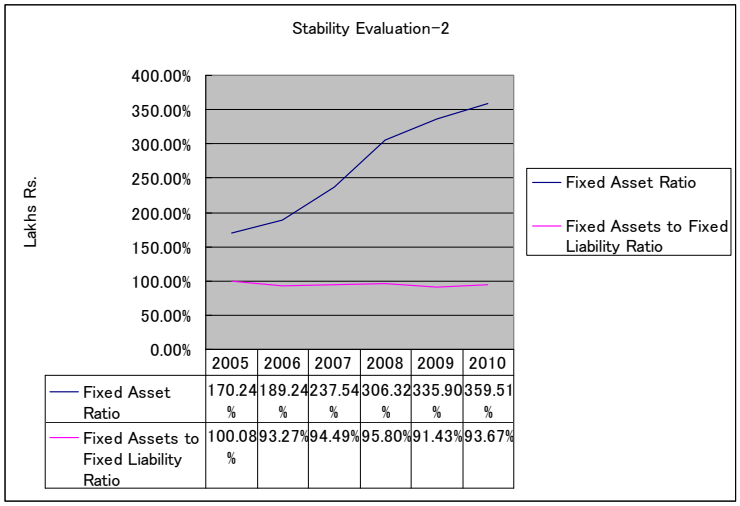
5) Stability Evaluation



(Source: JICA Study Team, based on Annual Report of MAHAGENCO)

Figure 3.3.2-5 Stability Evaluation on MAHAGENCO -1

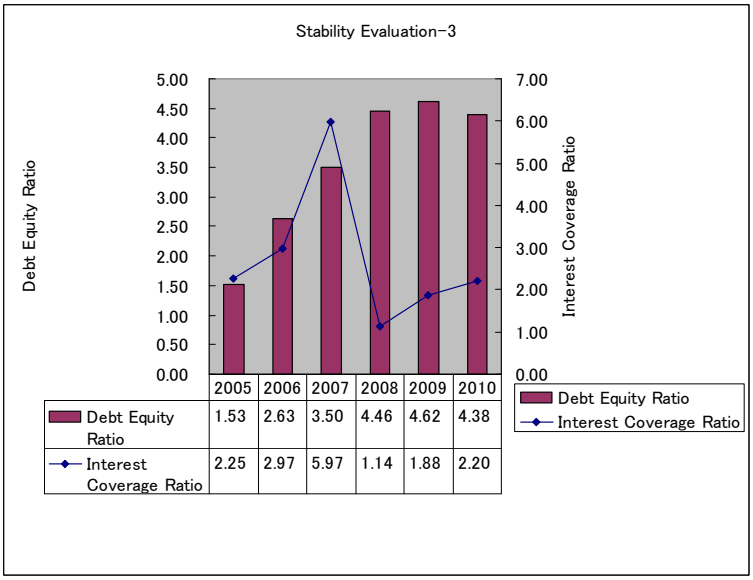
Current ratio, which is to be around 100%, and high ability to repay debt but in general (Very high ability is around 200%), is determined to be stable. On the other hand, the quick ratio has remained very low number because their liquidity is low. Accordingly, it is possible to determine the liquidity of short-term has some problem, and short-term financial status is stable enough.



(Source: JICA Study Team, based on Annual Report of MAHAGENCO)

Figure 3.3.2-6 Stability Evaluation on MAHAGENCO -2

Fixed Assets Ratio in FY 2010 shows a significant increase compared to FY 2005. Because the increase of fixed assets is much higher than that of shareholder's equity. In addition, Fixed Assets to Fixed Liability Ratio, considering the long-term liabilities, has remained around 100%. Therefore long-term financial status has no problem in general.

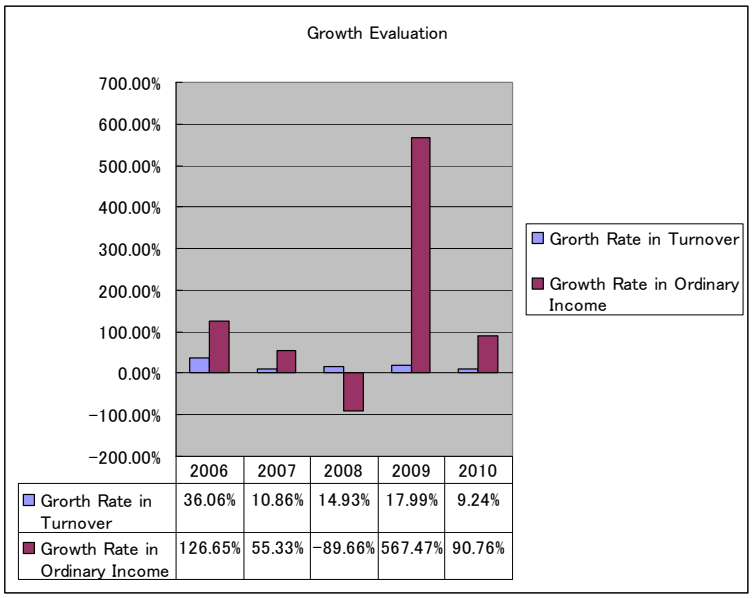


(Source: JICA Study Team, based on Annual Report of MAHAGENCO)

Figure 3.3.2-7 Stability Evaluation on MAHAGENCO -3

Debt Equity ratio has been increasing about three times during FY 2005 to FY 2010 due to an increase in borrowing. In addition, the interest coverage ratio has been also increasing about four times during FY 2005 to FY 2010 due to increase of financial expenditure, however it has almost remained flat. However, in short-term, there is no issue while there seems to be possible that there is a slight problem in terms of financial expenditures. In any case it should also consider compression of borrowing and increase of shareholder's equity.

6) Growth Evaluation



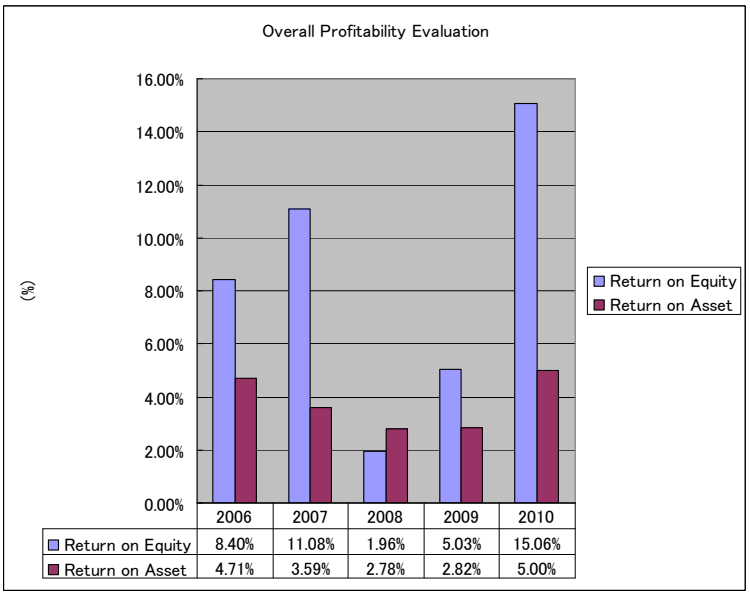
	2006	2007	2008	2009	2010
Grorth Rate in Turnover	36.06%	10.86%	14.93%	17.99%	9.24%
Growth Rate in Ordinary Income	126.65%	55.33%	-89.66%	567.47%	90.76%

(Source: JICA Study Team, based on Annual Report of MAHAGENCO)

Figure 3.3.2-8 Growth Evaluation on MAHAGENCO

Growth rate in Turnover has increased every year in two digits. Growth rate in ordinary income has remained at very high level without FY 2008.

7) Overall Profitability Evaluation



	2006	2007	2008	2009	2010
Return on Equity	8.40%	11.08%	1.96%	5.03%	15.06%
Return on Asset	4.71%	3.59%	2.78%	2.82%	5.00%

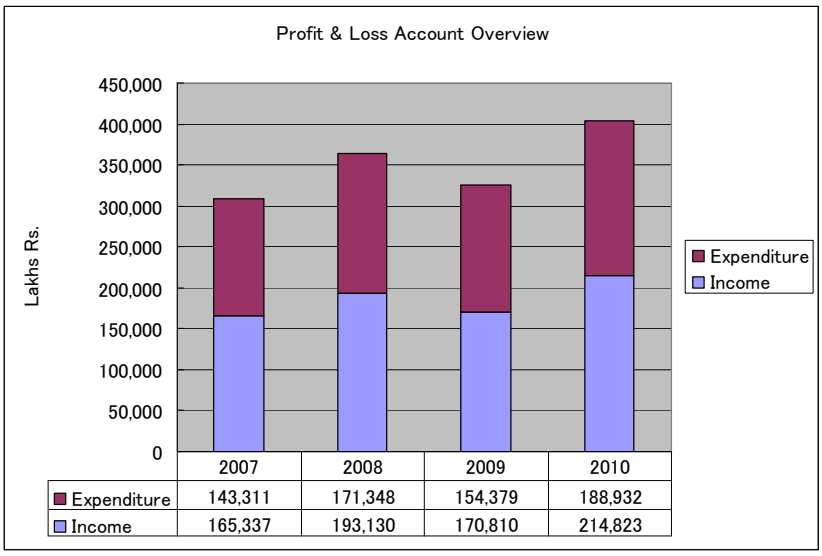
(Source: JICA Study Team, based on Annual Report of MAHAGENCO)

Figure 3.3.2-9 Overall Profitability Evaluation on MAHAGENCO

AHAGENCO has no problem from the viewpoint of financial stability because ROE and ROA have remained positive (+). However profitability leaves some room for improvement, taking interest rate and inflation in account.

(3) Financial Status on Maharashtra State Electricity Transmission Co., Ltd. (MAHATRANSCO)

1) Profit & Loss Account Overview



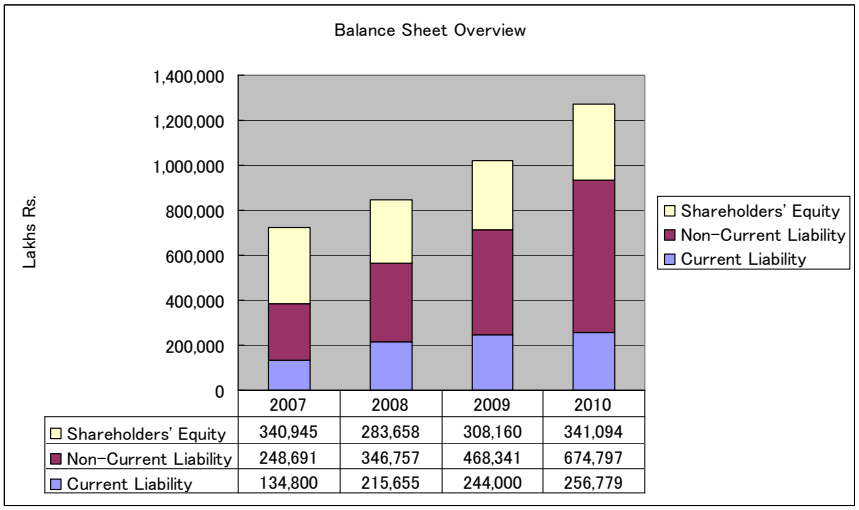
	2007	2008	2009	2010
Expenditure	143,311	171,348	154,379	188,932
Income	165,337	193,130	170,810	214,823

(Source: JICA Study Team, based on Annual Report of MAHATRANSCO)

Figure 3.3.2-10 Profit & Loss Account Overview on MAHATRANSCO

Operating income has remained in surplus since FY 2007 but in FY 2009 income fell temporarily. Except for FY 2009, income has increased steadily. On the other hand, expenditure has also increased the amount of operating income has not increased.

2) Balance Sheet Overview



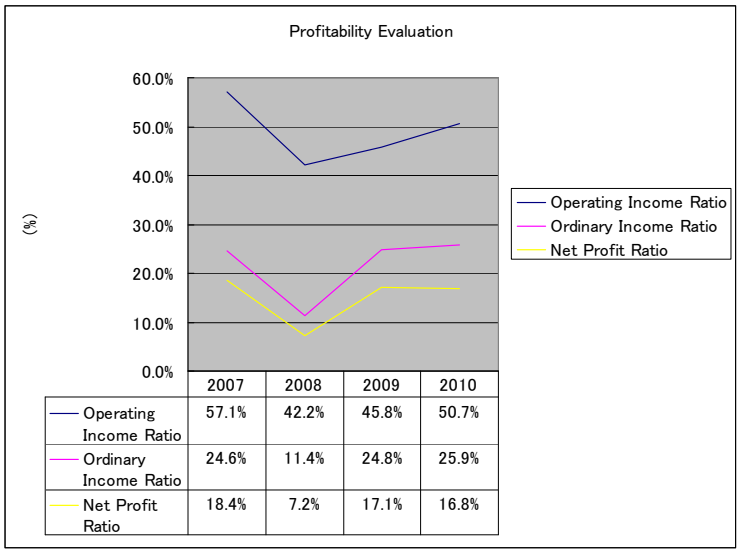
	2007	2008	2009	2010
Shareholders' Equity	340,945	283,658	308,160	341,094
Non-Current Liability	248,691	346,757	468,341	674,797
Current Liability	134,800	215,655	244,000	256,779

(Source: JICA Study Team, based on Annual Report of MAHATRANSCO)

Figure 3.3.2-11 Balance Sheet Overview on MAHATRANSCO

Total assets of MAHATRANSCO is increasing since FY 2007, have shown (2.7 times). Compared to the growth of shareholder's equity and current liability (virtually unchanged, increase of 90.5% respectively), the non-current liabilities is particularly high.

3) Profitability Evaluation



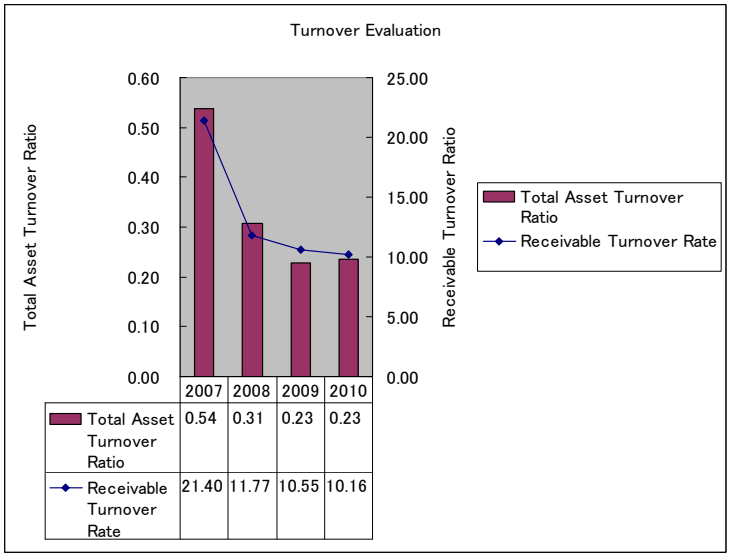
	2007	2008	2009	2010
Operating Income Ratio	57.1%	42.2%	45.8%	50.7%
Ordinary Income Ratio	24.6%	11.4%	24.8%	25.9%
Net Profit Ratio	18.4%	7.2%	17.1%	16.8%

(Source: JICA Study Team, based on Annual Report of MAHATRANSCO)

Figure 3.3.2-12 Profitability Evaluation on MAHATRANSCO

Operating income ratio of MAHATRANSCO, remained more than 40%, shows a very high ratio. In addition, ordinary income ratio and net profit ratio have shown exceeding the rate of almost 10%. Therefore profitability can be determined with extremely high.

4) Turnover Evaluation



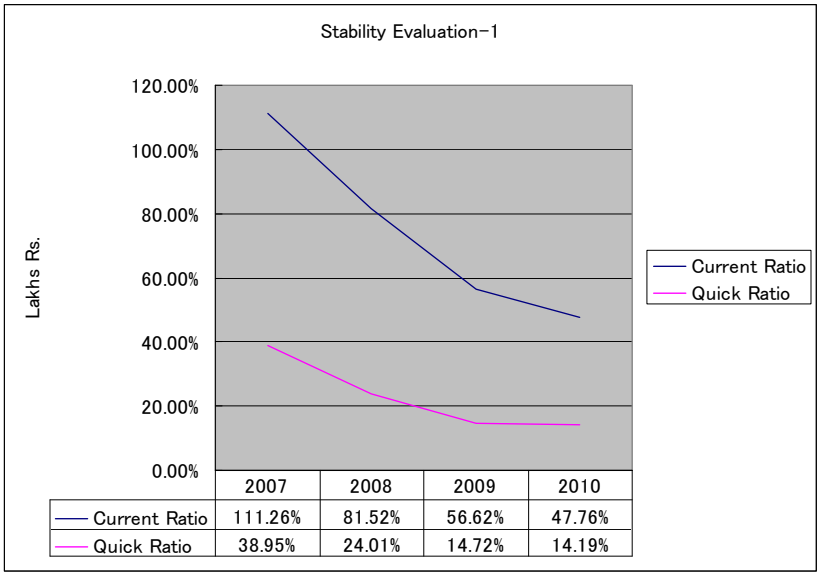
	2007	2008	2009	2010
Total Asset Turnover Ratio	0.54	0.31	0.23	0.23
Receivable Turnover Rate	21.40	11.77	10.55	10.16

(Source: JICA Study Team, based on Annual Report of MAHATRANSCO)

Figure 3.3.2-13 Turnover Evaluation on MAHATRANSCO

The total asset turnover ratio is equivalent to the average of power utility companies in Japan, while the power sector is intensive industries in general and calculated ratio lower than other sector. Also, receivable turnover ratio shows very high rate, because receivable amount has been kept low level. Therefore, the efficiency in accordance with assets and liability can be determined high level among electric power sector companies.

5) Stability Evaluation

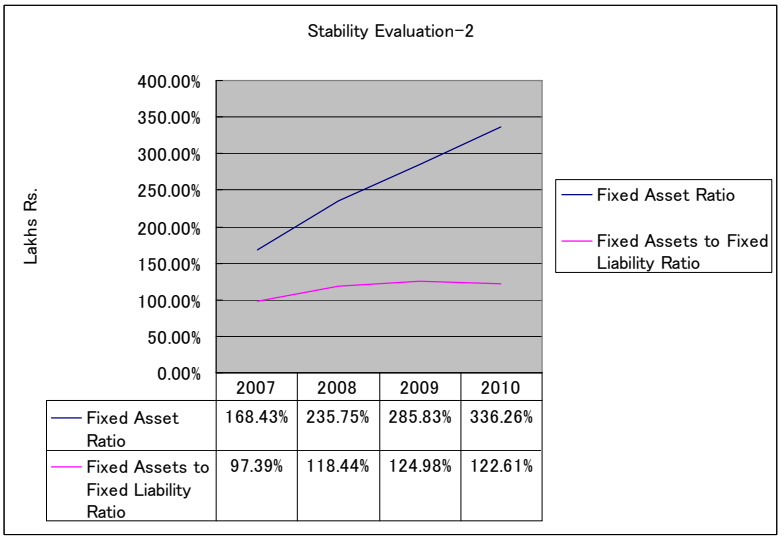


	2007	2008	2009	2010
Current Ratio	111.26%	81.52%	56.62%	47.76%
Quick Ratio	38.95%	24.01%	14.72%	14.19%

(Source: JICA Study Team, based on Annual Report of MAHATRANSCO)

Figure 3.3.2-14 Stability Evaluation on MAHATRANSCO -1

The current ratio shows that the ability of short-term repayment is gradually low because it ratio is decreasing according to increase of current liability. On the other hand, quick ratio is also decreasing and shows low liquidity. Therefore, there is a need for improvement of short-term liquidity.

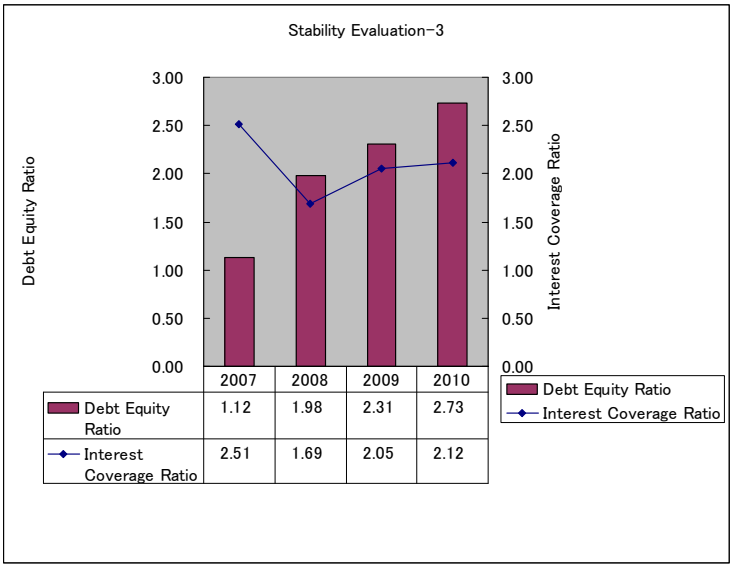


	2007	2008	2009	2010
Fixed Asset Ratio	168.43%	235.75%	285.83%	336.26%
Fixed Assets to Fixed Liability Ratio	97.39%	118.44%	124.98%	122.61%

(Source: JICA Study Team, based on Annual Report of MAHATRANSCO)

Figure 3.3.2-15 Stability Evaluation on MAHATRANSCO -2

Fixed asset ratio since FY 2007 has shown a significant increase, because the increase of fixed asset is higher than that of shareholder's equity. However fixed assets to fixed liability ratio, considering the long-term liabilities, has remained around 100%, long-term financial status has no problem in general.

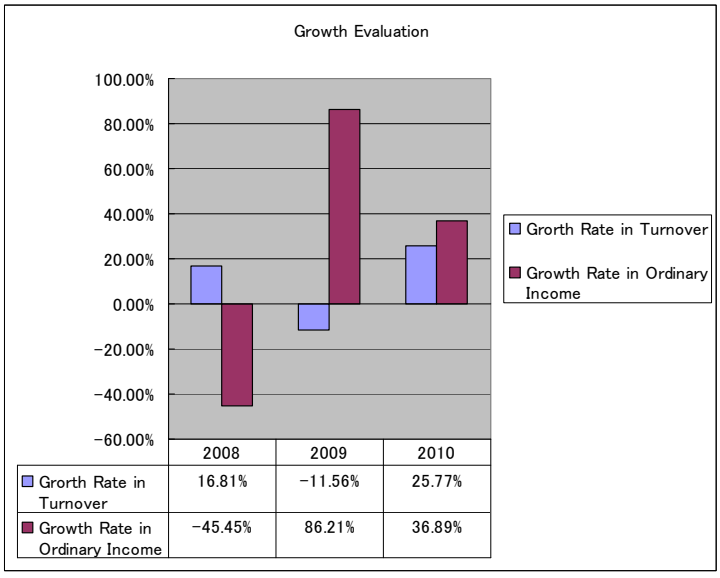


(Source: JICA Study Team, based on Annual Report of MAHATRANSCO)

Figure 3.3.2-16 Stability Evaluation on MAHATRANSCO -3

Debt Equity ratio has been increasing about 2.5 times since FY 2007 due to an increase in borrowing. In addition, the interest coverage ratio has remained at high level since FY 2007 due to increase of financial expenditure. However, in short-term, there is no issue because operating profit is stable. In any case it should also consider compression of borrowing and increase of shareholder's equity.

6) Growth Evaluation

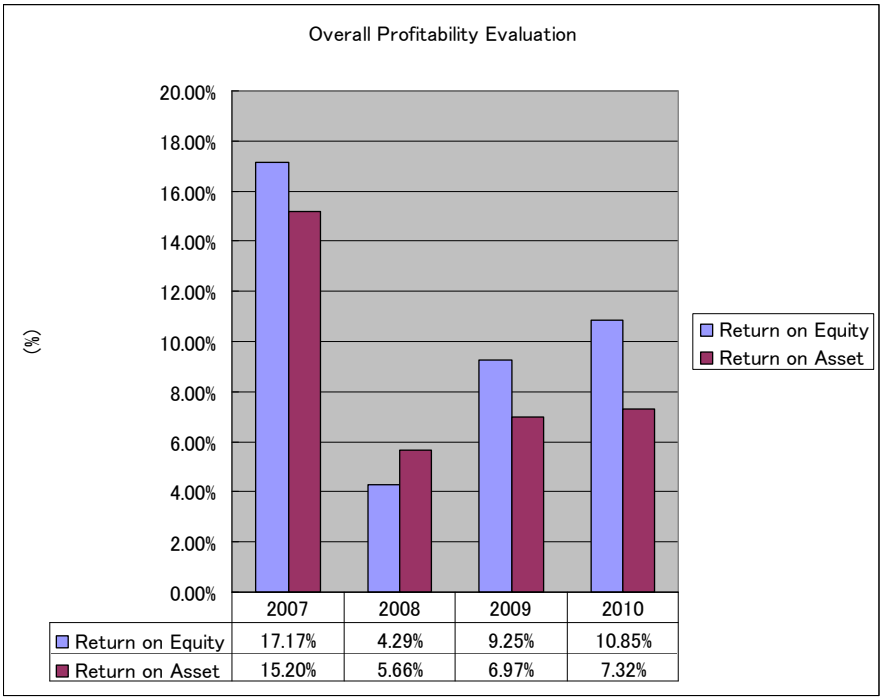


(Source: JICA Study Team, based on Annual Report of MAHATRANSCO)

Figure 3.3.2-17 Growth Evaluation on MAHATRANSCO

Growth rate in Turnover has increased every year in two digits except for FY 2009. Growth rate in ordinary income has remained at very high level without FY 2008.

7) Overall Profitability Evaluation



	2007	2008	2009	2010
Return on Equity	17.17%	4.29%	9.25%	10.85%
Return on Asset	15.20%	5.66%	6.97%	7.32%

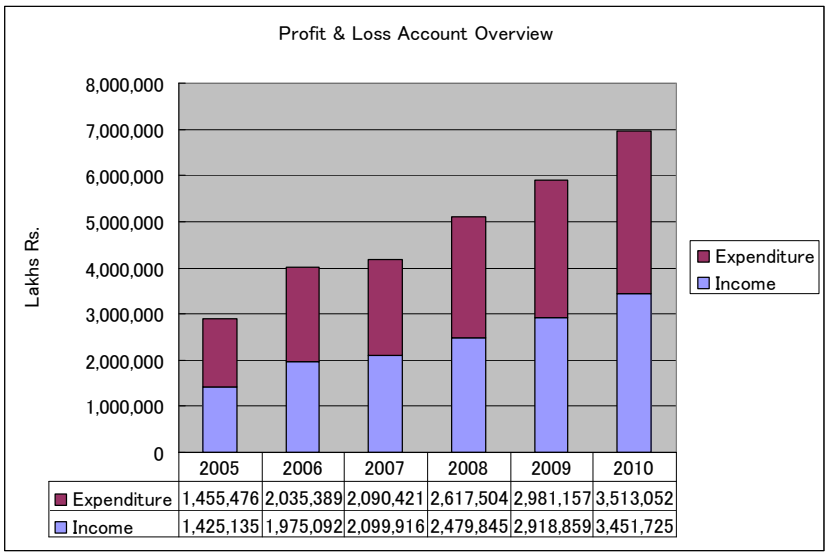
(Source: JICA Study Team, based on Annual Report of MAHATRANSCO)

Figure 3.3.2-18 Overall Profitability Evaluation on MAHATRANSCO

AHATRANSCO has no problem from the viewpoint of financial stability because ROE and ROA have remained positive (+). However profitability leaves some room for improvement, taking interest rate and inflation in account.

(4) Financial Status on Maharashtra State Electricity Distribution Co., Ltd (MAHADISCOM)

1) Profit & Loss Account Overview



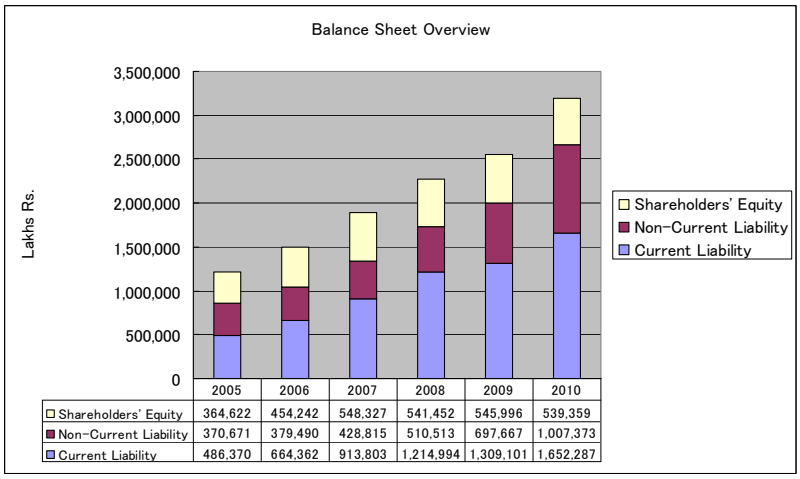
	2005	2006	2007	2008	2009	2010
Expenditure	1,455,476	2,035,389	2,090,421	2,617,504	2,981,157	3,513,052
Income	1,425,135	1,975,092	2,099,916	2,479,845	2,918,859	3,451,725

(Source: JICA Study Team, based on Annual Report of MAHADISCOM)

Figure 3.3.2-19 Profit & Loss Account Overview on MAHADISCOM

MAHADISCOM has recorded an operating loss except in FY 2007, while income are growing steadily. It is necessary to make a effort to increase income or reduce the expenditure.

2) Balance Sheet Overview



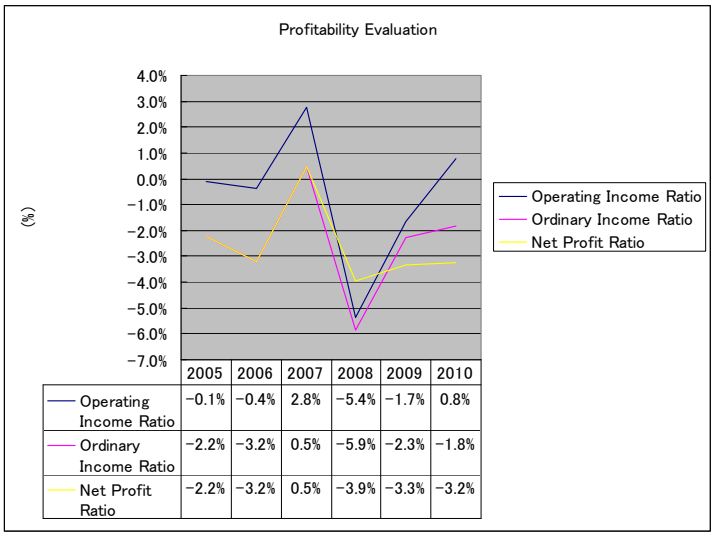
	2005	2006	2007	2008	2009	2010
Shareholders' Equity	364,622	454,242	548,327	541,452	545,996	539,359
Non-Current Liability	370,671	379,490	428,815	510,513	697,667	1,007,373
Current Liability	486,370	664,362	913,803	1,214,994	1,309,101	1,652,287

(Source: JICA Study Team, based on Annual Report of MAHADISCOM)

Figure 3.3.2-20 Balance Sheet Overview on MAHADISCOM

Key feature for structure of total assets of MAHADISCOM is that the share of current liability is large and the amount is increasing (2.7 times). Consumer deposit and accounts receivable according to electricity sales, accounted for much of the current liabilities, has increased year by year.

3) Profitability Evaluation



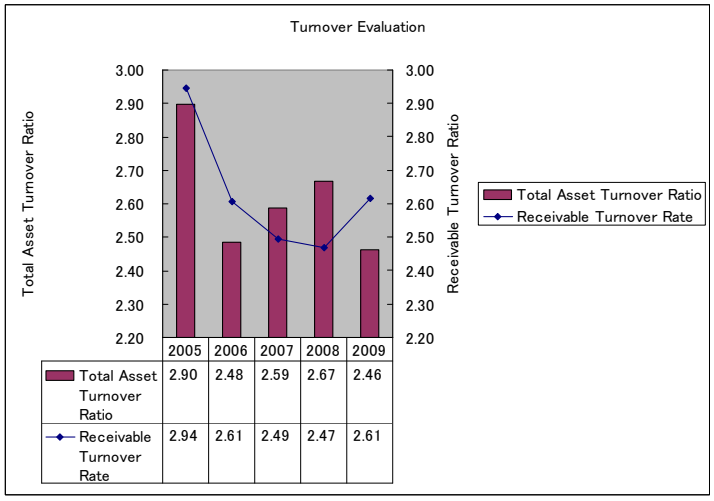
	2005	2006	2007	2008	2009	2010
Operating Income Ratio	-0.1%	-0.4%	2.8%	-5.4%	-1.7%	0.8%
Ordinary Income Ratio	-2.2%	-3.2%	0.5%	-5.9%	-2.3%	-1.8%
Net Profit Ratio	-2.2%	-3.2%	0.5%	-3.9%	-3.3%	-3.2%

(Source: JICA Study Team, based on Annual Report of MAHADISCOM)

Figure 3.3.2-21 Profitability Evaluation on MAHADISCOM

Operating income ratio of MAHADISCOM, except for FY 2007, has remained at all negative. Ordinary income ratio and net profit ratio also has remained in negative except for FY 2007. MAHADISCOM has continued severe situation in a viewpoint from profitability.

4) Turnover Evaluation



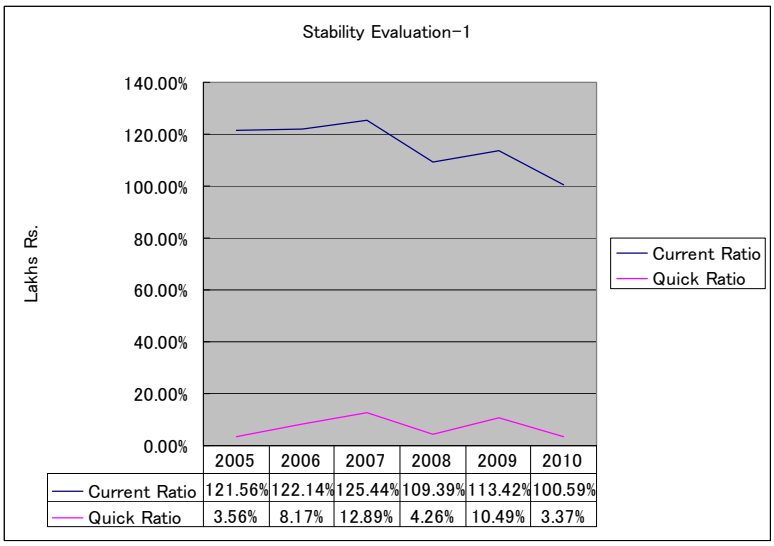
	2005	2006	2007	2008	2009
Total Asset Turnover Ratio	2.90	2.48	2.59	2.67	2.46
Receivable Turnover Rate	2.94	2.61	2.49	2.47	2.61

(Source: JICA Study Team, based on Annual Report of MAHADISCOM)

Figure 3.3.2-22 Turnover Evaluation on MAHADISCOM

The total asset turnover ratio, during FY 2005 to FY 2009, has remained almost flat. Its ratio is higher than average of power utility companies in Japan while ratio of equipment-intensive industries such as power sector in general is calculated relatively lower than that of other sector. In addition, receivable turnover rate is around 2.5, the problem is not seen in particular in this point. Therefore, the efficiency can be determined to remain at general level in accordance with asset and liability.

5) Stability Evaluation

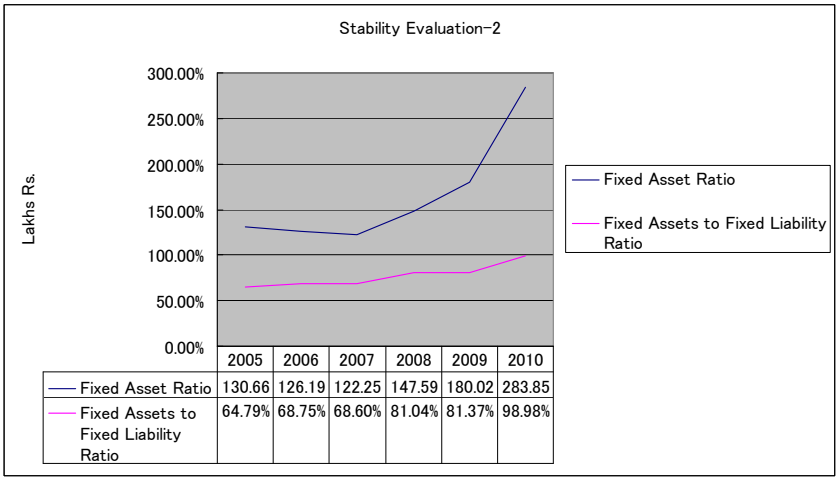


	2005	2006	2007	2008	2009	2010
Current Ratio	121.56%	122.14%	125.44%	109.39%	113.42%	100.59%
Quick Ratio	3.56%	8.17%	12.89%	4.26%	10.49%	3.37%

(Source: JICA Study Team, based on Annual Report of MAHADISCOM)

Figure 3.3.2-23 Stability Evaluation on MAHADISCOM -1

Current ratio, which is to be around 100%, and high ability to repay debt but in general (Very high ability is around 200%), is determined to be stable. On the other hand, the quick ratio has remained very low number because their liquidity is low. Accordingly, it is possible to determine the liquidity of short-term has some problem, and short-term financial status is stable enough.

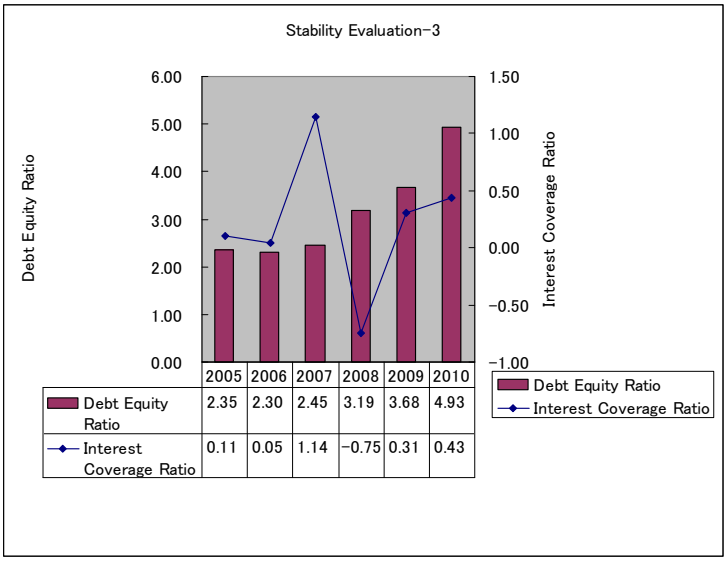


	2005	2006	2007	2008	2009	2010
Fixed Asset Ratio	130.66	126.19	122.25	147.59	180.02	283.85
Fixed Assets to Fixed Liability Ratio	64.79%	68.75%	68.60%	81.04%	81.37%	98.98%

(Source: JICA Study Team, based on Annual Report of MAHADISCOM)

Figure 3.3.2-24 Stability Evaluation on MAHADISCOM -2

Fixed asset ratio has increased since FY 2008 due to increases in fixed assets increased without increasing capital. In addition, the fixed assets to fixed liability ratio is below 100% but tends to improve. Considering the long-term liabilities, long-term financial stability has no problem in general.



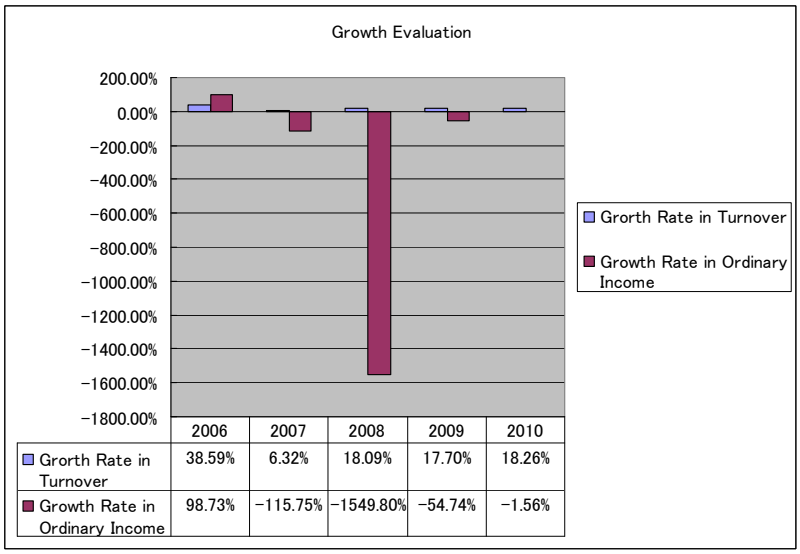
	2005	2006	2007	2008	2009	2010
Debt Equity Ratio	2.35	2.30	2.45	3.19	3.68	4.93
Interest Coverage Ratio	0.11	0.05	1.14	-0.75	0.31	0.43

(Source: JICA Study Team, based on Annual Report of MAHADISCOM)

Figure 3.3.2-25 Stability Evaluation on MAHADISCOM -3

Debt Equity ratio has been increasing since FY 2008 due to an increase in borrowing. In addition, the interest coverage ratio has remained around 0%. Therefore there is some problems in terms of financial expenditures. It should consider compression of borrowing and increase of shareholder's equity.

6) Growth Evaluation



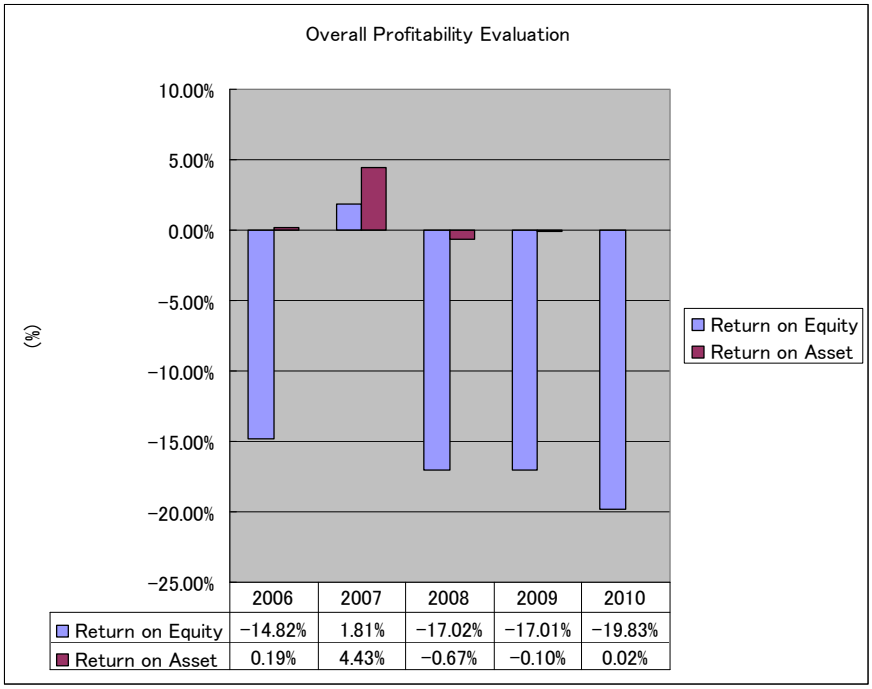
	2006	2007	2008	2009	2010
Grorth Rate in Turnover	38.59%	6.32%	18.09%	17.70%	18.26%
Growth Rate in Ordinary Income	98.73%	-115.75%	-1549.80%	-54.74%	-1.56%

(Source: JICA Study Team, based on Annual Report of MAHADISCOM)

Figure 3.3.2-26 Growth Evaluation on MAHADISCOM

Growth rate in turnover is growing steadily, and tend to increase in the future. However, growth rate in ordinary income has become almost negative compared with the previous fiscal year, the current account deficit has become chronic.

7) Overall Profitability Evaluation



	2006	2007	2008	2009	2010
Return on Equity	-14.82%	1.81%	-17.02%	-17.01%	-19.83%
Return on Asset	0.19%	4.43%	-0.67%	-0.10%	0.02%

(Source: JICA Study Team, based on Annual Report of MAHADISCOM)

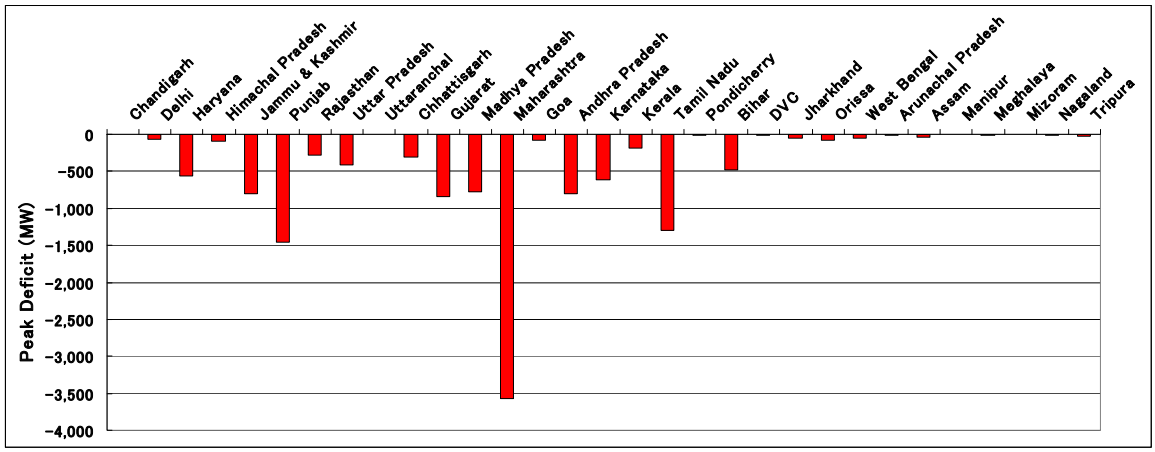
Figure 3.3.2-27 Overall Profitability Evaluation on MAHADISCOM

ROE and ROA is almost negative except in FY2007 when recorded a surplus of net income and operating profit. It is more important for MAHAGENCO to improve it generate a profit than to consider its ROE or ROA.

3.4 Electric Power Demand and Supply Balance

3.4.1 Electric Power Demand and Supply Balance

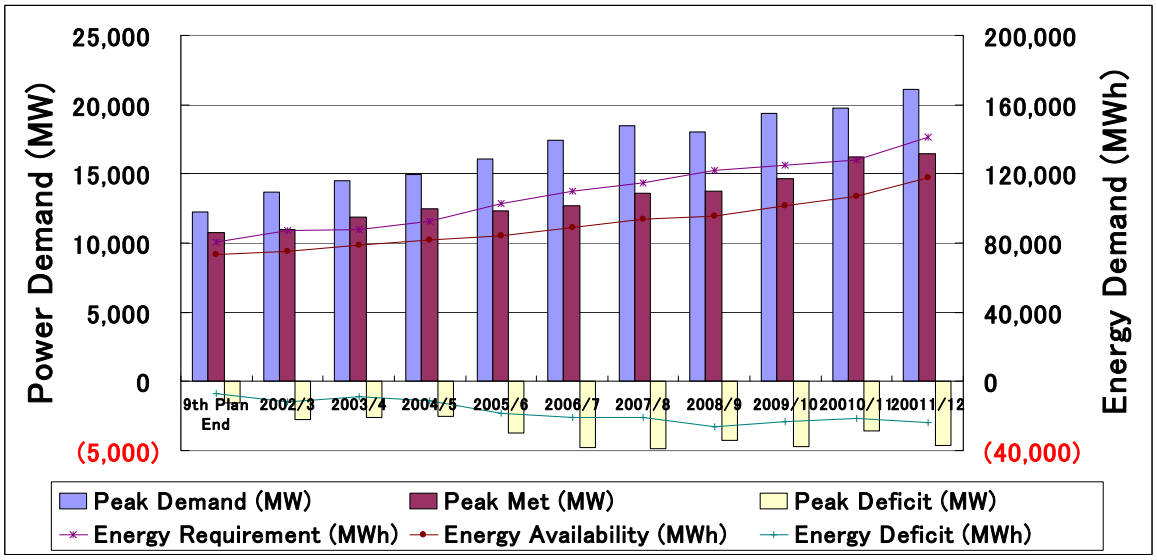
An electricity deficit of Maharashtra State in FY2010 is singularly bad compared with other States of India as shown in Figure 3.4.1-1.



(Source: CEA Annual Report)

Figure 3.4.1-1 Peak Power of India

The electric power demand and supply balance of Maharashtra State after the 9th Plan is shown in Figure 3.4.1-2. In spite that some increases and decreases are recognized in the power balance gaps in each year, an increasing trend can be found from this figure. That is because of the poor performance of the power development in the past in which the achievement ratios of the power development plans during the 10th Plan and the 11th Plan are around 50% only.



(Source: Monthly Report of Power Supply, CEA)

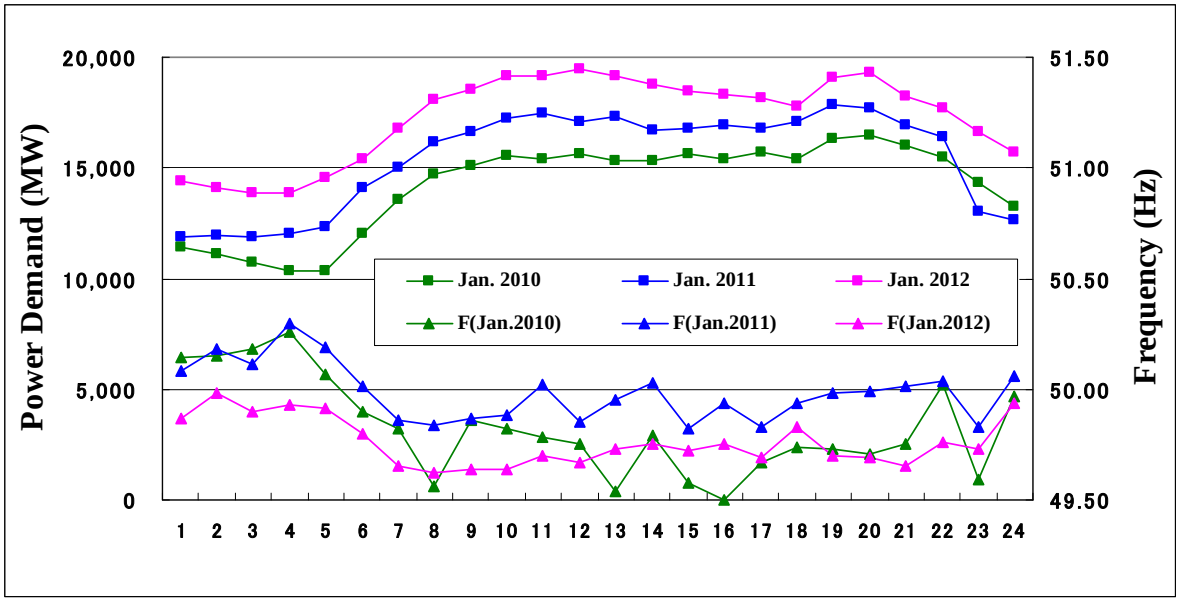
Figure 3.4.1-2 Power Balance of Maharashtra State

3.4.2 Power Demand Characteristic

The daily load curves and the frequency fluctuations at hourly intervals in January 2010, January 2011 and January are shown in Figure 3.4.2-1. Although the daily maximum peak loads in FY 2010 and FY 2011 occurred at 20 o'clock and 19 o'clock respectively mainly due to lighting, that in FY 2012 occurred at 12 o'clock. An occurrence of daily maximum peak load at lightning timing during night is a typical power demand characteristics for developing countries, while a peak load that in developed countries occurs in the daytime mainly due to industrial activities such as factory operation and air conditioner. In that sense, the power demand characteristic of Maharashtra state might be a transitional period from a developing country's pattern to a developed country's pattern.

Although power demand from 12 o'clock to 13 o'clock declines due to lunch break in Japan, the daily maximum power demand in Maharashtra State occurred 12 o'clock as shown in Figure 3.4.2-1 probably due to late lunch break in India (generally from 13 o'clock to 14 o'clock).

As shown figure below, lowering of frequency due to deficit of power is obvious. In spite that frequencies during midnight in the year 2010 and 2011 exceeded 50Hz, frequencies in the year 2012 fell below 50Hz all the day long.

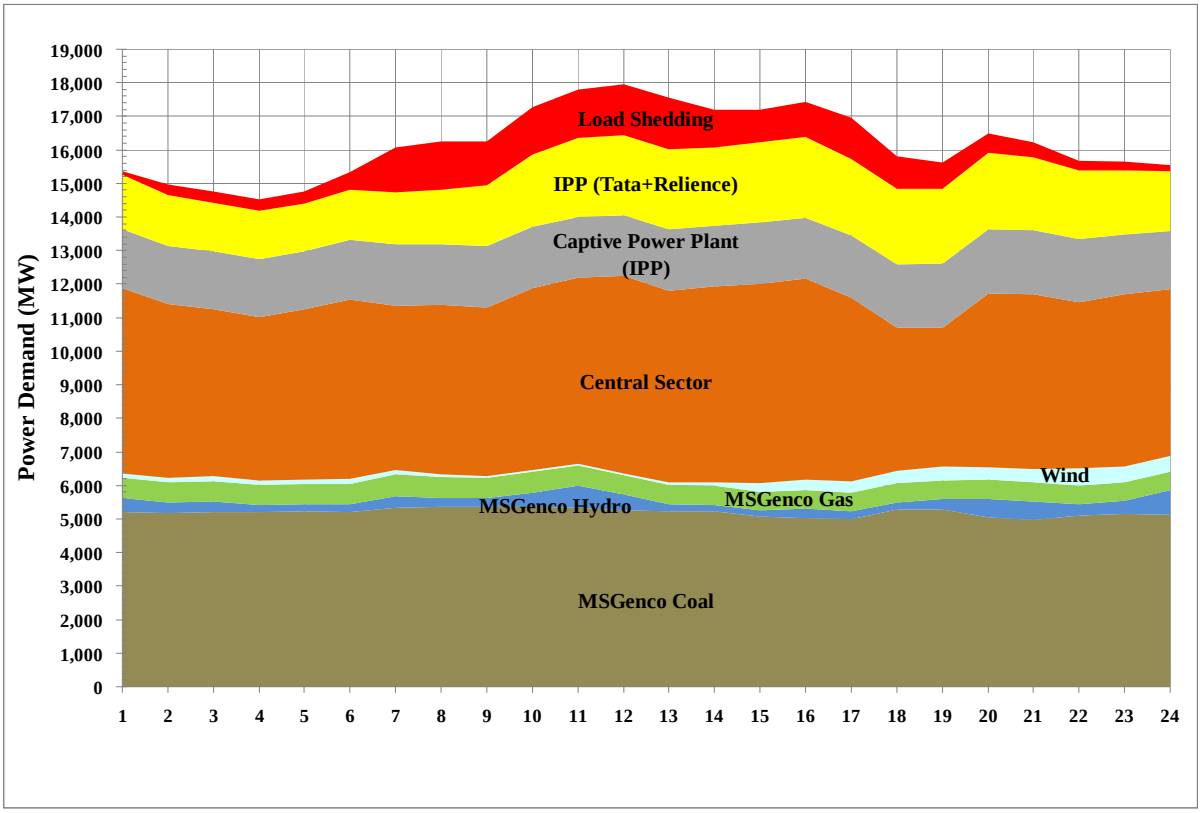


(Source: Daily Report, Mahatransco)

Figure 3.4.2-1 Daily Load & Frequency

Figure 3.4.2-2 shows the relation between the daily load curve on March 29 (Thu.), 2012 and power facilities to meet the power demand. The daily maximum peak load occurred at 12 o'clock too on that day. The occurrence of daily maximum peak load during daytime instead of during nighttime on that day is more apparent that that on January 2012. The power is insufficient all the day long, and the maximum deficit power of 1,556MW occurred at 13 'clock.

The daily maximum peak load was met around 35% with coal thermal power plants, gas thermal power plants and hydropower plants owned by MSGenco[1], around 33% with power interchange from Central Sector, around 33% with IPPs and around 8% with power cut.



(Source: Mahatransco)

Figure 3.4.2-2 Hourly Load on 29 March-2012[2]

3.5 Power Facilities

3.5.1 Generation

The power plants of Maharashtra State are ownership wisely classified into the State Sector, the Private Sector and the Central Sector. The generation companies of the Central Sector are such as National Thermal Power Corporation Ltd. (NTPC), National Hydroelectric Power Corporation Ltd. (NHPC) and Nuclear Power Corporation of India Ltd. (NPCIL)

The installed generation capacity of Maharashtra State as of the end of March 2012 is 26,142MW consisting of 57%coal thermal, 13% gas thermal, 3% nuclear, 13% hydro and 14% renewable energy. The coal and gas thermal plants for base load account for 70% of the total.

[1] MSGenco Coal/Hydro/Gas: Coal Thermal/Hydro/Gas Thermal Power Station owned by Maharashtra State Generation Co., Ltd.

[2] Captive Power Plants (IPP): owned by JSW Energy

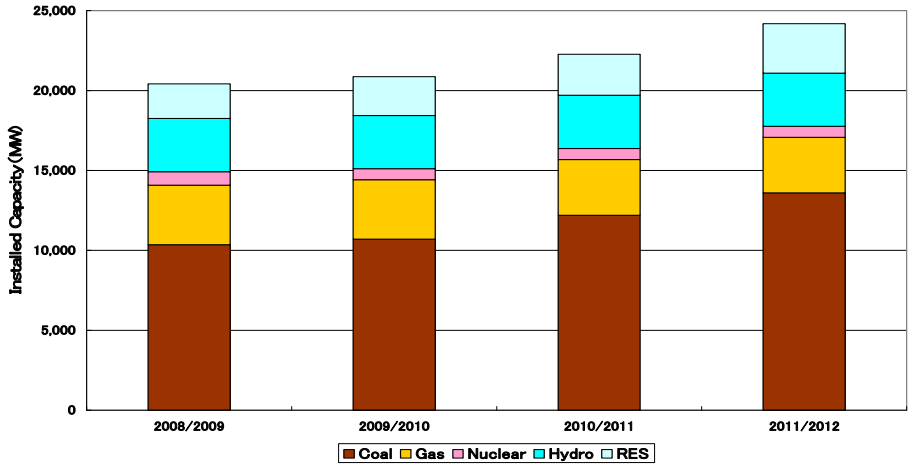
Table 3.5.1-1 Installed Generation Capacity of Maharashtra State (as of 31.3.2012)

(Unit: MW)

	Coal	Gas	Nuclear	Hydro	RES[3]	Total
States	8,650	672	0	2,885	287	12,494
Private	3,886	180	0	447	3,343	7,856
Central	2,478	2,624	690	0	0	5,792
Total	15,014	3,476	690	3,332	3,630	26,142
Ratio	57%	13%	3%	13%	14%	100%

(Source: CEA Monthly Report)

The constitution of power resource of Maharashtra State since FY2008 to FY2011 is shown in Table 3.5.1-1. During this time, the capacity expansion was achieved mainly by coal thermal and secondly by renewable energy. The capacity of gas thermal and hydro increased very little.

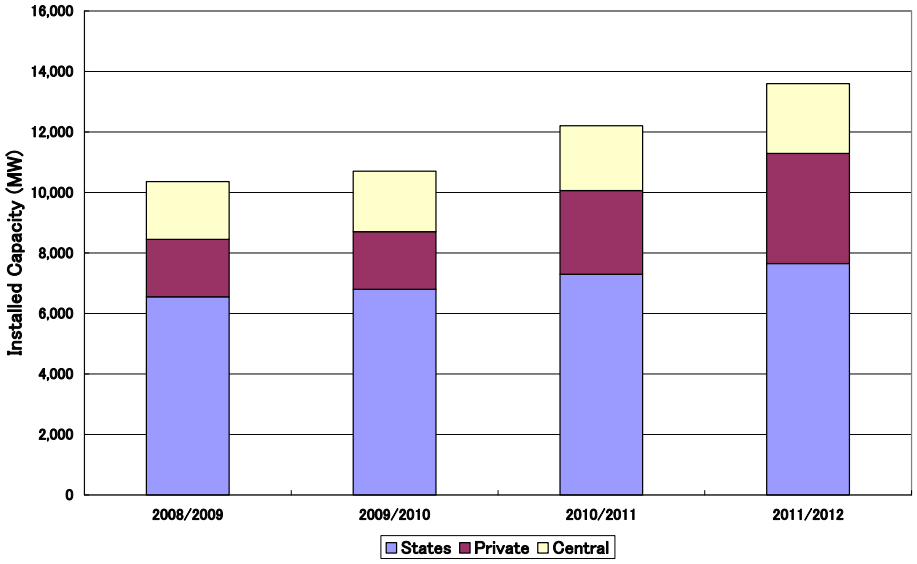


(Source: Annual Report, Ministry of Power)

Figure 3.5.1-1 Power Generation Composition of Maharashtra State

Coal thermal is playing a major role to meet the increasing power demand of Maharashtra State. As shown in Figure 3.5.1-2, all sectors, the State Sector, the Private Sector and the Central Sector, is contributing for new coal thermal power plants.

[3] RES: Renewable Energy Sources



(Source: Annual Report, Ministry of Power)

Figure 3.5.1-2 Sector Wise Coal Thermal Composition of Maharashtra State

The existing power plants owned by MSGenco are shown in Table 3.5.1-2.

Table 3.5.1-2 Installed Generation Capacity of Maharashtra State (as of 30.11.2011)

	Power Station	Unit	Capacity (MW)	Total Capacity (MW)
Coal Thermal	Nasik	No. 3	210	610
		No. 4	210	
		No. 5	210	
	Koradi	No. 5	200	620
		No. 6	210	
		No. 7	210	
	Bhusawal	No. 2	210	1,420
		No. 3	210	
		No. 4	500	
		No. 5	500	
	Parli	No. 3	210	1,130
		No. 4	210	
		No. 5	210	
		No. 6	250	
		No. 7	250	
	Paras	No. 3	250	500
		No. 4	250	
	Chandrapur	No. 1	210	2,340
		No. 2	210	
		No. 3	210	
		No. 4	210	
		No. 5	500	
		No. 6	500	

	Power Station	Unit	Capacity (MW)	Total Capacity (MW)
		No. 7	500	
	Khaparkheda	No. 1	210	1,340
		No. 2	210	
		No. 3	210	
		No. 4	210	
		No. 5	500	
	Total			7,980
Gas Themal	Uran	No. 5	108	432
		No. 6	108	
		No. 7	108	
		No. 8	108	
	Uran EHR	AO	120	240
		BO	120	
	Total			672
Hydro	Koyna-I		320	320
	Koyna-II		280	280
	Koyna-III		320	320
	Koyna-IV		1,000	1,000
	Koyna DPH		36	36
	Vaitarna		60	60
	Bhira-TR		80	80
	Tillari		60	60
	Bhandardara		34	34
	Penchi-(1/3) Share		53	53
	Sardar Sarovar (27%)		392	392
	Ghatghar PSS		250	250
	Total		2,885	2,885

(Source: Mahagenco)

3.5.2 The Existing Transmission Lines and Substations

The voltage 765kV, 400kV, 220kV, 132kV, 110kV, 66kV, 33kV are applied as the nominal voltages for the power network system in India and HVDC is applied for the system.

The transmission sector in Maharashtra State has a national transmission utility, which is called PGCIL (Power Grid Corporation of India Limited), as a central sector and a state transmission utility, which is called MAHATRANSCO (Maharashtra State Electricity Transmission CO.LTD).

PGCIL plans to construct and maintain 765kV and 400kV transmission lines and substations. MAHATRANSCO plans to construct and maintain partial 400kV and 220kV and under transmission lines and substations.

3.6 Status of Power Distribution Sector

3.6.1 Power Exchange Market

Electricity Act of 2003 includes a stipulation to power trading and introduction of such market to trade electric power was decided. In February 2007, Central Electricity Regulatory Committee (CERC), which regulates the electric power business established guidelines to trade electricity at a national level, and the basis to set up a power trading market was made.

(1) Power Exchangers

As of 2012, two (2) companies are operating in the power exchange market: one is Indian Power Exchange Limited (IEX), and the other is Power Exchange India Limited (PXIL). In addition to these forerunners, National Power Exchange Limited (NPEX) and Marquis Energy Exchange Limited (MEX) have been preparing for entering into the market.

Characteristics of the forerunners are shown below.

◆ Indian Energy Exchange Ltd (IEX)

IEX commenced its service in June 2008. Promoters and equity partners of IEX is shown below.

Promoters:	Financial Technologies (India) Ltd,
	PTC India Financial Services Limited (PFS).
Equity Partners:	Adani Enterprises,
	Infrastructure Development Finance Company (IDFC),
	Jindal Power Limited,
	Lanco Infratech,
	Reliance Energy,
	Rural Electrification Corporation, and
	Tata Power Company.

IEX has the following menu for power exchange:

- Day Ahead Market/Day Ahead Contingency Contract;
- Daily Contract;
- Weekly Contract;
- Intra-day Contract.

IEX divides India into twelve (12) regions, and the State of Maharashtra belongs to W2 region. W2 region includes Gujarat, Goa, Daman and Diu-1, Daman and Diu-2, Dadar and Nagar

Haveli, North Goa, in addition to Maharashtra.

◆ Power Exchange India Limited (PXIL)

PXIL began its operation in October 2008. Promoters and equity partners are as follows:

Promoters: National Stock Exchanges of India Limited(NSE)
National Commodity & Derivatives Exchange Limited (NCDEX)

Equity Partners: Power Finance Corporation Limited (PFC),
Gujarat Urja Vikas Nigam Limited
Madhya Pradesh Power Trading Company Limited
West Bengal State Electricity Distribution Company Limited,
GMR Energy Limited,
JSW Energy Limited,
Tata Power Trading Company Limited

PXIL is the first to propose minimum bid size of 1 MW to help small generators, and led the initiative for introduction of 15 minute trading block. PXIL offers the following market for transaction:

- Day Ahead Spot / Day Ahead Contingency market
- Weekly market

PXIL divides India into 10 (ten) regions. State of Maharashtra belongs to W2 region. W2 region includes Gujarat, Daman and Diu, Dadar and Nagar Haveli, North Goa, in addition to Maharashtra. (In comparison of the area established by IEX, Goa is excluded here.)

(2) Result of Power Exchange

Table 3.6.1-1 shows the market share of power exchange by PXIL and IEX at a national level. Volume of power exchange in FY2011-12 resulted in that IEX being14.41BU and PXIL being 1.14BU. IEX occupies the share of 93%, and 7% by PXIL. Although the share varies year by year, IEX occupies the major part of the power exchange.

Table 3.6.1-1 Market Share of Power Exchange in India

(Unit: BU)

FY	IEX	PXIL	Total	Rs./kWh	Market Sizein Crore
2008-09	2.62 (95%)	0.15	2.77	---	---
2009-10	6.27 (87%)	0.92	7.19	4.96	3,563
2010-11	12.71 (82%)	2.81	15.52	3.47	5,389
2011-12	14.41 (93%)	1.14	15.54	3.57	5,553

(Source: Report on Short-term Power Market in India: 2011-12 (CERC))

Transition of price and volume of transaction at IEX for W2 region, which include Maharashtra, is indicated in Table 3.6.1-2. This table show that the volume of transaction gradually increases from 443,184MWh in 2008 to 2,283,904MWh in 2011, while the average price decreases from 7072 Rs./MWh to 3382 Rs./MWh. This indicates that, in general terms, the increase of transaction volume induces the decrease of transaction price.

Table 3.6.1-2 Transition of Price and Volume of Transaction at IEX for W2 Region

Year	2008	2009	2010	2011	
Average (Round the Clock)	7,072.32	5,193.91	3,540.72	3,381.53	Rs./MWh
Peak	7,779.63	5,756.88	4,104.13	3,919.03	Rs./MWh
Non Peak	6,836.55	5,006.25	3,352.91	3,202.36	Rs./MWh
Day	7,811.12	6,159.57	3,837.35	3,685.31	Rs./MWh
Night	5,574.26	3,665.59	2,884.06	2,744.34	Rs./MWh
Morning	7,340.06	5,334.09	3,325.64	3,158.73	Rs./MWh
Volume	433,184	867,629	1,957,846	2,283,904	MWh

(Source: IEX website)

3.6.2 Cost of Distribution

Breakdown of the cost of MSEDCL for the past five (5) years is shown in Table3.6.2-1. Total cost for FY 2010/11 is 3,513,052 Lacs, and the power purchase cost accounts for 2,894,945 Lacs. That is, more than 80% is spent for power purchase and the share remains the similar level for the last five years. The breakdown of power purchase cost is 90% for the payment to the generators and the rest to the transmission companies.

Table 3.6.2-1 Annual Expenditures of MSEDCL

(Unit: Rupee in Lacs)

Item	2006/07	2007/08	2008/09	2009/10	2010/11
1. Purchase of Power	1,627,664	1,700,639	2,060,630	2,384,195	2,894,945
Power purchase from generators	1,490,875	1,526,062	1,851,516	2,199,558	2,652,439
Wheeling/Transmission charges	136,789	174,577	209,114	184,637	242,506
2. Employee Costs	203,706	179,526	239,839	183,807	204,687
3. Administration and General Expenses	20,694	27,391	91,627	89,899	74,613
4. Other Expenses	41,626	52,580	81,940	152,017	123,930
5. Depreciation	50,225	53,983	64,677	81,227	106,747
6. Interest and Financial Charges	63,289	66,023	78,790	90,013	108,130
TOTAL	2,007,204	2,080,142	2,617,503	2,981,158	3,513,052

(Source: MAHAVITARN Annual Report)

Cost of power distributors operating in Maharashtra, i.e. MSEDCL, Tata Power (Distribution) and

RInfra (Distribution) is shown in Table 3.6.2-2. Average power purchase cost including power transmission by MSEDCL is 3.204 Rs./kWh, which is some 70% of the other distributors. On the other hand, unit selling cost becomes similar level with TATA. Difference in distribution loss rate may have led to such a result.

Table 3.6.2-2 Comparison of Unit Cost by Distributors

Item	unit	MSEDCL	TATA-D	RINFRA-D
Power Purchase（PP）				
- PP Volume	MU	90,341	4,620	8,641
- Payment for PP	Crore	28,949	2,073	3,702
- Unit cost for PP	Rupee/kWh	3.204	4.486	4.284
Total cost				
- Power Sale Volume	MU	71,280	4,401	7,448
- Total Cost for Distribution	Crore	35,131	2,247	4,945
- Unit cost	Rupee/kWh	4.929	5.107	6.639

(Source: JICA Study Team)

Average unit cost of power purchase by MSEDCL is shown in Table 3.6.2-3. Increase in purchase cost during the last three (3) years is notably as high as 8 to 19%.

Table 3.6.2-3 Average Unit Cost of Power Purchase by MSEDCL

	Unit	2006/07	2007/08	2008/09	2009/10	2010/11
Purchase of Power	Lacs	1,627,664	1,700,639	2,060,630	2,384,195	2,894,945
Power Purchase	MU	75,436	78,597	79,871	85,474	90,341
Unit cost	Rp/kWh	2.158	2.164	2.580	2.789	3.204
Increase			100%	119%	108%	115%

(Source: JICA Study Team)

Approved tariff of MSPGCL for sale to MSEDCL is composed of fixed charges and energy charges. Tariff is established for each thermal power plant, however, the same charge is applied to hydropower plants. Table 3.6.2-4 shows excerpt of Approved Tariff of MSPGCL for FY 2012.

Table 3.6.2-4 Excerpt of Approved Tariff of MSPGCL

Station name	Fixed Charge (Rs. Crs.)	Energy Charge (Rs/kWh)		
		Thermal power	Peak hours	Non Peak hours
Chandrapur	867.64	2.09	---	---
Parli	308.10	2.75	---	---
Nashik	278.73	3.91	---	---
Uran	174.55	2.06	---	---
Hydropower	520.20	---	2.00	1.65

(Source: MERC Order Case No.06 of 2012)

3.6.3 Electricity Tariff

Electricity tariff system is basically composed of fixed charge and energy charge. For example tariff established by MSEDCL (effective from November 1, 2011) for domestic is Rs.30/month (single phase) as fixed charge and Rs.2.82/kWh as energy charge. For those living with the minimum necessity, the below poverty line tariff is set as Rs.3/month as fixed charge and Rs.0.89/kWh as energy charge.

Table 3.6.3-1 shows the average unit rate, which is obtained from the power sale cost divided by power sale volume, for FY2010-11.

Table 3.6.3-1 Comparison of Average Tariff

Item	Unit	MAHA	RINFRA	TATA	BEST
Power Sale Revenue	Crore	3,324	4,450	2,371	2,678
Power Sold	MU	7,128	7,448	4,401	4,267
Unit Cost	Rp/kWh	4.66	5.97	5.39	6.27

(Source: Study team preparation)

MSEDCL offers the less expensive price level than other companies. One of the reasons may come from the cross subsidy. Cross subsidy is realized through setting higher tariff for industrial and commercial category, while lower tariff for domestic and agriculture. Due to the fact that MSEDCL does not supply electricity to the urban area of Mumbai where commercial and industrial consumers are concentrated, it is not possible for MSEDCL to make enough revenue from those categories which generate budget for subsidy.

Electricity tariff for customers set by distribution companies is approved through review by MERC. As a general rule, distributors are allowed to recover the cost required for operation of power distribution business and appropriate fee (Cost plus method). For this reason, the companies are required to prepare a document for tariff revision, based on audited cost of the last financial year as well as future forecast. Such documents are submitted to MERC for review by November 30 each year. MERC holds public hearing and the new tariff is approved within 120 days, i.e. by the end of March. It should be noted that all the cost required for the distribution business is not necessarily approved by MERC, therefore, a managerial effort is always required by the distributors.

MERC decided to introduce Multi Year Tariff (MYT), and announced to implement it from 2011. It is considered that there are advantages to adopt MYT: for customers, it is easier to formulate a business plan with a knowledge of the perspective of long term tariff for five years; and for the utilities, incentive system is included: in case of revenue increase with the reduction of loss rate, one third is used to decrease tariff, one third is reserved internally by utilities, and the last one third is used by utilities without any restriction.

MYT covers tariff for five years. Utilities prepare a business plan, estimation of power sales for each category, power demand, power procurement plan, investment plan, financial plan, target values, etc. Base on these data, required cost and power sale revenue are estimated, and submitted to MERC for review and approval. As to the cost of fuel used at thermal power plants, due to fluctuation of the cost, utilities are allowed to adjust the tariff biannually.

As of 2012, Tata Power is the only company which applies MYT. Other companies have been admitted not to use the MYT, by reasons of the lack of clarifications of the regulations, etc.

3.6.4 Power Losses

In India, an index of Aggregate Technical and Commercial Loss (AT&C) is often used, as well as usual distribution loss. The reason is that an element of commercial loss (power theft, collection inefficiencies) is much larger than technical loss. Definition of AT&C is as follows:

$$\text{AT\&C Loss (\%)} = \frac{(\text{Energy Input} - \text{Energy Realised})}{\text{Energy Input}} \times 100$$

$$\text{Energy Realised} = \text{Energy Billed} \times \text{Collection Efficiency}$$

$$\text{Collection Efficiency (\%)} = \frac{\text{Amount Realised}}{\text{Amount Billed}} \times 100$$

Table 3.6.4-1 Transition of Distribution Loss of MSEDCL

Item/Year	2006/07	2007/08	2008/09	2009/10	2010/11
Distribution Loss	29.50%	24.09%	21.98%	20.60%	17.28%
AT&C Loss	33.98%	26.08%	24.62%	21.41%	18.45%

(Source: MSEDCL Annual Report)

In order to reduce the loss rate, MSEDCL has been rendering the following actions:

Technical loss
- Strengthening of distribution network
- Erection of new 33/11kV substation and distribution lines
- Augmentation of existing substation capacity
- Reducing LT/HT ratio
- High Voltage Distribution System (HVDC)

Commercial loss
- Establishment of 43 flying squads to curb theft of electricity
- Establishment of 6 dedicated police stations to handle power theft
- Regular theft detection drives

- Mass meter replacement
- DTC metering
- Introduction of distribution franchise in high loss making area
- Regular review on loss reduction

As a result of such actions, distribution loss became 17.28% as of FY 2010/11, and the figure is expected to go further down to 16.27%.

Distribution loss is compared among companies operating in Maharashtra in Table 3.6.4-2. RInfra says that they do not calculate AT&C.

Table 3.6.4-2 Comparison of Distribution Loss in Maharashtra

Item	MSEDCL	TATA	RInfra	BEST
Distribution Loss	17.28%	--	9.14%	7.34%
AT&C Loss	18.45%	1.27%	--	--

(Source: Study Team Preparation)

Loss rate of TATA is very low. This is because they have a very good performance in tariff collection fate of 99.86%, and they mainly sell electricity to the bulk consumers. On the other hand, loss rate of MSEDCL is comparatively high. This is because the difference of operating area: MSEDCL covers all Maharashtra, while TATA, RInfra and BEST cover a limited area of city of Mumbai.

Distribution loss in India by State is compared in Table 3.6.4-3. This comparison seems to have been made based on the data around 2008, the performance in Maharashtra is better than average in India.

Table 3.6.4-3 Comparison of Losses in Different States in India

Item	State
Less than 20%	Goa, Tamil Nadu
Between 20-30%	Andhra Pradesh, Gujarat, West Bengal, Himachal Pradesh, Maharashtra, Tripura, Punjab, Uttaranchal
Between 30-40%	Karnataka, Kerala, Assam, Haryana, Rajasthan, Meghalaya, Mizoram, Chhattisgarh
Above 40%	Delhi, Uttar Pradesh, Bihar, Jharkhand, Madhya Pradesh, Arunachal Pradesh, Manipur, Nagaland

(Source: “Minimization of Power Loss in Distribution Networks by Different Techniques”, IJSER Vol.3, Issue 5 May 2012)

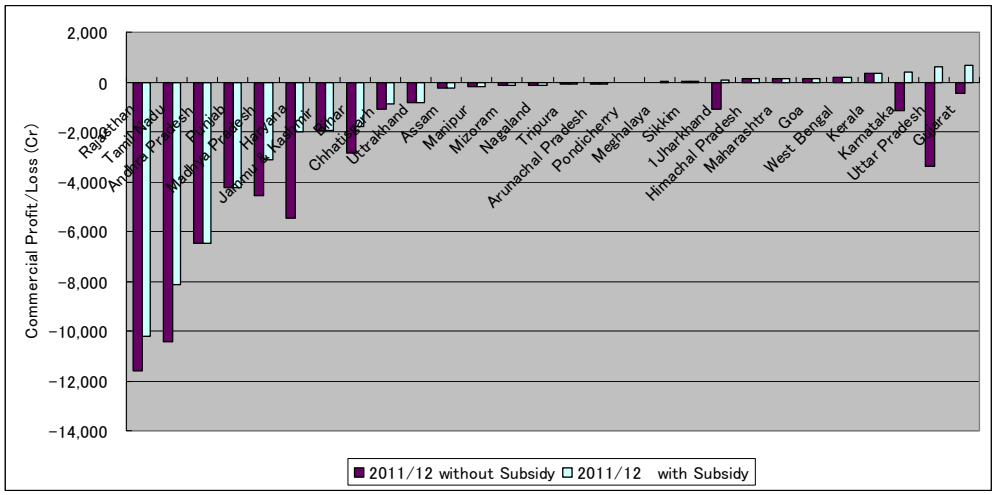
For reference, the comparisons of all state distribution companies are discussed below. The latest comparison was filed by Planning Commission, India.

Table 3.6.4-4 Commercial Profit of State Discoms (with subsidy)

(Unit: Rupees in Crores)

	2007/8	2008/9	2009/10	2010/11	2011/12
	(Actual)	(Actual)	(Provi.)	(RE)	(AP)
Andhra Pradesh	-71	-173	-124	-6,612	-6,463
Assam	-139	-122	-290	-206	-223
Bihar	-951	-1,215	-1,576	-1,542	-1,788
Chhatisgarh	464	846	-333	-694	-901
Delhi	-222	121	615		
Gujarat	124	150	385	513	642
Haryana	-823	-1,382	-1,675	-1,797	-2,024
Himachal Pradesh	-25	32	-153	-126	115
Jammu & Kashmir	-1,313	-1,316	-1,541	-1,950	-1,968
1Jharkhand	-761	-141	-488	-314	101
Karnataka	33	-1,609	-258	175	385
Kerala	217	217	241	287	361
Madhya Pradesh	-1,981	-2,260	-3,661	-3,364	-3,130
Maharashtra	40	-1,381	-623	165	150
Meghalaya	-8	67	45	-54	7
Orissa	-114	-148	-172		
Punjab	-1,611	-1,293	-1,302	-3,475	-4,230
Rajasthan	-2,703	-6,743	-9,456	-9,128	-10,238
Tamil Nadu	-3,512	-7,768	-9,680	-8,872	-8,144
Uttar Pradesh	-3,147	-5,111	-4,954	-3,612	605
Uttrakhand	-243	-355	-391	-450	-831
West Bengal	102	49	101	196	204
Arunachal Pradesh	-83	-48	-33	-73	-73
Goa	139	225	182	169	159
Manipur	-93	-113	-106	-173	-190
Mizoram	-44	-74	-131	-150	-143
Nagaland	-81	-66	-111	-134	-129
Pondicherry	21	-80	-47	-120	-37
Sikkim	91	144	132	26	26
Tripura	28	52	-33	-86	-77
Total	16,666	-29,495	-35,437	-41,401	-37,836

(Source: Annual Report (2011-12) on The Working of State Power Utilities & Electricity Department, Planning Commission, 2011/10)



(Source: JICA Study Team compiled after Annual Report (2011-12) on The Working of State Power Utilities & Electricity Department, Planning Commission, 2011/10)

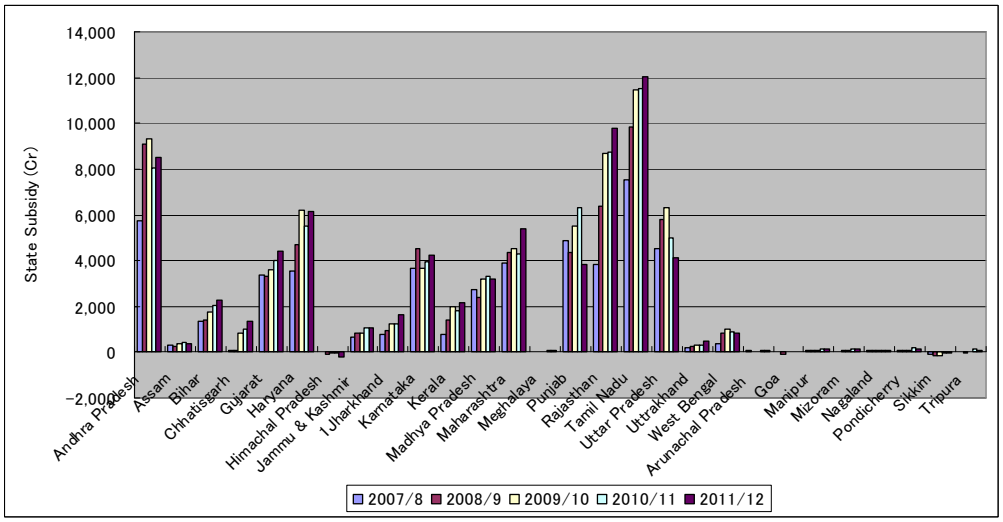
Figure 3.6.4-1 Profits/Losses of State Discoms (with /without subsidy)(2011/12)

It is clear that almost all distribution companies still suffer the financial deficit. The prospect of 2011/12 shows the total losses of all distribution companies amount as much as 37,836 Crores deficit with subsidies. It even becomes worse to as much as 55,520 Crores.

Among these, it is noted Maharashtra state distribution company (MAHADISCOM) has improved its defict in 2010/11, 2011/12 successively that is among a few.

The tariff of distributed electricity in India normally has been set as low onto the agricultural and domestic categories (subsidy), and compensated by state subventions as well as by tariffs from other industry categories (Cross Subsidy). However, the sufficient recovery by such compensations is not made that as a result the debt on the distribution companies have been accumulated

The subsidy (paid to agricultural and domestic categories) of each state are shown below



(Source: JICA Study Team compiled after Annual Report (2011-12) on The Working of State Power Utilities & Electricity Department, Planning Commission, 2011/10)

Figure 3.6.4-2 Historical trend of State Subsidy

Figure 3.6.4.2 indicates each state has been increasing its subsidy annually, probably because of the increase of the whole generation. Maharashtra is in the states of rather large subsidy, showing the state pays consideration to the agricultural sector, etc.

The following table shows the details how the subsidy was recovered in 2011/12.

Table 3.6.4-5 Subsidy of each State (2011/12)

(Unit: Rupees in Crores)

	Total Subsidy (to Agricture, Domestic Consumers)	State Subvention	Cross Subsidy	uncovered Subsidy	uncovered ratio (%)
Andhra Pradesh	8,516	0	1,664	6,852	80
Assam	341	0	58	283	83
Bihar	2,255	1,080	-753	1,928	86
Chhatisgarh	1,348	202	-1	1,147	85
Gujarat	4,394	1,100	2,922	372	8
Haryana	6,119	3,425	-31	2,725	45
Himachal Pradesh	-236	0	-320	84	(36)
Jammu & Kashmir	1,071	0	-900	1,972	184
1Jharkhand	1,614	1,200	-43	457	28
Karnataka	4,241	1,558	2,411	272	6
Kerala	2,155	0	53	2,102	98
Madhya Pradesh	3,173	1,455	-2,044	3,762	119
Maharashtra	5,375	0	4,197	1,178	22
Meghalaya	102	14	18	70	69
Punjab	3,857	0	-877	4,733	123
Rajasthan	9,767	1,348	-2,658	11,077	113
Tamil Nadu	12,060	2,282	1,194	8,584	71
Uttar Pradesh	4,100	3,995	108	-3	(0)
Uttrakhand	458	0	-341	799	174
West Bengal	819	0	926	-107	(13)
Arunachal Pradesh	69	0	-4	73	106
Goa	5	0	133	-128	(2369)
Manipur	132	0	-59	191	145
Mizoram	117	0	-27	144	123
Nagaland	101	0	-29	130	128
Pondicherry	160	0	115	45	28
Sikkim	-23	0	3	-26	113
Tripura	101	25	-5	81	80
Total	71,028	17,685	4,754	48,590	68

(Source: Annual Report (2011-12) on The Working of State Power Utilities & Electricity Department, Planning Commission, 2011/10)

It is worth pointing out, the subsidy amounts to 71,028 Crores but only 17,685 Crores were paid by state governments. The Cross Subsidy reached as much as 4,754 Crores only. Most of the Subsidy got uncompensated.

States like Andhra Pradesh, Tamil Nadu state reported a large deficit from the table. However Maharashtra state succeeded in reducing the uncovered subsidy using Cross Subsidy for 80%.

3.7 Japanese Overseas Development Assistance, and Assistance of Other Donors

JICA, the World Bank (IBRD/IDA), Asian Development Bank (ADB), (KfW) are the major donor in power sector in India. The number of assistance since 2001 is as follows:

ADB: 83, JICA; 21 (financial cooperation 19, technical cooperation 3), the World Bank: 16. Power sector project in Maharashtra by each donor is summarized below.

3.7.1 Government of Japan

Government of Japan has rendered the following assistance to Maharashtra:

(1) Technical Cooperation (JICA)

Project	Period	Counterpart
Master Plan Study on Pumped Storage Hydroelectric Power Development in Maharashtra State	1994-1998	GoM
Study on Renovation & Modernization / Complete Replacement of Old Coal based Thermal Power Stations*	2012	MSPGCL
Data Collection Survey on Pumped Storage Hydropower Development in Maharashtra	2012	GoM DWR

*This study include projects in Uttar Pradesh, Madhya Pradesh and Tamil Nadu.

(2) Financial Cooperation (OECF/JBIC/JICA)

Project	Amount	L/A	Executing Agency
Paitan Hydroelectric Project	JY1,300M	August 1978	GoM
Ujjani Hydroelectric Project	JY1,500M	Nov. 1985	GoM ID
Ghatghar Pumped Storage Power Project	JY11,414M	Dec. 1988	GoM ID
Power System Improvement and Small Hydroelectric Project*	JY24,379M	Jan. 1991	RECL
Rural Electrification Project**	JY20,629M	March 2006	MSEDCL
Maharashtra Transmission System Project	JY16,749M	Sept. 2007	MSETCL
Total	JY75,971M		

*This Project includes sub-projects in Maharashtra, Andhra Pradesh, southern states, etc.
** This Project includes sub-projects in Maharashtra, Andhra Pradesh and Madhya Pradesh.

3.7.2 Asian Development Bank (ADB)

ADB has rendered the following assistance to Maharashtra:

Project	Amount	Approval	Executing Agency
Power Finance Corporation	n/a	July 1999	MSEB
Power Grid Transmission III	US$10M	Dec. 2004	MSEB
Maharashtra Solar Park and Green Grid Development Investment Program	US$350,000	March 2012	MSPGCL/MSETCL

As to the Power Finance Corporation (PFC) project, MSEB requested technical and financial cooperation for organizational reform of MSEB as a subproject. Power Grid Transmission III included a subproject for development of integrated software for MSEB.

A technical assistance to development of a solar park was decided in March 2012. ADB finance had also been examined and the concept clearance was obtained also in March 2012. This project includes construction of a solar park with a total installed capacity of 350MW, control center for renewable energy, and assistance for introduction of PPP.

3.7.3 World Bank (IBRD/IDA)

The World Bank has rendered the following assistance to Maharashtra:

Project	Amount	Approval	Executing Agency
Maharashtra Power Project	US$400M	June 1989	MSEB
Maharashtra Power Project II	US$350M	June 1992	MSEB
Organizational Transformation and PPPs in MSETCL	n/a	n/a	MSETCL
Coal-Fired Generation Rehabilitation	US$180M	June 2009	MSPGCL

Maharashtra Power Project includes construction of Koyna IV Hydropower Project (1000MW) and related transmission lines. Its second phase covers construction of Chandrapur Coal-fired Power Project (500MW) and HVDC transmission line between Chandrapur and Padghe (500kV). Coal-fired Generation Rehabilitation Project includes improvement of fuel consumption at Koradi Unit 6.

Unbundling of MSEB was made in 2005 at the initiative of the World Bank, the Bank commenced cooperation in the field of software to MSETCL through ESMAP.

In the first phase cooperation was made in 2006 for formulation of business plan and organizational structure to implement the required US$4 billion transmission investment program including PPP option was developed; In the second phase, which began in 2007, a framework was designed for implementing a strategic alliance approach for initial investments of US $1.5 billion; In the third phase, capacity building was made for MSETCL in 2009. In relation to this assistance in the field of software, International Finance Corporation, a World Bank Group, financed US$200M to MSETCL for organizational restructuring and implementation of PPP.

3.7.4 Kreditanstalt für Wiederaufbau (KfW)

KfW has rendered the following assistance to Maharashtra:

Project	Amount	L/A	Executing Agency
Shivajinagar Sakri Solar Power	Euro250M	August 2011	MSPGCL

KfW signed a loan agreement with MSPGCL for construction of a solar power project. With a total budget of Euro 370M financed from KfW and own fund, MSPGCL is to construct the largest solar power plant (125MW) in India.

Chapter 4

Power Development Plan

Chapter 4 Power Development Plan

4.1 Power Demand Forecast

4.1.1 Precondition

In the 17th Electric Power Surveys (the17th EPS) operated by Central Electricity Authority (CEA), the power demand forecast of all India was issued March 2007.

In the 17th EPS, the short term power demand forecast up to FY 2011, the end of the 11th Plan, and the long term forecasts up to FY 2016, the end of the 12th Plan, and up to FY 2021, the end of 13th Plan, were introduced.

The power demand forecast was made State/Union Territory wise and category wise.

Although, the final result of the 18th EPS has not yet authorized, the actual power demand has been compared with that forecasted in the 17th EPS.

Table 4.1.1-1 Comparison between Forecasted and Actual Power Demand of All India in 17th EPS

YEAR	Energy Requirement (GWh)			Peak Load (MW)		
	17TH EPS	ACTUAL	DEV. IN %	17TH EPS	ACTUAL	DEV. IN %
2004-05	602,787	591,373	-1.89%	90,221	87,906	-2.57%
2005-06	654,603	631,554	-3.52%	97,269	93,255	-4.13%
2006-07	697,961	690,587	-1.06%	104,867	100,715	-3.96%
2007-08	744,515	739,343	-0.69%	113,059	108,866	-3.71%
2008-09	794,561	777,039	-2.21%	121,891	109,809	-9.91%
2009-10	848,390	830,594	-2.10%	131,413	119,166	-9.32%

(Source: 17th EPS Meeting)

It is apparent from the above table the power demand forecast of the 17th EPS was overestimated not only in energy (kWh base) but also in peak load (kW base). Although the reason of forecasted errors has not discussed in the 18th EPS, uncertainty of introduction of captive power in industry category was raised as one of possible factor of the error.

The 17th EPS's power demand forecast can be acceptable in energy (kWh base) of all India because of the small error between forecasted and actual energy. The main factor of the error was assumed to be due to the overestimation of energy demand in less developed States.

On the other hand, the difference between forecasted and actual peak power (kW base) of all India is almost 10%. Following factors of the error might be considered,

- installation of captive power was much than expected, or
- the end use methodology itself contains some defects, or

- misestimating in the diversity factor[1]

Since a part of the18th EPS has been obtained, it is introduced later.

(1) Short term power demand forecast (up to FY2011)

1) Methodology

The Partial End-Use Methodology (PEUM) was applied for the short term power demand forecast up to FY2011. The PEUM means that power demands of some categories are forecasted by estimating number of electricity consumer and electricity consumption per consumer and those of other categories are projected based on past trends. Category wise power demands are classified into following 8 categories:

(i) Domestic
(ii) Commercial
(iii) Public Lighting
(iv) Public Water Works
(v) Irrigation
(vi) Industrial (Low Voltage, High Voltage < 1MW, High Voltage ≥ 1MW)
(vii) Railway Traction &
(viii) Bulk Non-Industrial High Voltage Supply

The end use methodology was applied to most of categories from (i) to (viii), and the power demands of low voltage and high voltage less than 1MW in industrial category were are projected based on past trend. The total forecasted electrical energy consumption at end-consumer (net system energy demand) is the sum of all categories.

2) Transmission and distribution losses

Generating end energy is sent through transmission and distribution lines. In the 17th EPS, transmission and distribution losses (T & D Losses) was defined as technical losses during T & D losses plus nontechnical losses including stealing electricity.

3) Generating end energy

Generating end energy is the sum of electrical energy consumption at end-consumer (net system energy demand) and T & D Losses.

[1] Diversity factor is a ration between the sum of all loads in a grid and the maximum load of a grid, and is defined as following equation.
Diversity factor = the sum of each maximum load in a grid / the maximum load of a grid

(2) Long term power demand forecast (after FY2011)

1) Methodology

The long term power demand forecast after FY2011 was made based on econometric model. The basic equation of the model is established as:

$$Q = f(PCGDP, P\ SS, INTEN)$$

Where,

Q:	electricity demand
PCGDP:	per capita GDP
P:	price
SS:	structural changes
INTEN:	electricity intensity

The power demands of domestic, commercial, industrial and irrigation categories were forecasted by obtaining coefficients for variables of per capita GDP and electricity price of each category. The power demands of public lightning, public water works and railway traction were forecasted based on past trends.

4.1.2 Result of power demand forecast

(1) Short term power demand forecast (up to FY2011)

The result of category wise short term power demand forecast of Maharashtra State in the 17th EPS is shown in Table 4.1.2-1. But the result was not accepted for the last time.

The electrical energy consumption (EEC) is the sum-up of category- wise power demand forecasts. The generating end energy (Electrical Energy Requirement at Power Station: EER) is the sum the EES and the transmission and distribution losses. The EER since FY 2004 to FY2011 was forecasted to increase by 6.3% annually in kWh base and by 8.4% annually in kW base. Since the annual electric load factor was expected to decrease every year, the expected growth rate of peak power demand is higher than that of energy demand. That is to say, the peak power demand is expected to become more radical.

The T & D Losses rate in FY2004 was 32.4％, and the rate in FY 2011 was expected to fall to 25.4% by decreasing it by 1％ annually.

Table 4.1.2-1 Category Wise Short Term Forecasted Electric Power Demand of Maharashtra Sate (up to 2011-12)

	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Electrical Energy Requirement at Power Station (GWh)	78,667	82,043	86,495	91,875	97,689	103,940	110,690	117,918	125,661
Electrical Energy Requirement Growth Rate (%)		4.29%	5.43%	6.22%	6.33%	6.40%	6.49%	6.53%	6.57%
Electrical Energy Consumption (GWh)	51,824	55,457	59,332	63,940	68,963	74,416	80,355	86,782	93,737
- Domestic	12,460	12,662	13,538	14,844	16,276	17,846	19,568	21,456	23,526
- Commercial	4,937	5,354	5,717	6,181	6,683	7,226	7,812	8,447	9,133
- Public lightning	632	632	678	753	871	1,014	1,206	1,408	1,621
- Public Water Works	1,493	1,545	1,689	1,836	1,995	2,168	2,356	2,561	2,783
- Irrigation	10,572	10,733	11,410	12,049	12,721	13,427	14,168	14,947	15,764
- Industries	19,963	22,681	24,375	26,237	28,244	30,409	32,744	35,264	37,982
- LT Industries	4,724	4,818	5,262	5,786	6,362	6,995	7,691	8,457	9,299
- HT Industries	15,239	17,863	19,113	20,451	21,882	23,414	25,053	26,807	28,683
- Railway Traction	1,749	1,849	1,925	2,040	2,173	2,325	2,500	2,700	2,929
- Non Industriall	19	0	0	0	0	0	0	0	0
Transmission & Distribution Losses (%)	34.12	32.40	31.40	30.40	29.40	28.40	27.40	26.40	25.40
Transmission & Distribution Losses (GWh)	26,843	26,586	27,164	27,934	28,725	29,524	30,334	31,136	31,924
Annual Electric Load Factor at Power Station (%)	75.67	75.14	73.74	72.34	70.94	69.54	68.14	66.74	65.34
Peak Electric Load at Power Station (MW)	11,868	12,464	13,390	14,498	15,720	17,062	18,543	20,169	21,954
Peak Electric Load at Power Station (%)		5.02%	7.43%	8.27%	8.43%	8.54%	8.68%	8.77%	8.85%

(Source: 17th EPS)

The result of category wise short term power demand forecast of Maharashtra State in the 17th EPS, which was finally authorized, is shown in Table 4.1.2-2.

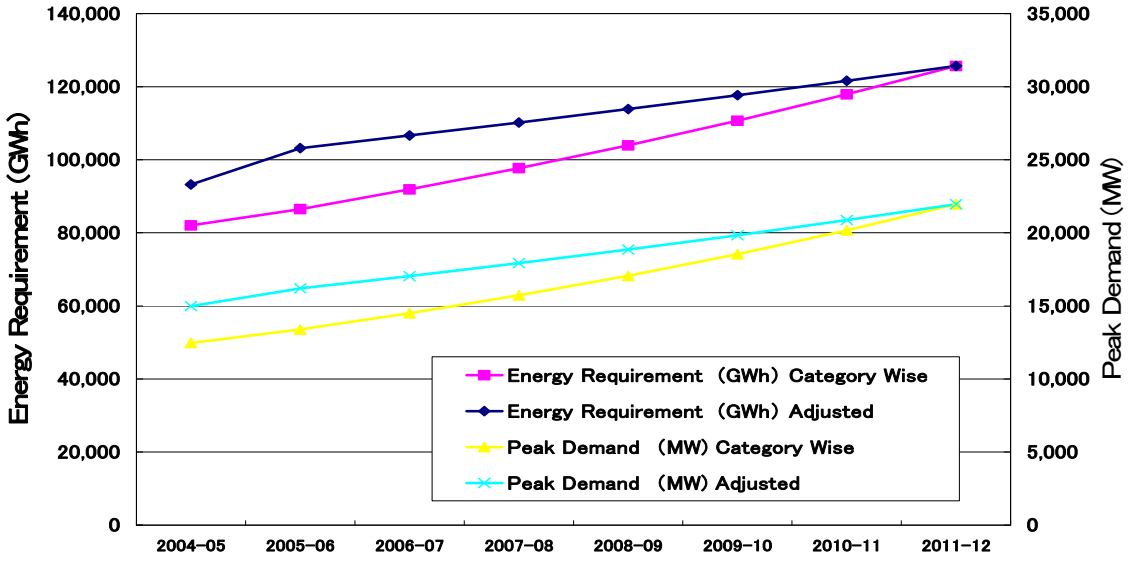
It should ne noted that the result of category wise short term power demand forecast in Table4.1.2-1 was not used as a result. The category wise short tem power demand forecast was made by the PEMU based on the data in the FY2004. But the data in the FY2004 was adjusted and increased because it was considered that the data was obtained under low frequency condition and lower than the actual demand. Focusing the figures of FY2004 in Table4.1.2.-2, the adjusted figures are much higher than those originally forecasted.

It is presumed that the category wise power demand forecast in FY2005 had already been adjusted based on the actual date in FY2005 at the timing that the 17th EPS was published March 2007. But, at that time, the forecasted values in FY2011 were not revised and the figures between the adjusted figure in FY2005 and the unadjusted figures in FY 2011 were increased by constant annual growth rate.

Table 4.1.2-2 Short Term Forecasted Electric Power Demand of Maharashtra Sate (up to 2011-12)

Year	Energy Requirement (GWh)				Peak Demand (MW)			
	Category Wise	Growth	Adjusted	Growth	Category Wise	Growth	Adjusted	Growth
2004-05	82,043	-	93,217	-	12,464	-	14,986	-
2005-06	86,495	5.43%	103,200	10.71%	13,390	7.43%	16,200	8.10%
2006-07	91,875	6.22%	106,643	3.34%	14,498	8.27%	17,042	5.20%
2007-08	97,689	6.33%	110,201	3.34%	15,720	8.43%	17,929	5.20%
2008-09	103,940	6.40%	113,878	3.34%	17,062	8.54%	18,859	5.19%
2009-10	110,690	6.49%	117,678	3.34%	18,543	8.68%	19,839	5.20%
2010-11	117,918	6.53%	121,604	3.34%	20,169	8.77%	20,870	5.20%
2011-12	125,661	6.57%	125,661	3.34%	21,954	8.85%	21,954	5.19%
AVERAGE		6.28%		4.36%		8.42%		5.61%

(Source: 17th EPS)



(Source: 17th EPS)

Figure 4.1.2-1 Short Term Forecasted Electric Power Demand of Maharashtra Sate (up to 2011-12)

(2) Long term power demand forecast (after FY2011)

The result long term power demand forecast of Maharashtra State in the 17th EPS is shown in Table 4.1.2-3.

The generating end energy (Electrical Energy Requirement at Power Station: EER) since FY 2011 to FY2016 and since FY2016 to FY2021 were forecasted to increase by 5.9% and by 5.9% annually in kWh base and by 5.2% and by 4.0% annually in kW base.

Since the annual electric load factor in the future was expected to be improved by some tools of demand side management such as different tariffs between peak time and off-peak time, .the expected growth rate of peak power demand is lower than that of energy demand. That is to say, the peak power demand is expected to become duller.

The target T & D losses in FY 2011 was set as 25.4% and expected to decrease 1% annually from FY2011 to FY2016 and decrease 0.6% annually from FY2016 to FY2021.

Table 4.1.2-3 Long Term Forecasted Electric Power Demand of Maharashtra Sate (up to 2021-22)

	2011-12	2016-17	2021-22
Electrical Energy Requirement at Power Station (GWh)	125,661	167,227	219,910
Electrical Energy Requirement Growth Rate (%)	-	5.88%	5.63%
Electrical Energy Consumption (GWh)	93,737	133,104	181,635
Transmission & Distribution Losses (%)	25.40%	20.41%	17.40%
Transmission & Distribution Losses (GWh)	31,924	34,123	38,275
Annual Electric Load Factor at Power Station (%)	65.34%	67.34%	69.84%
Peak Electric Load at Power Station (MW)	21,954	28,348	35,944
Peak Electric Load at Power Station (%)	-	5.25%	4.86%

(Source: 17th EPS)

4.1.3 Validation of power demand forecast

The forecasted and the actual power demand of Maharashtra State in the 17th EPS is shown in the table below.

Table 4.1.3-1 Comparison between Forecasted and Actual Power Demand of Maharashtra Sate

YEAR	Energy Requirement (GWh)			Peak Load (MW)		
	17th EPS	Actual	Dev. (%)	17th EPS	Actual	Dev. (%)
2004-05	93,217	92,715		14,986	14,986	
2005-06	103,200	102,765	-0.4%	16,200	16,069	-0.8%
2006-07	106,643	110,005	3.2%	17,042	17,455	2.4%
2007-08	110,201	114,885	4.3%	17,927	18,441	2.9%
2008-09	113,878	121,890	7.0%	18,859	18,049	-4.3%
2009-10	117,678	124,961	6.2%	19,839	19,388	-2.3%
2010-11	121,604	128,296	5.5%	20,870	19,766	-5.3%
2011-12	125,661	141,382	12.5%	21,954	21,069	-4.0%
Annual Growth Rate	4.36%	6.21%		5.61%	4.99%	

(Source: 17th EPS)

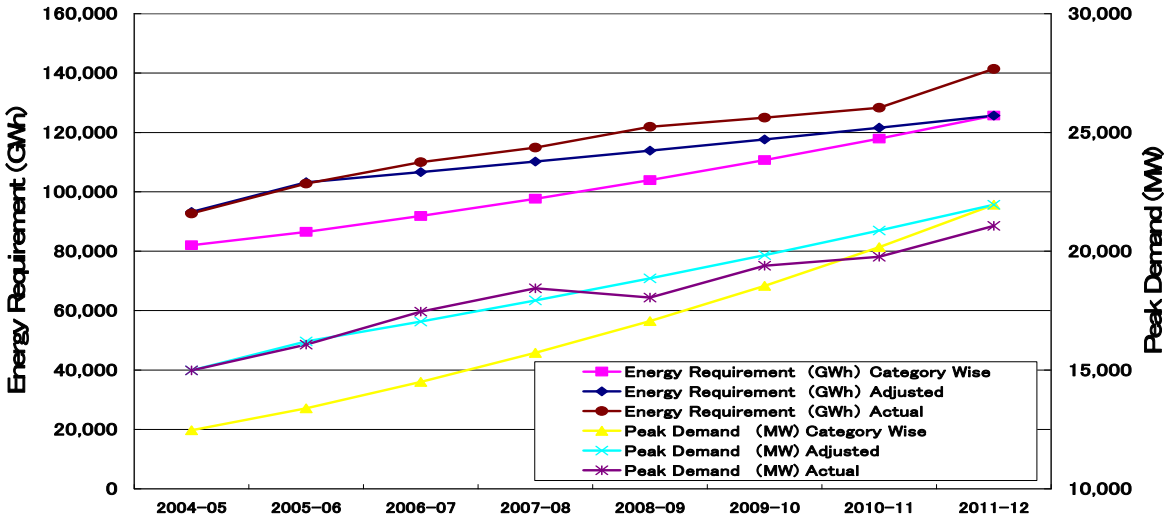
Comparing the forecasted and actual figures, the annul growth rates of the forecasted and actual EER were 4.36% and 6.21% respectively in kWh base and 5.61% and 4.99% respectively in kW base. In other words, the forecasted EER were underestimated in kWh base and overestimated in kW base.

It should be highlighted that the annual growth rate of the forecasted and adjusted EER was 4.36% and that of the forecasted but not adjusted EER was 6.28%, which figure is quite close to 6.21%, the annul growth rate of actual EER.

It is quite doubtful why the final forecasted figure was not revised in spite the initial kWh based EER was adjusted in the 17th EPS.

Regarding the error in peak power demand (kW base), following factors might be considered,

- installation of captive power was much than expected, or
- misestimating in the diversity.



(Source: 17th EPS)

Figure 4.1.3-1 Short Term Forecasted Electric Power Demand of Maharashtra Sate (up to 2011-12)

The forecasted and the actual T & D Losses of Maharashtra State in the 17th EPS is shown in the table below.

Table 4.1.3-2 Comparison between Forecasted and Actual T & D Losses of Maharashtra Sate

Year	Maharashtra State			All India	
	T & D[2] Losses (%)		AT & C[3] Losses (%)	T &D Losses (%)	AT & C Losses (%)
	Estimated	Actual	Actual	Estimated	Actual
2003-04	34.12	34.12	-	32.53	34.78
2004-05	32.40	32.40	-	31.25	34.33
2005-06	31.40	31.60	-	30.42	33.02
2006-07	30.40	31.64	34.0	28.65	30.62
2007-08	29.40	29.79	26.1	27.20	29.45
2008-09	28.40	-	24.7	25.47	27.74
2009-10	27.40	-	21.4	25.39	27.15
2010-11	26.40	-	18.5	-	-
2011-12	25.40	-	-	-	-

(Source: CEA Annual Report, MOP Power Scenario at a Glance 2010, Economic Survey of Maharashtra 2011-12)

The description of T & D Losses ratio has been missing in the CEA Annual Report since FY2008. The T & D Losses ratios up to FY2007 have not largely deviated from those forecasted. On the other hands, Aggregate Technical & Commercial Losses (AT & C Losses) ratios of Maharashtra State from FY 2006 to FY 2010 are introduced instead of T & D Losses in the "Economic Survey of Maharashtra

[2] T & D: Transmission and Distribution
[3] AT & C: Aggregate Technical and Commercial

(20011-2012)". According to MOP's definition, the difference between T & D Losses and AT & C Losses is as following.

$$\text{AT \& C Losses (\%)} = \frac{(\text{Enegy Input} - \text{Energy Realized}) \times 100}{\text{Energy Input}}$$

$$\text{Energy Realized} = \text{Energy Billed} \times \text{Collection Efficiency}$$

$$\text{Collection Efficiency (\%)} = \frac{\text{Amount Realised} \times 100}{\text{AmountBilled}}$$

Since uncollected electrical energy consumption is included in the commercial losses, the AT & C Losses ratio is estimated to be around 2% higher than the T & D Losses.

In spite that an unreasonable relation, that the T & D Losses exceed the AT & G Losses of Maharashtra State, is found in FY2007 in Table 4.1.2-5 because these figures come from different sources, the target of T & D Losses of the 17th EPS has fully been achieved judging from the AT & C Losses ratios after FY2017.

The actual electric energy consumption in kWh base is larger than that estimated in the short term power demand forecast during the 17th EPS in spite that the T & D Losses ratios under run the target, which means the estimated electrical energy consumption was much more underestimated.

4.1.4 Power demand forecast of Maharashtra Sate in The 18th Electric Power Surveys (Tentative)

Although the official 18th ESP has not yet been issued, the power demand forecast of Maharashtra Sate can be introduced here since it has been unofficially obtained through CEA.

The adjustment of the figures of the power demand forecast, which brought the deviation between the forecasted values and the actual values in the 17th EPS, is exactly made again in the 18th EPS. Focusing on the figures of the peak demand, which in FY2011 in the 18th ESP is 18,398MW while that of actual in FY2011 has been recorded as 21,069MW. In the 18th EPS, the peak demand is forecasted in two ways. Firstly the peak demand is forecasted to increase by around 9% annually up to FY2016 by using the Partial End-Use Methodology (PEUM) without taking into account the actual record in FY2011, and secondly the peak demand is forecasted to increase by around 6% up to FY2016 by adjusting the initial figure recorded in FY2011. The latter is called Un-restricted Energy Requirement.

Even though the 18th EPS has not been authorized yet, the power demand may be underestimated again if these figures are accepted. The power demand forecasts in India are made in each State/Union and the central government, CEA, aggregates all those figures. The actually recorded figures have been announce during the process of aggregation and adjustment has been made for the initial figures but not for the final figures of the 5-year Plan, which cause problems.

As shown in the deviation between the forecasted values and the actual values in the 17th EPS, it may be more reasonable to adjust the initial value based on the recorded value and adjust other values in parallel with the adjusted initial values.

Table 4.1.4-1 Power Demand Forecast of Maharashtra Sate in The 18th EPS (Tentative Version)

Year	Energy Requirement (GWh)				Peak Demand (MW)			
	Original	Growth	Un-restricted	Growth	Original	Growth	Un-restricted	Growth
2011-12	120,856	-	Actual (141,382)	-	18,398	-	Actual (21,069)	-
2012-13	128,353	6.20%	140,736	(-0.46%)	19,963	8.51%	22,368	(6.17%)
2013-14	136,751	6.54%	147,402	4.74%	21,685	8.63%	23,795	6.38%
2014-15	145,641	6.50%	154,383	4.74%	23,586	8.77%	25,313	6.38%
2015-16	155,276	6.62%	161,695	4.74%	25,693	8.93%	26,928	6.38%
2016-17	169,353	9.07%	169,353	4.74%	28,645	11.49%	28,645	6.38%
2017-18	175,870	3.85%	175,870	3.85%	29,983	4.67%	29,983	4.67%
2018-19	187,034	6.35%	187,034	6.35%	32,122	7.13%	32,122	7.13%
2019-20	199,001	6.40%	199,001	6.40%	34,431	7.19%	34,431	7.19%
2020-21	211,836	6.45%	211,836	6.45%	36,926	7.25%	36,926	7.25%
2021-22	225,606	6.50%	225,606	6.50%	39,622	7.30%	39,622	7.30%
Average		6.44%		4.78%		7.97%		6.52%
2026-27	310,654				54,982			
2031-32	417,826				74,528			

(Source: CEA)

The Load Factor used for the power demand forecast of Maharashtra Sate in the 18th EPS is shown in Table below.

Table 4.1.4-2 Load Factor for Power Demand Forecast of Maharashtra Sate in The 18th EPS

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Load Factor (%)	80.99	77.99	74.99	73.49	71.99	70.49	68.99	67.49	66.96	66.47	65.98	65.49	65.00

(Source: CEA)

The load factors, which are used for power demand forecast of Maharashtra Sate in the 18th EPS, are forecasted to get worse and annually decrease by 3.0% up to FY2011, by 1.5% up to FY2016 and by around 0.5% up to FY2021. That is to say, the peak power demand is expected to become more radical and power for peak demand is to be developed.

The actual generating end energy (Electrical Energy Requirement at Power Station: EER) since FY 2004 to FY2011 increased by 6.21% annually in kWh base in spite that in kW base was by 4.99% annually, even though the reasons has not yet been analyzed. It is recommended to review carefully that the load factors will unilaterally decrease or not as estimated in the 18th EPS.

4.2 Power Development Plan

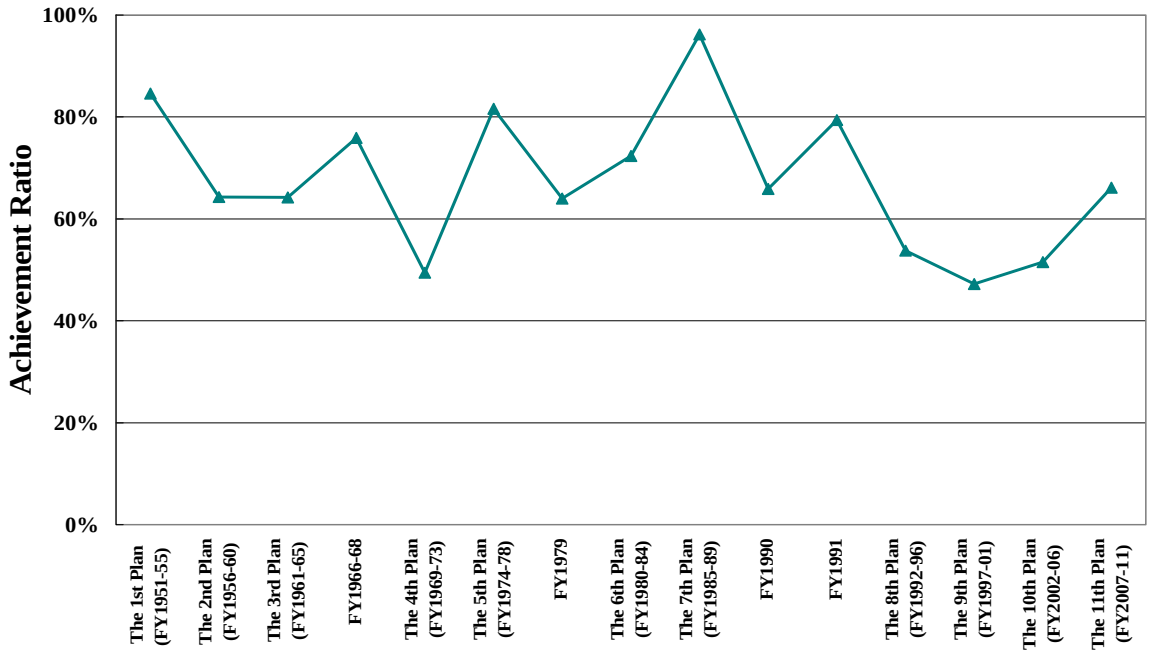
4.2.1 Power development plan

The 5 years power development plans and the results of all India in the past are shown in Figure 4.2.1-1. The actual performances have remained stagnant against the target, and the achievement ratios were around 50% during the 8th, 9th, 10th Plan.

The power development plan during the 11th Plan (from April 2007 to March 2012) was originally to add 78,700MW capacity as shown in Table 4.2.1-1. This figure was almost double of the 10th Plan.

It was estimated that a 1/3 of financial resources required for all infrastructural development such as power, traffic, telecommunication and irrigation projects, which is 6,670,000 million rupiahs, are necessary for power sector.

But the power development plan of the 11th Plan has not attained due to delay of construction works, environmental issues including resettlement, opposition movement by neighboring people and so on. The original target of the 11th Plan has been reviewed during the mid term appraisal by the Indian Planning Committee and revised downward from 78,700MW to 62,374MW, and the assumption of the actual achievement of the 11th Plan has also been announced before establishing the 12th Plan. The change from the original target to the assumption is shown in table below.



(Source: All India Electricity Statistics General Review 2010, CEA, etc.)

Figure 4.2.1-1 Achievement Ratio of Past Power Development Plan

Table 4.2.1-1 Original Power Development Target During The 11th Plan

(Unit: MW)

Sector	Hydro	Thermal				Nuclear	Grand Total
		Coal	Lignite	Gas	Total		
CENTRAL	8,654	22,600	750	1,490	24,840	3,380	36,874
STATE	3,482	19,535	450	3,316	23,301	0	26,783
PRIVATE	3,491	8,435	1,080	2,037	11,552	0	15,043
TOTAL	15,627	50,570	2,280	6,843	59,693	3,380	78,700

(Source: The Report of Working Group on Power for 12th Plan, MOP)

Table 4.2.1-2 Change in Power Development Plan During The 11th Plan

(Unit: MW)

Sector		Hydro	Thermal	Nuclear	Total
Central	Original	8,654	24,840	3,380	36,874
	Revised	2,922	14,920	3,380	21,222
	Estimated Result	2,005	11,290	2,880	16,175
	Achievement (%)	23.2	45.5	85.2	43.9
	Revised Achievement (%)	68.6	75.7	85.2	76.2
State	Original	3,482	23,301	0	26,783
	Revised	2,854	18,501	0	21,355
	Estimated Result	2,744	14,493	0	17,237
	Achievement (%)	78.8	62.2	-	64.4
	Revised Achievement (%)	96.1	78.3	-	80.7
Private	Original	3,491	11,552	0	15,043
	Revised	2,461	17,336	0	19,797
	Estimated Result	1,362	17,289	0	18,651
	Achievement (%)	39.0	149.7	-	124.0
	Revised Achievement (%)	55.3	99.7	-	94.2
Total	Original	15,627	59,693	3,380	78,700
	Revised	8,237	50,757	3,380	62,374
	Estimated Result	6,111	43,072	2,880	52,063
	Achievement (%)	39.1	72.2	85.2	66.2
	Revised Achievement (%)	74.2	84.9	85.2	83.5

(Source: The Report of Working Group on Power for 12th Plan, MOP)

The power development achievement ratio of the 11th Plan is 66% against the original target and 83% against the revised target in the mid term appraisal. These figures are higher than those of the 8th, 9th and 10th Plans, but the target to meet the power demand can not be attained in the year 2012.

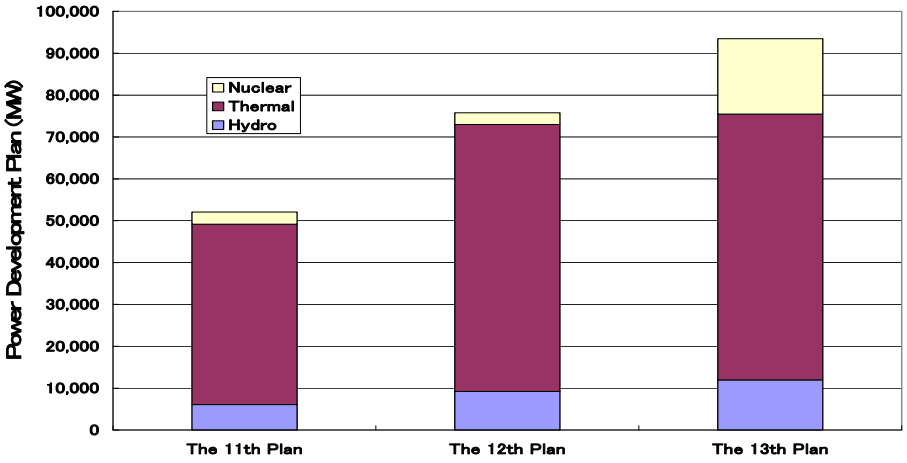
From resources wise aspect, the hydro power development achievement ratio is quite low and just 39% of the original target. Especially, the hydro power development achievement ratio by the Central Sector is 23% of the original target only. The thermal power development achievement ratio is 72% and that by the Private Sector is 150%, which is pushing up not only the thermal power development achievement ratio but also the whole power development achievement ratio.

Although the 12th Plan has not yet been approved, the draft power development plan is introduced in

the Report of Working Group for the 12th Plan. The power development plan during the 12th Plan from FY2012 to FY 2016 and that during the 13th Plan from FY2017 to FY2021 are introduced in the Report of Working Group for 12th Plan. But, States / Territories wise power development plan is nit available

The annual power development achievement during the 11th Plan is around 10,000MW, and the targets during the 12th Plan and 13th Plan are around 15,000MW and 18,000MW annually, which means the development pace must be accelerated. The resources wise target power development during the 12th Plan (Draft) consists around 12% by hydro, around 84% by thermal in which coal thermal is around 83%.It is sure coal thermal will be a major for new power development in India.

The specific project names to be developed in the State of Maharashtra Sate during the 12th Plan (Draft) are listed in Table 4.2.1-5. No hydro and no gas thermal project is identified.



(Source: The 12th & 13th Plan)

Figure 4.2.1-2 The 12th & 13th Plan

Table 4.2.1-3 Power Development Target during 12th Plan (Draft)

(Unit: MW)

	FY2012	FY2013	FY2014	FY2015	FY2016	Total
Hydro	1,370	1,808	2,077	2,530	1,419	9,204
Thermal	14,671	13,070	13,555	12,575	9,910	63,781
Coal	13,685	12,970	13,555	12,575	9,910	62,695
Gas	986	100	-	-	-	1,086
Nuclear	-	-	-	1,400	1,400	2,800
Total	16,041	14,878	15,632	16,505	12,729	75,785

(Source: CEA)

Table 4.2.1-4 Power Development Target during 13th Plan (Draft)

(Unit: MW)

	FY2017	FY2018	FY2019	FY2020	FY2021	Total
Hydro	1,964	2,497	2,426	2,430	2,689	12,006
Thermal	17,400	14,790	10,960	11,365	8,935	63,450
Nuclear	4,900	4,900	3,100	3,450	1,650	18,000
Total	24,264	22,187	16,486	17,245	13,274	93,456

(Source: CEA)

Table 4.2.1-5 Power Development Plan during 12th Plan in Maharashtra (Draft)

Project Name	Developer	Sector	Capacity (MW)
Mauda #1, 2	NTPC	Central	1,000
Chandrapur Ext. #8, 9	MSPGCL	State	1,000
Koradi Ext #8-10	MSPGCL	State	1,980
Parli Ext #8	MSPGCL	State	250
Amravati-I #1-5	India Bulls	Private	1,350
Amravati-II #1-5	India Bulls	Private	1,350
Nasik-I #1-5	India Bulls	Private	1,350
Nasik-II #1-5	India Bulls	Private	1,350
Dhariwal Infrastructure #1, 2	Dhariwal Infrastructure (P) Ltd.	Private	600
EMCO Warora #1, 2	EMCO Energy Ltd. (GMR)	Private	600
Butibori-II #1	Vidarbha Industries Power Ltd.	Private	300
Lanco Vidarbha #1, 2	Lanco Vidarbha	Private	1,320
Tiroda-I #2	Adani Power Ltd.	Private	660
Tiroda-II #1	Adani Power Ltd.	Private	660

(Source: CEA)

4.3 Current Status of Power System

4.3.1 Criteria of Power System Operation

Criteria of Power system operation in India are as follows.

(1) Voltage

Table 4.3.1-1 shows desired operating voltage range and allowed limit in India.

Table 4.3.1-1 Desired operating voltage range and allowed limit

Voltage-(kV rms)		
Nominal	Nominal	Nominal
765	765	765
400	400	400
220	220	220
132	132	132
110	110	110
66	66	66
33	33	33

(Source: IEGC)

High voltages prevailed in the month of monsoon months of June, July, August and September during night hours.

During the Rabi season, agricultural loads picked up and the voltage profile begins to deteriorate, due to high reactive power requirement of agricultural loads specifically during morning time.

Table 4.3.1-2 shows voltage profile of important 400kV substations in western region.

There are many cases that are beyond 420kV as maximum limit due to overvoltage during night off-peak time.

Table 4.3.1-2 Voltage Profile of Important Substations

Month	Indore		Itarsi		Karad		Dhule		Asoj		Kasor		Bhilai	
	Max. Kv	Min. Kv	Max. Kv	Min. Kv	Max. Kv	Min. Kv	Max. Kv	Min. Kv	Max. Kv	Min. Kv	Max. Kv	Min. Kv	Max. Kv	Min. Kv
Apr'10	426	397	430	403	426	381	434	391	423	398	424	403	419	392
May	423	393	430	403	428	383	436	396	425	406	425	401	425	391
June	424	388	431	394	432	391	438	396	426	406	429	406	424	382
Jul	430	398	431	407	436	398	438	406	428	408	429	408	423	400
Aug	434	383	434	400	436	396	438	400	428	411	430	409	421	363
sep	428	390	431	394	435	400	436	400	427	406	429	400	423	396
oct	425	379	430	393	434	400	432	390	427	404	432	405	422	401
Nov	425	385	431	390	435	397	434	394	429	405	429	406	425	397
Dec	421	384	428	386	430	397	434	396	427	406	430	408	427	399
Jan'11	424	388	427	389	427	393	432	392	428	404	433	404	423	401
Feb	426	390	432	397	430	397	432	390	426	408	431	411	421	401
Mar	427	392	427	396	427	393	432	396	427	413	431	412	419	401
Yearly	434	379	434	386	436	381	438	390	429	398	433	400	427	363

(Source: WRLDC annual report 2010-2011)

(2) Frequency

According to IEGC, all users shall take all possible measures to ensure that the grid frequency always remains within the 49.5 – 50.2Hz band.

Figure 4.3.1-1 and Table 4.3.1-3 show frequency band variation in western region includes Maharashtra States.

The average frequency of Western Region varied between 49.73Hz – 50.00Hz.5.86 – 21.3% of time didn't remain in IEGC band in Western Region.

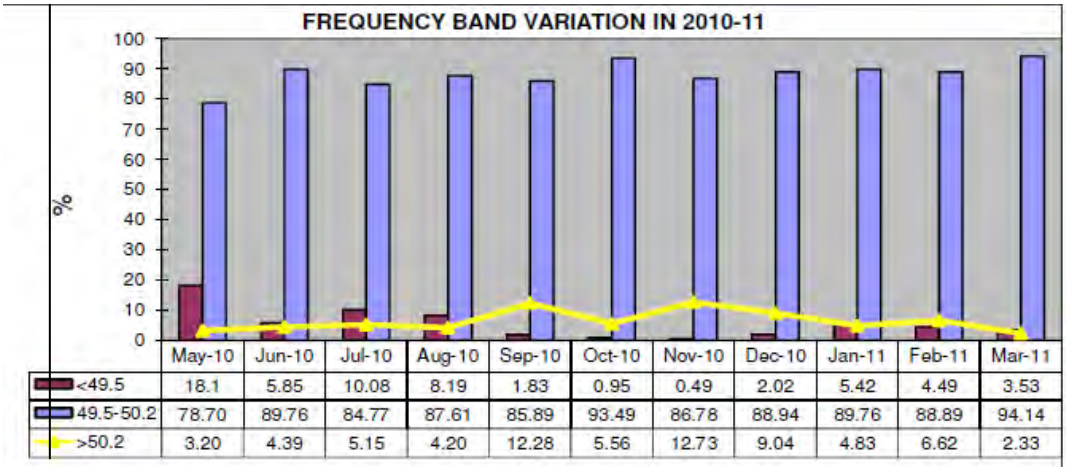
Frequency profile deteriorated in the month of April, 2010 due to more outages and inadequate load shedding. Frequency remained below 49.2Hz for 39.63% of time. Frequency touched

48.8Hz for 438 times and touched 48.6 for 4 times. As per CERC order IEGC grid operating frequency narrowed down from 49.2 – 50.3Hz to 49.5 – 50.2Hz. Percentage of time frequency remained in IEGC band more than 90% in the month of October and March, 2011. High frequency prevailed in the month of September and November, 2010 whereas severe low frequency observed during April and May, 2010.

Table 4.3.1-3 Frequency Band Variation 2010-2011

Month	<48.8	48.8 - 49.2	49.2 -49.5	49.5-50.0	50.0-51.0	>51.0	<49.2	49.2-50.3	>50.3
Apr-10	3.68	35.95	40.48	19.04	0.85	0.00	39.63	59.73	0.64
Month	<48.8	48.8 - 49.2	49.2 -49.5	49.5-50.2	50.2-51.0	>51.0	<49.5	49.5-50.2	>50.2
May-10	0.02	2.44	15.64	78.7	3.2	0.00	18.1	78.70	3.20
Jun-10	0	0.58	5.27	89.76	4.39	0.00	5.85	89.76	4.39
Jul-10	0.07	2.23	7.78	84.77	5.15	0.00	10.08	84.77	5.15
Aug-10	0.02	1.76	6.41	87.61	4.2	0.00	8.19	87.61	4.20
Sep-10	0.02	0.34	1.47	85.89	12.28	0.00	1.83	85.89	12.28
Oct-10	0	0.01	0.94	93.49	5.56	0.00	0.95	93.49	5.56
Nov-10	0	0.01	0.48	86.78	12.73	0.00	0.49	86.78	12.73
Dec-10	0	0.08	1.94	88.94	9.04	0.00	2.02	88.94	9.04
Jan-11	0	0.35	5.07	89.76	4.83	0.00	5.42	89.76	4.83
Feb-11	0	0.17	4.32	88.89	6.62	0.00	4.49	88.89	6.62
Mar-11	0	0.12	3.41	94.14	2.33	0.00	3.53	94.14	2.33
						AVG	5.54	88.07	6.39

(Source: WRLDC annual report 2010-2011)



(Source: WRLDC annual report 2010-2011)

Figure 4.3.1-1 Frency Band Variation in 2010-2011

(3) Reserve margin

There isn't adequate spinning reserve because of load shedding.

Load shedding schemes have been implemented by means of Flat Under Frequency Relays (AUFLS) as well as Frequency Trend Relays (df/dt Relay).

Table 4.3.1-4, 4.3.1-5 show schemes of relays.

Table 4.3.1-4 Flat Under Frequency Relays (AUFLS)

UFR Setting	Time delay	Recommended Load Relief (MW)	Load Relief Implemented (MW)
(Hz)	(Sec.)	(WR)	(WR)
48.8	Inst.	960	1358
48.6	Inst.	960	1384
48.2	Inst.	1280	1699
Total		3200	4441

(Source: WRPC annual report 2009 - 2010)

Table 4.3.1-5 Frequency Trend Relays (df/dt relays)

Stage	Settings (Hz)/(Hz/Sec)	Total Load Relief in Region (MW)
Stage 1	49.9/0.1	2000
Stage 2	49.9/0.1	2000
Stage 3	49.9/0.4	2472
	Total	6472

(Source: WRPC annual report 2009 - 2010)

4.3.2 Organization regarding Power System

(1) Transmission Utility

1) Central Transmission Utility (CTU)

- CTU is national transmission utility(Power Grid Corporation of India Limited: PGCIL)
- CTU plan, construct and maintain 765kV and 400kV transmission system and inter-State transmission system.
- CTU have subsidiary which is called Power System Corporation Limited (POSOCO) operate power system.

2) State Transmission Utility (STU)

- STU plan, construct and maintain 400kV and under intra-State transmission system.
- STU have branch which is called SLDC.

(2) Organization of Power System Operation

Organization of Power System Operation are National Load Dispatch Centre, 5 Regional Load Dispatch Centre State Load Dispatch Centre. NLDC and RLDC belong to POSOCO. SLDC is branch of STU.

Figure 4.3.2-1 shows the organization of power system operation in India.

1) National Load Dispatch Centre (NLDC)

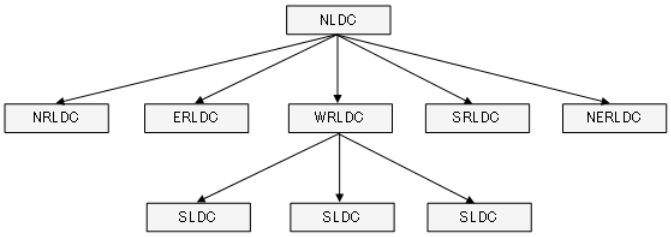
- NLDC engage scheduling and dispatch of electricity over inter-regional links.
- NLDC monitor operation and security of National Grid.
- NLDC coordinate for regional outage.

2) Regional Load Dispatch Centre (RLDC)

- There are 5 Regional Load Dispatch Centre. They are North Regional Load Dispatch Centre (NRLDC, The location is New Delhi), Eastern Regional Load Dispatch Centre (ERLDC, The location is Kolkata), Western Regional Load Dispatch Centre (WRLDC, The location is Mumbai), Southern Regional Load Dispatch Centre (SRLDC, The location is Bangalore), North Eastern Regional Load Dispatch Centre (NERLDC, The location is Shillong). Also, WRLDC have Maharashtra State Load Dispatch Centre.
- RLDC are responsible for optimum scheduling and dispatch of electricity within the region.

3) State Load Dispatch Centre (SLDC)

- SLDC are responsible for optimum scheduling and dispatch of electricity within a State.
- There are 33 SLDCs.



(Source: JICA study team)

Figure 4.3.2-1 Organization of Power System Operation in India

4.3.3 Status of Power System Operation

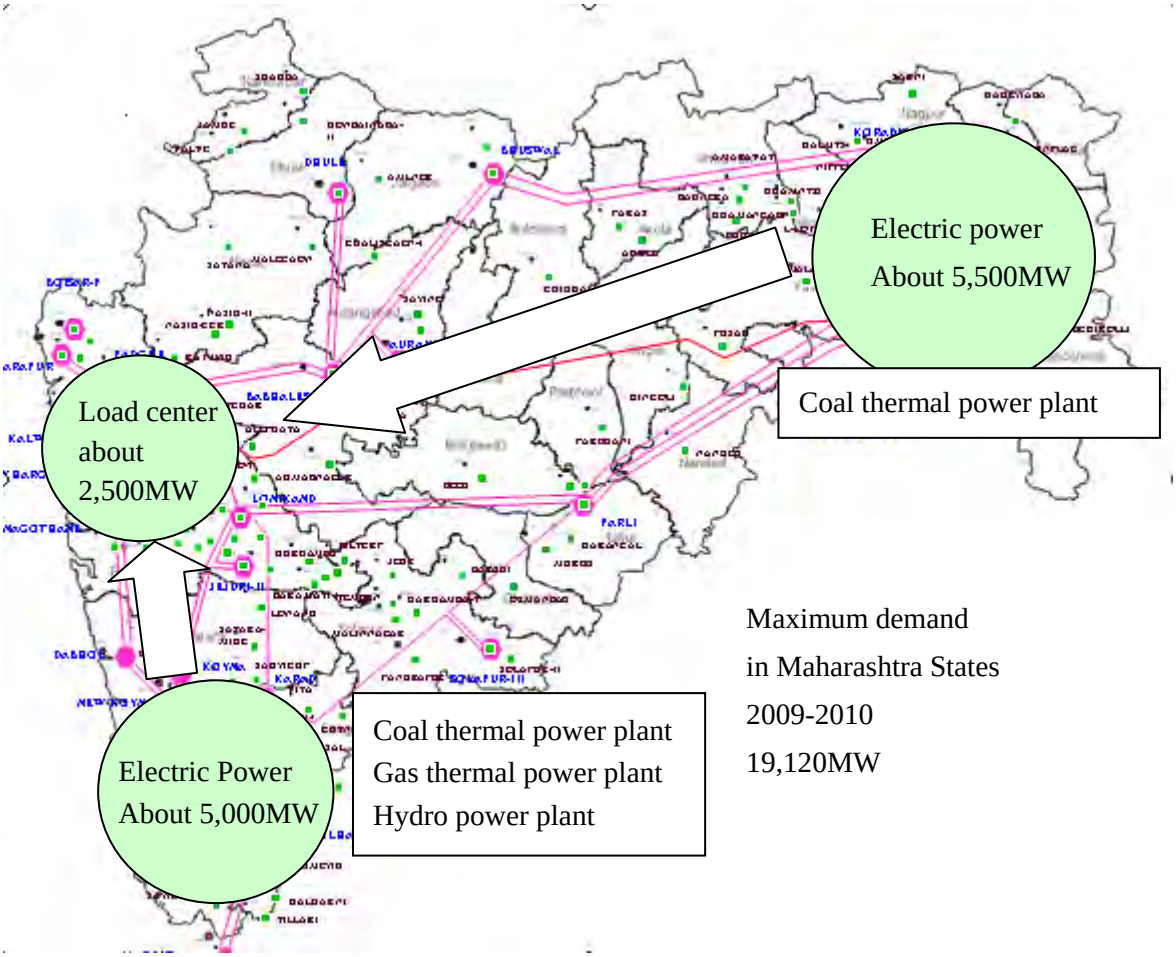
(1) Power System Operation in Maharashtra

Mumbai which is the capital of the state and commercial city is load center. That is about 13% of Maharashtra State. The place is spread on the west side of the state.

Much electric power is generated by the coal thermal power stations in eastern area and the gas thermal power, coal thermal power, hydro electric power in south western area. There is much electric power in eastern area. Whereas there is load center in western area. So it is found that power flow occur from eastern area to western area.

Figure 4.3.3-1 shows Maharashtra States power map.

Maharashtra states have shortage of electric power and receive interstate exchange from other states. However, load shedding is conducted because it still has shortage.



(Source: SLDC)

Figure 4.3.3-1 Maharashtra States Power Map

(2) Open Access

1) Outline

Open access in transmission has been introduced to promote competition amongst the generating companies who can now sell to different distribution licencees across the country. This should lead to availability of cheaper power. When open access to distribution networks is introduced for enabling bulk consumers to buy directly from competing generators, competition in the market would increase the availability of cheaper and reliable power supply. To provide facilitative framework for non-discriminatory open access requires load dispatch facilities with state-of-the art communication and data acquisition capability on a real time basis.

Table 4.3.3-1 Type of Open Access

Type	Period	Intra/Inter state	Organization
Long	12 – 25years	Inter state	CEA、CTU
		Intra state	STU
Medium	3 months - 3years	Inter state	CEA、CTU
		Intra state	STU
Short	Up to 1 month	Inter state	RPC、RLDC
		Intra state	SLDC

(Source: JICA study team)

2) Transmission Congestion

Generally there is no congestion for transfer of power under Long term open access. However, for short term/medium term transfers of power, congestion can occur. PGCIL says that there is no congestion currently in India.

In case of inter-regional transactions, reservation of transmission capacity to the short term customer may be reduced or cancelled by the Regional Load Dispatch Centre. If the RLDC decides to reduce or cancel transmission capacity reserved for a short term customer, it shall, as soon as possible, intimate the short term customer concerned of its decision to reduce or cancel transmission capacity.

(3) Smart Grid

1) Smart Transmission Grid – Need for Indian system

With liberalization of power sector, advent of open access, power exchange etc and increasing share of short term transactions and renewable generation, it has become necessary to design and operate Indian grid as a Smart National Grid. Indian power system is expanding at a fast pace to meet the growing requirement. In order to facilitate optimal utilization of unevenly distributed energy resources, strengthening of regional grids through inter state/regional system is being taking place continuously. Out of the 5 regional grids, 4 grids 133GW have been synchronized with one another while the remaining Southern grid (49GW) is expected to be synchronized with these grids by 2014. Total capacity of the integrated all India grid is expected to be of the order of 300GW including about 40 -50GW of renewable generation in next 5 to 6 years. In such a way much installation of renewable energy would increase the complexity towards the monitoring and control of such large grid. The wide spread grid and increasing complexity in its operation and of electricity market requires wide area monitoring technology.

2) Wide Area Monitoring System (WAMS)

WAMS like using Phasor measurement Units (PMUs) is advanced measurement system that provides synchronized measurements at very fast rate. The WAMS technology provides real time measurements in terms of amplitude and phase angle which are utilized for better visualization & help to increase the situational awareness of power system operators. The WAMS technology is the main building block towards Smart Grid development in Transmission System.

The basic building block of WAMS technology is Phasor Measurement Units (PMUs), wide band communication and Phasor Data Concentrators (PDCs).

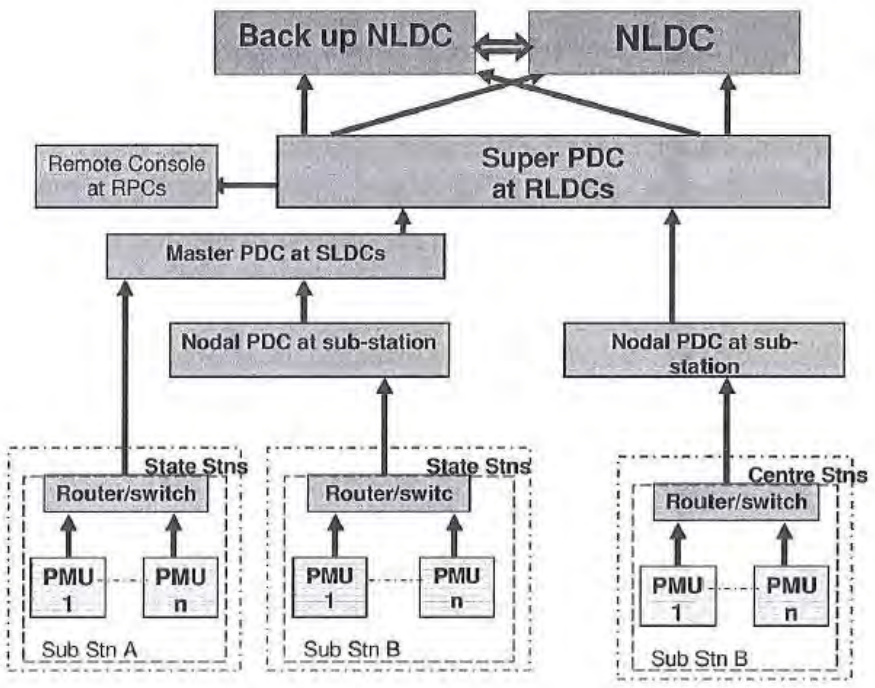
3) Plan for WAMS in India

The process for installation of PMUs has already been started, and 8 PMUs have already been commissioned in Northern Region with a Phasor data concentrators (PDC) at NRLDC. Phasor data at each PMU is being sampled at 25 samples per second and transferred to phasor data concentrator provided at NRLDC through dedicated 64kbps fiber optic communication link.

With the commissioning of the Northern Region pilot project, Phasor data from different locations is available at NRLDC and its existing SCADA system. From the phasor data, load angle between different pockets of the grid is available more accurately with updation time of order of few milliseconds and this enhances the capability of the tools available to grid operator.

Proposal for installation of PMUs in other regions is also in the pipe line.

Figure 4.3.3-2 shows outline of WAMS.



(Source: Draft National Electricity Plan(Vol-2) Transmission)

Figure 4.3.3-2 Outline of WAMS

4.3.4 Status of Power System Plan

(1) Power System Plan in Maharashtra

Table-4.3.4-1、Figure 4.3.4-1、Figure 4.3.4-2 show the plan of 765kV and 400kV transmission line in Maharashtra States based on STU_FIVE_YEAR_PLAN_2010-11 to 2014-15.

More 765kV and 400kV transmission line from eastern area to western area will be constructed. The plan would contribute to power system operation of Maharashtra State.

The candidate sites are good point because they are close to load center and T & D losses are less.

As there are a lot of thermal power stations facing Arabian sea, we will be able to get effectively the resource of the pumping storage for the power station of this project by the electric power those generated.

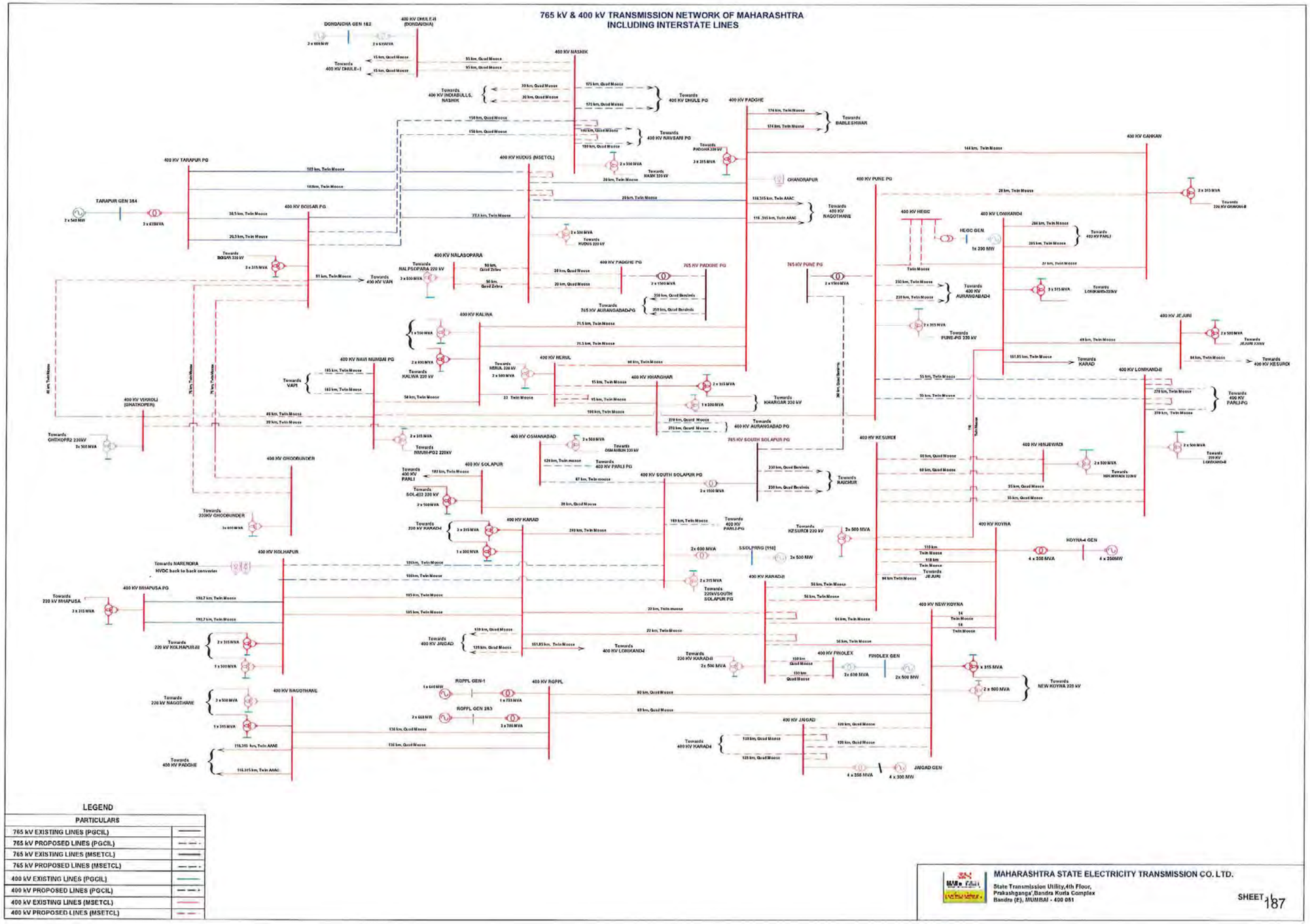
There are much T & D losses in India. According to Report on 17th Electric Power Survey of India (Issued in March 2007), India have T & D losses which is from19 to 45 %. Maharashtra States is expected to have T & D losses which are 25.4% in 2011 - 2012.

Therefore we have to consider plan to improve T & D losses.

Table-4.3.4-1 STU_FIVE_YEAR_PLAN_2010-11 to 2014-15(765kV,400kV)

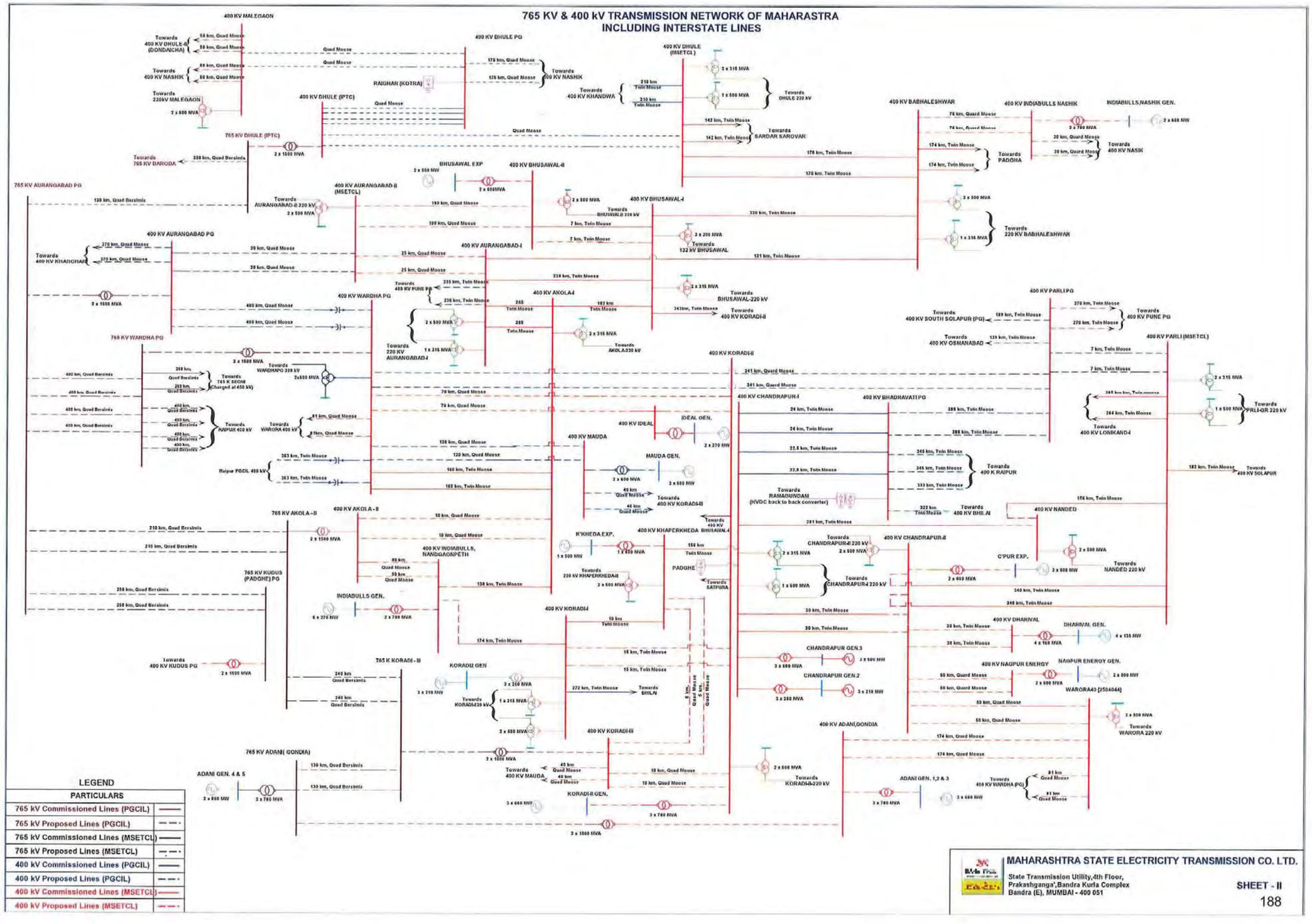
Name of transmission line	Length (km)	Name of transmission line	Length (km)
765kV LINES			
Pune PG – South Solapur PG	260	Wardha PG – Riapur	400
South Solapur PG – Raichur	230	Aurangabad PG – Akola-2	210
Dhule(IPTC) – Baroda	250	Aurangabad – Kudus PG	250
Dhule(IPTC) – Aurangabad PG	130	Adani – Koradi-3	130
Aurangabad PG – Wardha PG	400	Akola-2 – Koradi-3	240
400kV LINES			
Chakan – Pune PG	28	Parli PG – Bhadravati PG	388
Pune PG – Aurangabad	230	Bhadravati – Raipur	345
Pune PG – Lonikand	55	Bhadravati – Bhilai	322
Jejuri – Kesurdi	84	Chandrapur-2 – Dharival	30
Lonikand – Parli PG	270	Chandrapur-2 – Nagpur Energy	50
Kesurdi – Hinjewadi	60	Chandrapur-2 – Warora	50
Kesurdi – Lonokand	55	Warora – Adani Gondia	174
Kesurdi – Jejuri	84	Warora – Wardha PG	81
Kesurdi – Koyna	110	Koradi-2 – Koradi-3	10
Kesurdi – Lonikand	116	Koradi-3 – Khaperdkhea	6
Kesurdi – Korad-2	56	Koradi-1 – Koradi-2	15
Finolex – Koead-2	150	Koradi-2 – Wardha PG	70
New Koyna – Jaigad	120	Akola-1 – Akola-2	10
Jaigad – Karad-1	139	Koradi-3 – Mauda	40
South Solapur PG – Karad	196	Mauda – Wardha PG	120
South Solapur PG – Parli PG	189	Akola-2 – Indiabulls Nandgaonpeth	90
South Solapur PG – Osmanabad	67	Wardha PG – Aurangabad PG	400
Osmanabad – Parli PG	129	Aurangabad-2 – Aurangabad PG	30
Kharghar – Aurangabad PG	270	Aurangabad PG – Kharghar	270
Kharghar – Vikroli	20	Aurangabad-2 – Aurangabad-1	25
Navi Munbai PG – Vikroli	40	Aurangabad-2 – Bhusawal-2	190
Vikroli – Boisar PG	40	Bhusawal-2 – Bhusawal-1	7
Ghodbunder – Boisar	76	Babhaleshwar – Indiabulls Nashik	76
Navi Munbai PG – Vapi	185	Indiabulls Nashik – Nasik	30
Boisar PG – Nashik	150	Dhule –Dhule (IPTC)	-
Nashik – Indiabulls	30	Dhule PG – Dhule (IPTC)	-
Nashik – Dhule PG	175	Dhule PG – Malegon	-
Nashik – Dhule-2	95	Malegon – Dhule-2 (dondaichai)	50
Pune PG – Parli PG	270	Malegon – Nashik	50
Parli – Parli PG	7	Dhule PG – Nashik	175
Parli PG – Wardha PG	341	Wardha PG – Riapur	400

(Source: STU_FIVE_YEAR_PLAN_2010-11 to 2014-15)



(Source: STU_FIVE_YEAR_PLAN_2010-11 to 2014-15)

Figure 4.3.4-1 Single line diagram No.1 (include plan of transmission)



(Source: STU_FIVE_YEAR_PLAN_2010-11 to 2014-15)

Figure 4.3.4-2 Single line diagram No.2 (include plan of transmission)

(2) 1200kV Transmission System Plan

In order to increase the power density of the corridor, development of 1200kV AC system as next higher AC voltage level has been decided. As a planning initiative, considering need of higher capacity transmission corridor between Aurangbad and Wardha, the Aurangabad – Wardha 400kV Quad D/C line which is part of the transmission system has been planned and designed in such a way that this line would be converted into 1200kV S/C line at a later date.

As, the 1200kV AC technology is relatively a new one in the world, therefore, to develop this technology indigenously, POWERGRID along with Indian manufactures is establishing a 1200kV UHVAC Test Station at Bina. In this test station, a 1200kV test line (S/c+D/c) is being constructed along with 1200kV bays in which the leading manufactures are providing main equipment like transformers, surge arresters, circuit breakers, CTs, CVTs, and transmission line hardware etc. POWERGRID shall provide civil foundation, 1200kV line, control & protection system, various testing equipment, auxiliaries & fire protection system, 1200kV bushing etc. These test bays and test line shall be used by the manufactures and transmission utilities for various field tests so that the results and feedback can be used for developing filed proven equipment of 1200kV system in India as well as gain initial operation experience.

Chapter 5

Necessity of Pumped Storage Hydropower Scheme

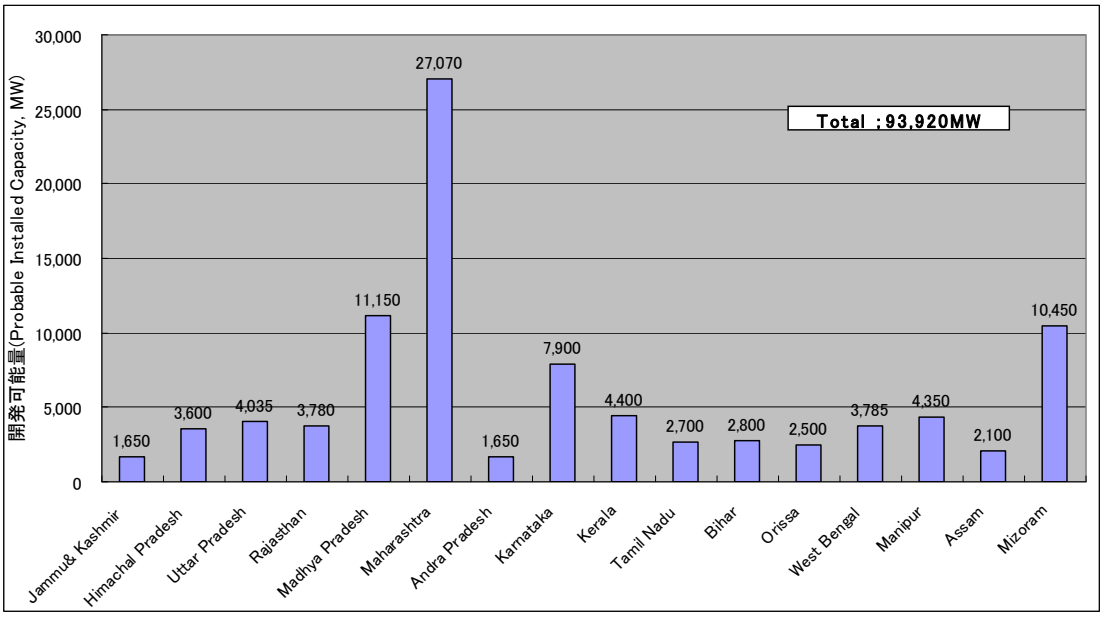
Chapter 5 Possibility of Introduction of Pumped Storage Power Station

5.1 Necessity of Pumped Storage Power Station

5.1.1 Potential of pumped storage power station

India, and Maharashtra state among all, has revealed itself in the significant power shortage, and it urges the state to establish the right suitable power supply development schemes which are meeting the future power demand situations. The discrepancy between daytime industry demand and nighttime lighting demand has been arising in the state already, thus not only the need for well planned development for power generation facilities and transmission facilities meeting the rapid demand growth in time, but also well advanced preparation for remedies to fulfill the steepening power peak to arise in the near future by the rapid economic growth and industry demand growth is inevitably important for keeping the stable power system operation and the higher level of economic development.

Maharashtra state geographically is constrained to have a relatively small remained capacity for new development and enhancement of hydropower energy. The potential hydropower resource of Maharashtra State is 3,769MW (Ministry of Power, Hydropower policy (2008)), and the developed hydropower has reached 3,332MW (as of 2012/3). On the contrary, the potential resource for pumped power storage scheme is the largest among the whole India states, with all promising sites located in the western Konkan region of the state. The pumped power storage scheme is reliable in peaking power source, and is expected to contribute to keep the grid system stable.



(Source: MOP, Hydropower Policy 2008)

Figure 5.1.1-1 Potentiality of Pumped Storage Hydropower scheme (Probable Installed Capacity, as of 1987)

5.1.2 Necessity of power sources to meet peak power demand

(1) From the aspect of power demand

According to the tentative 18th ESP, the electrical energy requirement (EER) of Maharashtra State in the decade ahead from FY2011 to FY2021 is forecasted to increase by 6.44% annually in kWh base and by 7.97% annually in kW base.

And the load factor is expected to decrease, which means the peak power demand will become more radical, although it is disputable.

Considering the T & D losses, over 20,000MW new power stations are to be developed and some of stations are to be targeted to meet peak power demand.

(2) From the aspect of power development plan

According to the tentative 12th Plan, only coal thermal projects are listed as candidates of new power stations to be developed from FY 2012 to FY 2016. No gas thermal project and no hydropower project, which is excellent in reacting demand, is nominate in the plan.

During next five years after FY2010, over 5,000MW wind power plants are scheduled to be developed, and the total capacity of wind power will be around 8,000MW including the existing plants. It is necessary to prepare equal amount of power supply as spinning reserve for the frequency stabilization when the wind generation is connected to the grid system because of wind power fluctuation.

Considering the above mentioned situation of Maharashtra State, it is safe to say that pumped storage power project can be major candidate to meet peak power demand.

5.1.3 Pumped Storage Power Plant Operation Record

Before explaining the operating rate of pumped storage power plant in Maharashtra state, the investigation of the world pumped storage power plant was carried out.

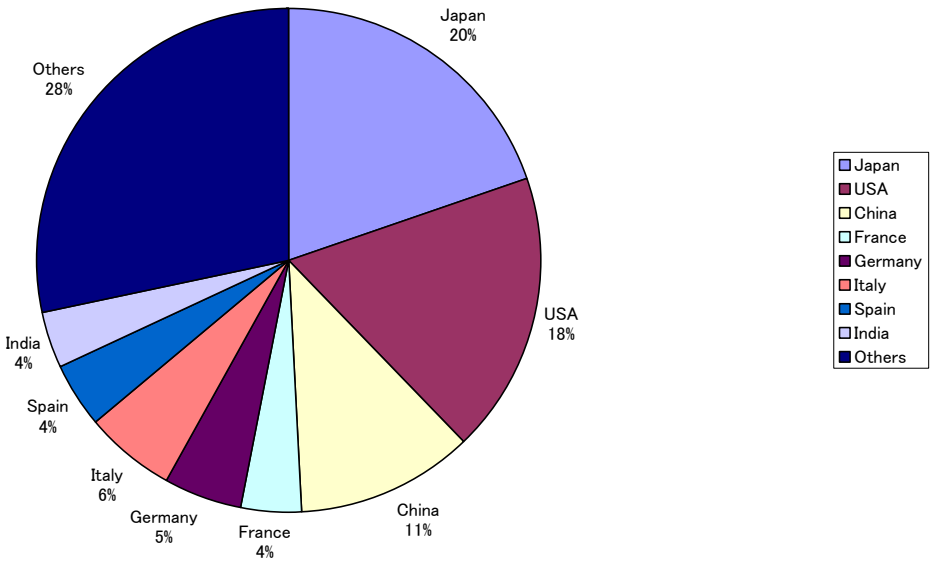
Japan has led the implementation of the pumped storage power plant, and gets ascendancy over past records and technologies.

It seems to be necessary to have the many pumped storage power plant for India, such as Japan , America and China, since the economic development in Maharashtra state grows rapidly.

Table 5.1.3-1 The implementation of the world pumped storage power plant

Country	MW
Japan	25,129
USA	22,957
China	14,550
France	5,050
Germany	6,361
Italy	7,421
Spain	5,208
India	4,640
Others	36,099
Total	127,416

(Source: International Water Power & Dam Construction Yearbook 2010)



(Source: International Water Power & Dam Construction Yearbook 2010)

Figure 5.1.3-1 The implementation of the world pumped storage power plant

12 pumped storage power stations (about 5,800MW) which have been constructed in India are shown in Table 5.1.3-2.

Japanese manufactures had been related to many projects. The pumped storage power generation had developed high head and huge output technology with the trend of the times.

Especially, Japanese manufactures almost have a monopoly on an adjustable speed pumped storage power system. The development of adjustable speed pumped storage system started in 1980s in Japan

In 1990, Tokyo Electric Power Company developed the first adjustable speed pumped storage system in the world on Unit No.2 in Yagisawa Pumped Storage Power Plant, which has already more than 20-years operational record

The Japanese construction and operation records of pumped storage power plants, especially adjustable speed pumped storage power plants records are very outstanding in the world.

As shown in Table 5.1.3-2, the first implementation of the adjustable speed pumped storage power plant, Tehri PSP, in India is in process. The manufacture is ALSTOM (France). The main concept of implementation is to enlarge the effective head of dam.

It is necessary to have an power supply reserve for stability of the power system. It seems that Tehri PSS aims to enlarge the dam head, there is no doubt about that it also aims the functions of power supply reserve for network stability in the future.

Table 5.1.3-2 Pumped Storage Power Plants in India

Name	State	Organization	Classification	Output (MW)	Manufacture		JPOWER
					Turbine	Generator	
In operation							
1 N.J.Sagar	Andhra Pradesh	APGENCO	Mixed PSP	7*100.8 (1*110)	Hitachi	Mitsubishi	
2 Paithon	Maharashtra	Mahagenco	Mixed PSP	1*12	Fuji	Fuji	
3 Kadamparal	Tamilnadu	TNEB	Mixed PSP	4*100	No.1:Boving, UK No.2-4:BHEL	No.1:GE, UK No.2-4:BHEL	
4 Kadana	Gujarat	GSEB	Mixed PSP	4*60	BHEL	BHEL (Skoda, [illegible])	
5 Panchet & Extn.	Bihar	DVC	Mixed PSP	2*40	No.2:Voist, Austria	No.2:Elin Union, Austria	
6 Ujaini	Maharashtra	Mahagenco	Mixed PSP	1*12	Fuji	Fuji	
7 Bhira PSS	Maharashtra	Tata Power	Mixed PSP	1*150	Sulzer-Siemens, GE	Sulzer-Siemens, GE	
8 Srisailam LBPH	Andhra Pradesh	APGENCO	Mixed PSP	6*150	Hitachi	Mitsubishi	D/D, S/V 1998.12-2001.2
9 Sardar Sarovar PSS	Gujarat	SSNNL	Mixed PSP	6*200	Hitachi	Toshiba	
10 Purulia PSS	West Bengal	WBSEDC	Recirculating PSP	4*225	Toshiba	Toshiba	D/D, S/V 1995.12-2008.3
11 Chatghar PSS	Maharashtra	Water Resources Dept. Govt of Maharashtra	Recirculating PSP	2*125	Fuji	Fuji	S/V 1995.8-2007.12
Uner construction							
Tehri PSS	Uttarakhand	THDC	Mixed PSP	4*250	Alstom	Alstom	

(Source: JICA Study Team)

In order to investigate the operating records of existing pumped storage power plants in Maharashtra state, the meetings with JICA study team, MAHAGENCO and GOMWRD were held.

According to the meetings, there are two (2) big pumped storage power plants in Maharashtra state except PAITHAN (12MW) pilot plant.

- Bhira PSP (1×150MW)
- Ghatghar PSP (2×125MW)

Bhira PSP belongs to TATA Power. Bhira PSP is used for generating operation only in recent years, due to the contract fee problem of pumping operation.

MAHA GENCO maintains and operates Ghatghar PSP by a lease contract with state government.

According to C/P explanation, the lease fee had been still under discussion, it seems that there is a different understanding regarding the value of pomped storage power generation between state government and facility operator.

Ghatghar PSP operating records are described in Table 5.1.3-3 ~ 5.1.3-5. In regard to Unit No.2, after the commissioning at 2008, the unit was obliged to long time outage due to the stator accident, therefore, the 2008-2009 operating ratio is not so good. But after the repair of the stator, unit No.2 operating ratio has been going well.

According to GOMWRD, Gahtghar PSP was oprelated for around 6 hours per day for peak demand. Table 5.1.3-2, 3 show the FY2010 and FY2011 total operating hours. The plants was operated for around 1,500 hours at the maximum capacity in FY2010, which is equivalent to around 4 hours per day including weekend and to around 6 hours per day excluding weekend.

Figure 5.1.3-2 ~ 5.1.3-9 are the graphs based on the data of the tables. It can be confirmed that FY2011 operating has been going well and particularly unproblematic.

It can be confirmed that a pumped storage power plant has been used adequately for the peak power supply and for network stability.

Table 5.1.3-3 Ghatghar Operation Record

GHATGHAR HPS (2 X 125 MW)

GENARATION & AUXILIARY CONSUMPTION														
Year	MONTH	GROSS GEN. (MUS)		Staition Total	AUX. CONS^{N} (MUS)			NET GEN^{N} (MUS)	AUX. CONS^{N} (MUS)	PUMPING consumption (MUS)		Total PUMPING consumption (MUS)	η	Pumping/ Gen.Ratio
		Unit#1	Unit#2		UAT-1	UAT-2	TOTAL		%	Unit#1	Unit#2			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
FY 2008-09	Aprl'	0.246	0.000	**0.246**			**0.00000**	0.246		0.102	0	**0.102**		**0.41**
	May	0.765	0.000	**0.765**			**0.00000**	0.765		2.332	0	**2.332**		**3.05**
	June	0.281	0.247	**0.528**			**0.00000**	0.528		0.087	0.216	**0.303**		**0.57**
	July	5.976	2.477	**8.453**			**0.00000**	8.453		0.733	1.902	**2.635**		**0.31**
	Aug	12.133	6.551	**18.684**			**0.27900**	18.405	1.49	19.22	10.146	**29.366**		**1.57**
	Sept	9.081	12.439	**21.520**			**0.25200**	21.268	1.17	10.181	13.618	**23.799**		**1.11**
	Oct	1.942	12.576	**14.518**			**0.33600**	14.182	2.31	1.736	16.172	**17.908**		**1.23**
	Nov	4.408	2.574	**6.982**			**0.33600**	6.646	4.81	5.89	2.715	**8.605**		**1.23**
	Dec	10.175	0.000	**10.175**			**0.36700**	9.808	3.61	13.045	0	**13.045**		**1.28**
	Jan	9.281	0.000	**9.281**			**0.31100**	8.970	3.35	13.901	0	**13.901**		**1.50**
	Feb	9.159	0.000	**9.159**			**0.29800**	8.861	3.25	10.494	0	**10.494**		**1.15**
	Mar	7.519	0.000	**7.519**			**0.33100**	7.188	4.40	10.745	0	**10.745**		**1.43**
Total FY		**70.966**	**36.864**	**107.830**			**2.51000**	**105.32**	**2.33**	**88.466**	**44.769**	**133.235**	**80.9**	**1.24**
FY 2009-10	Aprl'	10.230	0.000	**10.230**			**0.30400**	9.926	2.97	13.654	0	**13.654**		**1.33**
	May	6.983	0.000	**6.983**			**0.35400**	6.629	5.07	9.343	0	**9.343**		**1.35**
	June	9.027	0.000	**9.027**			**0.32400**	8.703	3.59	11.229	0	**11.229**		**1.24**
	July	5.401	0.000	**5.401**			**0.35400**	5.047	6.55	8.102	0	**8.102**		**1.50**
	Aug	7.772	0.000	**7.772**			**0.40100**	7.371	5.16	11.534	0	**11.534**		**1.48**
	Sept	7.905	0.000	**7.905**			**0.19452**	7.71	2.46	12.071	0	**12.071**		**1.53**
	Oct	10.838	0.000	**10.838**			**0.21636**	10.62164	2.00	13.647	0	**13.647**		**1.26**
	Nov	8.221	0.000	**8.221**			**0.20957**	8.01143	2.55	11.743	0	**11.743**		**1.43**
	Dec	23.428	0.000	**23.428**			**0.30920**	23.1188	1.32	29.75	0	**29.750**		**1.27**
	Jan	24.880	0.000	**24.880**			**0.29181**	24.58819	1.17	30.865	0	**30.865**		**1.24**
	Feb	21.209	0.000	**21.209**			**0.25553**	20.95347	1.20	27.794	0	**27.794**		**1.31**
	Mar	14.608	0.000	**14.608**			**0.26237**	14.34563	1.80	19.328	0	**19.328**		**1.32**
Total FY		**150.502**	**0.000**	**150.502**			**3.47636**	**147.02564**	**2.31**	**199.06**	**0**	**199.060**	**75.6**	**1.32**
FY 2010-11	Aprl'	6.565	0.000	**6.565**	0.15413	0.08033	**0.23446**	6.33054	3.57	5.7370	0.0000	**5.737**		**0.87**
	May	4.417	5.578	**9.995**	0.16052	0.15854	**0.31906**	9.67594	3.19	7.6300	6.3940	**14.024**		**1.40**
	June	13.676	16.036	**29.712**	0.18788	0.18870	**0.37658**	29.33542	1.27	17.3080	21.5180	**38.826**		**1.31**
	July	16.920	11.156	**28.076**	0.21809	0.16057	**0.37866**	27.69734	1.35	22.1170	18.6370	**40.754**		**1.45**
	Aug	20.146	16.529	**36.675**	0.30511	0.14563	**0.45074**	36.22426	1.23	22.0570	28.1830	**50.240**		**1.37**
	Sept	16.464	14.773	**31.237**	0.20315	0.20371	**0.40686**	30.83014	1.30	20.7920	22.6510	**43.443**		**1.39**
	Oct	16.020	12.841	**28.861**	0.23054	0.16817	**0.39871**	28.46229	1.38	15.2210	22.5490	**37.770**		**1.31**
	Nov	8.397	13.227	**21.624**	0.22506	0.08922	**0.31428**	21.309720	1.45	13.6180	13.1820	**26.800**		**1.24**
	Dec	19.013	18.379	**37.392**	0.14697	0.22403	**0.37100**	37.021000	0.99	25.4380	22.9900	**48.428**		**1.30**
	Jan	28.622	23.832	**52.454**	0.24092	0.18931	**0.43023**	52.023770	0.82	36.2510	31.0510	**67.302**		**1.28**
	Feb	25.633	26.525	**52.158**	0.21769	0.18608	**0.40377**	51.754230	0.77	33.6090	33.9270	**67.536**		**1.29**
	Mar	19.666	18.000	**37.666**	0.26788	0.13489	**0.40277**	37.263230	1.07	24.3030	23.5720	**47.875**		**1.27**
Total FY		**195.539**	**176.876**	**372.415**	**2.5579**	**1.9292**	**4.48712**	**367.92788**	**1.20**	**244.0810**	**244.6540**	**488.735**	**76.2**	**1.31**
FY 2011-12	Aprl'	8.64400	5.85400	**14.498**	0.22221	0.13187	**0.35408**	14.14392	2.44	8.5320	9.39700	**17.929**		**1.23665**
	May	5.60000	3.35700	**8.957**	0.21043	0.13897	**0.34940**	8.60760	3.90	5.1220	6.62400	**11.746**		**1.31138**
	June	10.70700	10.30000	**21.007**	0.23579	0.09686	**0.33265**	20.67435	1.58	11.5860	15.76100	**27.347**		**1.30180**
	July	11.03700	12.52500	**23.562**	0.24150	0.11869	**0.36019**	23.20181	1.53	17.6940	18.09700	**35.791**		**1.51901**
	Aug	7.75700	5.30900	**13.066**	0.21921	0.09566	**0.31487**	12.75113	2.41	12.9250	9.62600	**22.551**		**1.72593**
	Sept	10.34800	9.26200	**19.610**	0.22228	0.08105	**0.30333**	19.30667	1.55	15.7900	11.66900	**27.459**		**1.40025**
	Oct	**7.25400**	**4.80900**	**12.063**	**0.21428**	**0.03623**	**0.25051**	11.81249	2.08	10.1700	6.36100	**16.531**		**1.37039**
	Nov	12.558	13.687	**26.245**	0.18487	0.11534	**0.30021**	25.944790	1.14	16.6860	17.1910	**33.877**		**1.29080**
	Dec	21.463	21.230	**42.693**	0.18979	0.24855	**0.43834**	42.254660	1.03	25.5270	28.3920	**53.919**		**1.26295**
	Jan	28.752	31.081	**59.833**	0.22711	0.26653	**0.49364**	59.339360	0.83	36.7090	40.4020	**77.111**		
	Feb													
	Mar													
Total FY		**124.12**	**117.414**	**241.534**	**2.1675**	**1.3298**	**3.49722**	**238.03678**	**1.45**	**160.7410**	**163.5200**	**324.261**	**74.5**	**12.42**

Remarks:1. Ghatghar Unit-1 is commisioned on 08.04.2008 & handed over to MSPGCL on 17.08.2009.
2. Ghatghar Unit-2 is commmisioned on 21.06.2008 & handed over to MSPGCL on 03.01.2011.
3. Ghatghar Unit-2 iwas under Generator Stator repairs from 09.11.2008 to 04.05.2010.
***4. Generator for April'08 to July'08 to July '08 is Ex-Bus Gen. i.e. directly from ABT meter & UAT Readings are also not available.**

Corrected data

(Note: MUS: 10^6 kWh)

(Source: GOMWRD)

Table 5.1.3-4 Ghatghar Operation Record (FY2010)

GHATGHAR HYDRO POWER STATION

GENERATOR & PUMPING DATA OF GHATGHAR HPS UNIT-1 & UNIT-2 FOR 2010-11													
MONTH	UNIT-1		UNIT-2		TOTAL GROSS GEN. (MUS)	AUX.CONS^{N} (MUS)			TOTAL NET GEN^{N} (MUS)	UNIT-1		UNIT-2	
	GROSS GEN. (MUS)	GEN SERVICE HRS.	GROSS GEN. (MUS)	GEN SERVICE HRS.		UAT-1	UAT-2	TOTAL		PUMPING consumption (MUS)	PUMP. SERVICE HRS.	PUMPING consumption (MUS)	PUMP. SERVICE HRS.
Apr-10	6.56500	51:45:00	0.00000	0:00:00	6.56500	0.15416	0.08033	0.23449	6.33051	5.737	39:16:00	0.000	0:00:00
May-10	4.41700	35:10:00	5.57800	46:10:00	9.99500	0.16052	0.15854	0.31906	9.67594	7.630	50:07:00	6.394	43:23:00
Jun-10	13.67600	107:53:00	16.03600	129:04:00	29.71200	0.18788	0.18870	0.37658	29.33542	17.308	114:20:00	21.518	144:29:00
Jul-10	16.92000	133:23:00	11.15600	89:52:00	28.07600	0.21809	0.16057	0.37866	27.69734	22.117	145:38:00	18.637	125:54:00
Aug-10	20.14600	158:37:00	16.52900	133:01:00	36.67500	0.30511	0.14563	0.45074	36.22426	22.057	145:25:00	28.183	189:30:00
Sep-10	16.46400	129:56:00	14.77300	118:56:00	31.23700	0.20315	0.20371	0.40686	30.83014	20.792	134:37:00	22.651	150:04:00
Oct-10	16.02000	126:16:00	12.84100	103:30:00	28.86100	0.23054	0.16817	0.39871	28.46229	15.221	99:10:00	22.549	149:56:00
Nov-10	8.39700	66:20:00	13.22700	106:28:00	21.62400	0.22506	0.08922	0.31428	21.30972	13.618	87:48:00	13.182	87:12:00
Dec-10	19.01300	151:17:00	18.37900	148:26:00	37.39200	0.14697	0.22403	0.371	37.02100	25.438	163:27:00	22.990	151:36:00
Jan-11	28.62200	225:35:00	23.83200	191:34:00	52.45400	0.24092	0.18931	0.43023	52.02377	36.251	235:01:00	31.051	206:30:00
Feb-11	25.63300	201:40:00	26.52500	213:29:00	52.15800	0.21769	0.18608	0.40377	51.75423	33.609	218:29:00	33.927	225:46:00
Mar-11	19.66600	155:00:00	18.00000	145:05:00	37.66600	0.26788	0.13489	0.40277	37.26323	24.303	157:57:00	23.572	156:10:00
TOTAL FOR 2010-11	195.53900	1542:52:00	176.87600	1425:35:00	372.41500	2.55797	1.92918	4.48715	367.92785	244.081	1591:15:00	244.654	1630:30:00

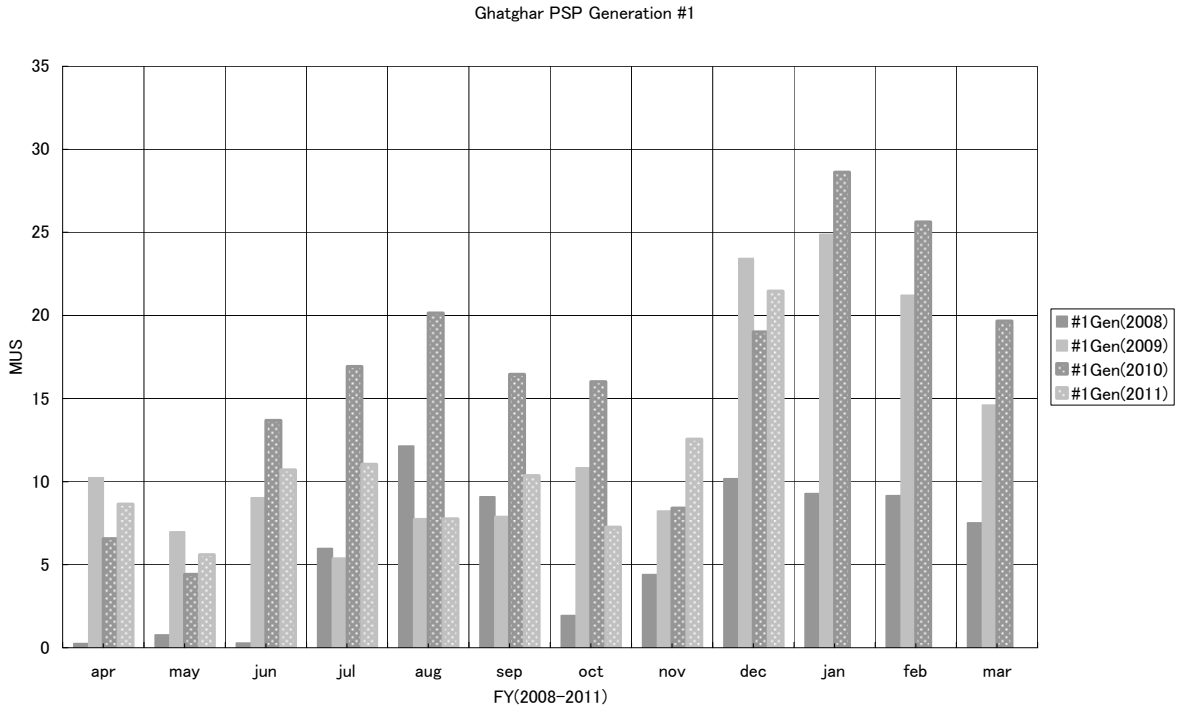
(Source: GOMWRD)

Table 5.1.3-5 Ghatghar Operation Record (FY2011)

GHATGHAR HYDRO POWER STATION

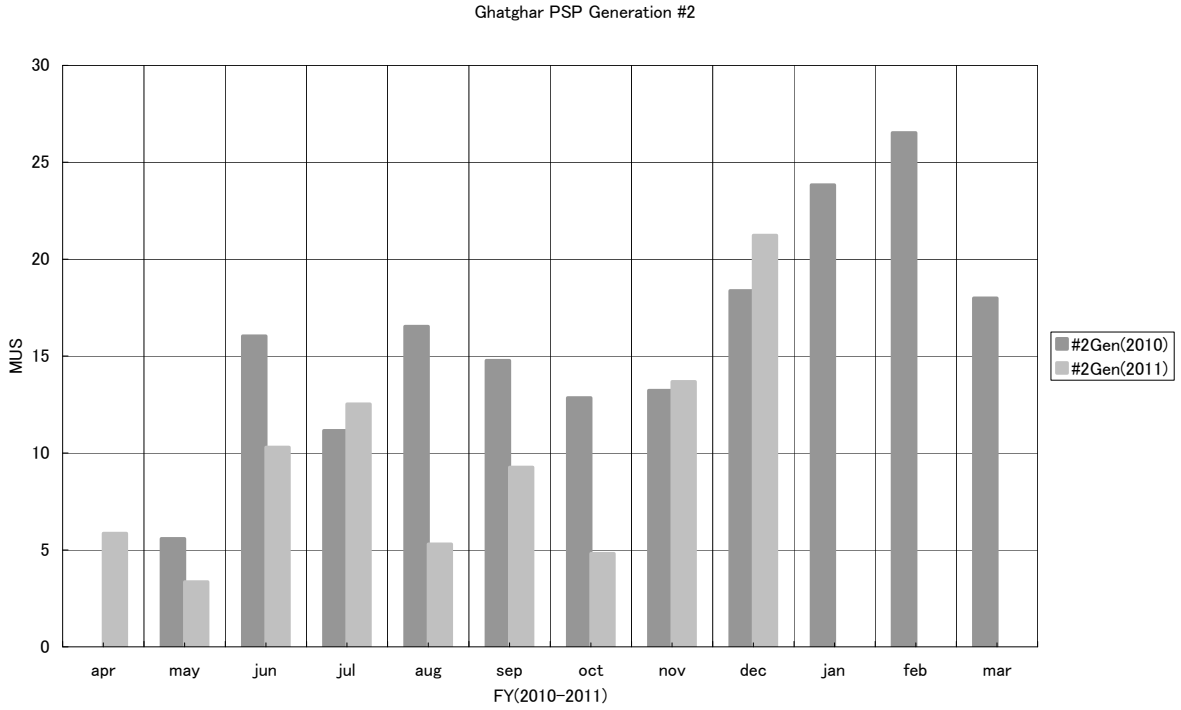
GENERATOR & PUMPING DATA OF GHATGHAR HPS UNIT-1 & UNIT-2 FOR 2011-12													
MONTH	UNIT-1		UNIT-2		TOTAL GROSS GEN. (MUS)	AUX.CONS^{N} (MUS)			TOTAL NET GEN^{N} (MUS)	UNIT-1		UNIT-2	
	GROSS GEN. (MUS)	GEN SERVICE HRS.	GROSS GEN. (MUS)	GEN SERVICE HRS.		UAT-1	UAT-2	TOTAL		PUMPING consumption (MUS)	PUMP. SERVICE HRS.	PUMPING consumption (MUS)	PUMP. SERVICE HRS.
Apr-11	8.64400	68:11:00	5.85400	47:03:00	14.49800	0.22221	0.13187	0.35408	14.14392	8.532	56:00:00	9.397	62:47:00
May-11	5.60000	44:18:00	3.35700	26:59:00	8.95700	0.21043	0.13897	0.3494	8.60760	5.122	33:16:00	6.624	43:58:00
Jun-11	10.70700	84:05:00	10.30000	82:06:00	21.00700	0.23579	0.09686	0.33265	20.67435	11.586	80:58:00	15.761	100:25:00
Jul-11	11.03700	86:58:00	12.52500	100:00:00	23.56200	0.24150	0.11869	0.36019	23.20181	17.694	117:28:00	18.097	120:47:00
Aug-11	7.75700	61:12:00	5.30900	42:20:00	13.06600	0.21921	0.09566	0.31487	12.75113	12.925	83:46:00	9.626	63:42:00
Sep-11	10.34800	81:40:00	9.26200	74:01:00	19.61000	0.22228	0.08105	0.30333	19.30667	15.790	101:12:00	11.669	75:02:00
Oct-11	7.25400	57:12:00	4.80900	38:24:00	12.06300	0.21428	0.03623	0.25051	11.81249	10.170	66:35:00	6.361	42:57:00
Nov-11	12.55800	97:58:00	13.68700	109:16:00	26.24500	0.18487	0.11534	0.30021	25.94479	16.686	111:18:00	17.191	115:04:00
Dec-11	21.46300	169:10:00	21.23000	168:58:00	42.69300	0.18979	0.24855	0.43834	42.25466	25.527	161:51:00	28.392	188:51:00
					0.00000				0.00000				
					0.00000				0.00000				
					0.00000				0.00000				
TOTAL FOR 2010-11	95.36800	750:44:00	86.33300	689:07:00	181.70100	1.94036	1.06322	3.00358	178.69742	124.032	812:24:00	123.118	813:33:00

(Source: GOMWRD)



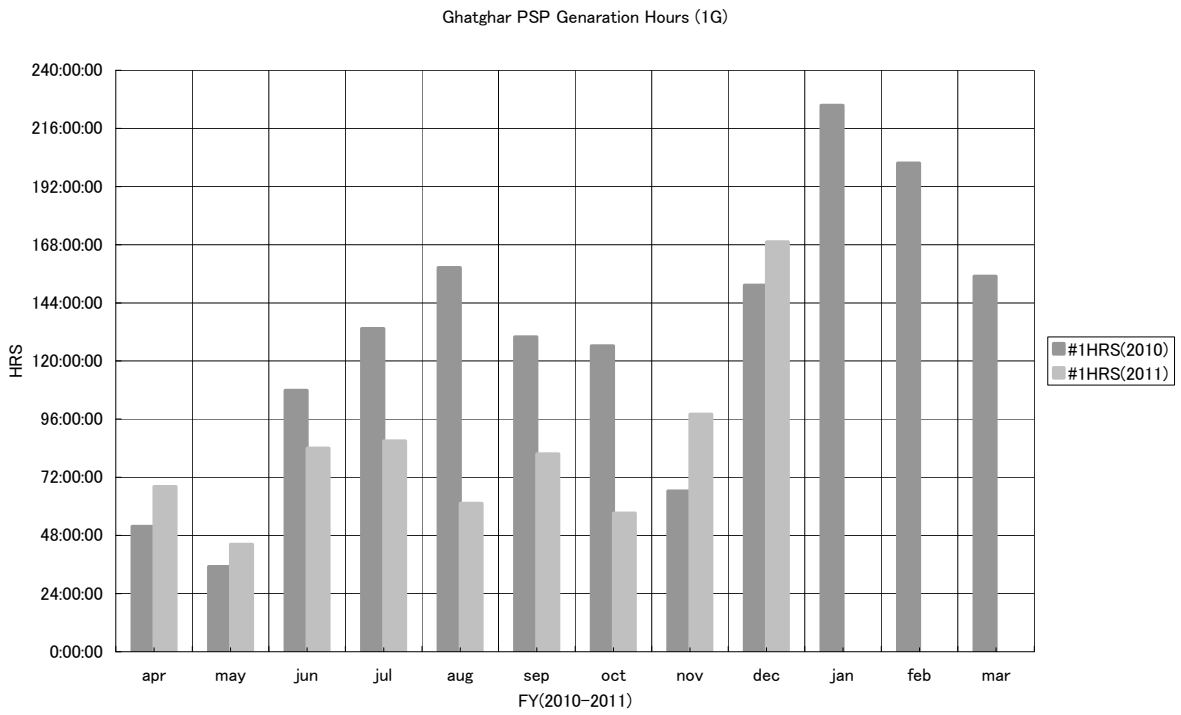
(Source: JICA Study Team, based on GOMWRD)

Figure 5.1.3-2 Ghatghar PSP Generation #1 (FY2008-2011)



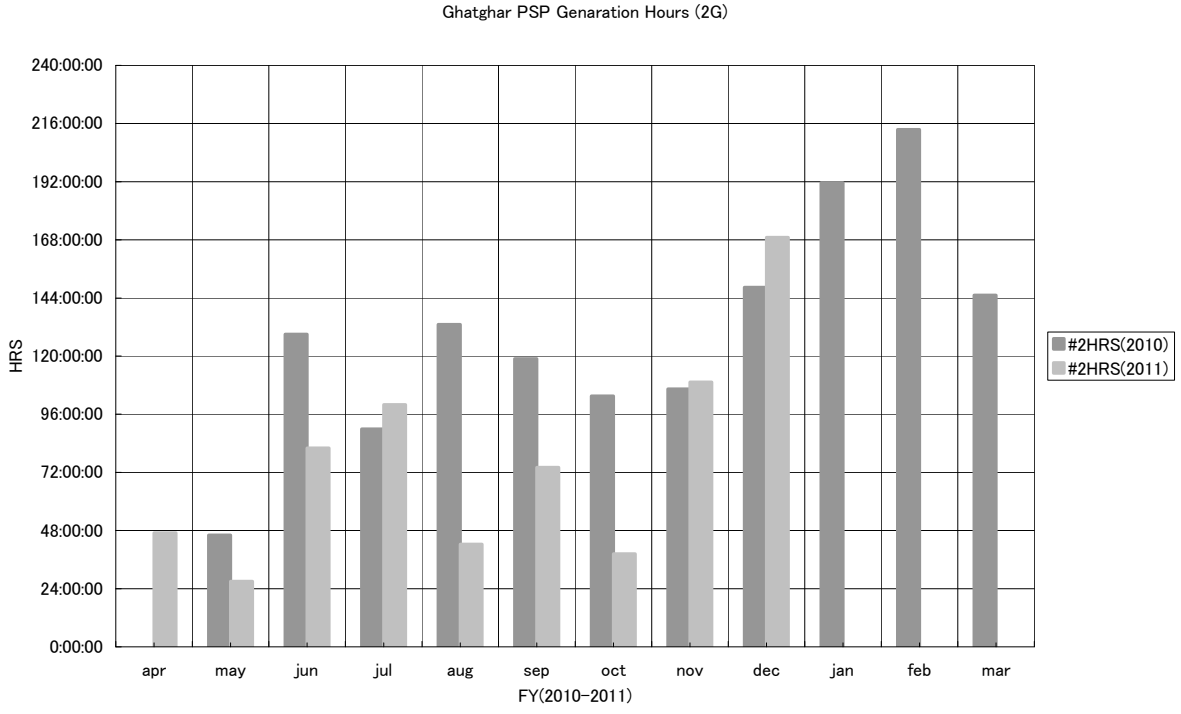
(Source: JICA Study Team, based on GOMWRD)

Figure 5.1.3-3 Ghatghar PSP Generation #2 (FY2010-2011)



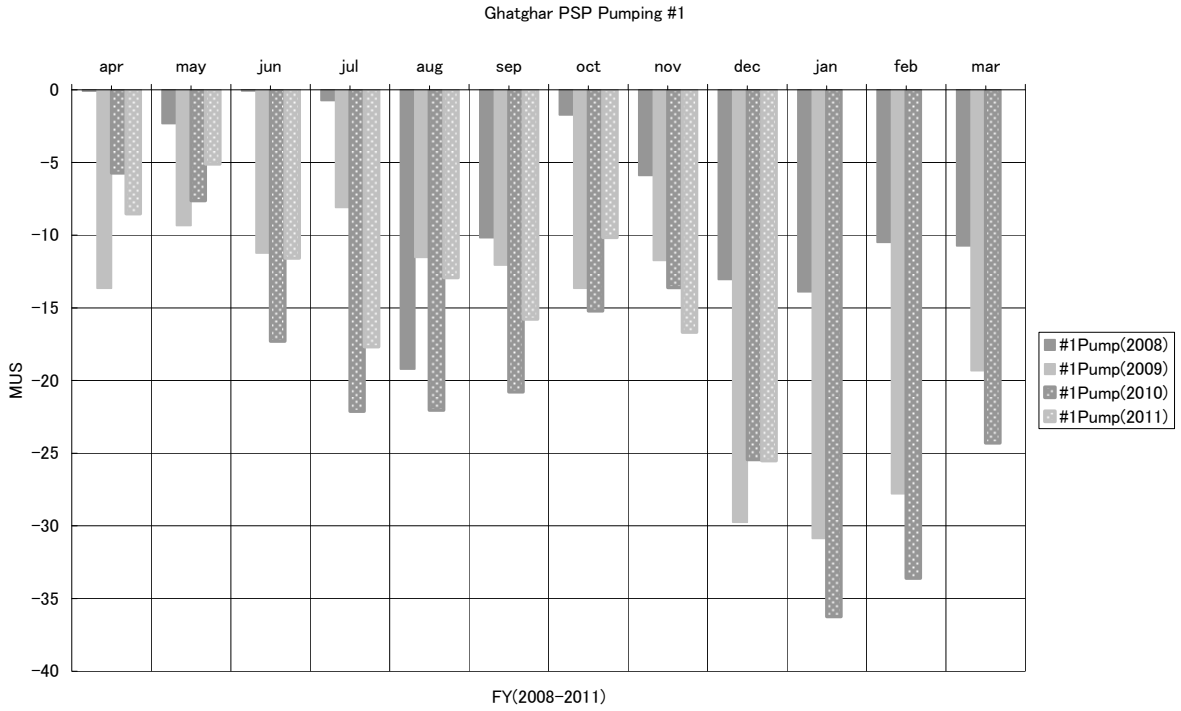
(Source: JICA Study Team, based on GOMWRD)

Figure 5.1.3-4 Ghatghar PSP Generation Hours #1 (FY2010-2011)



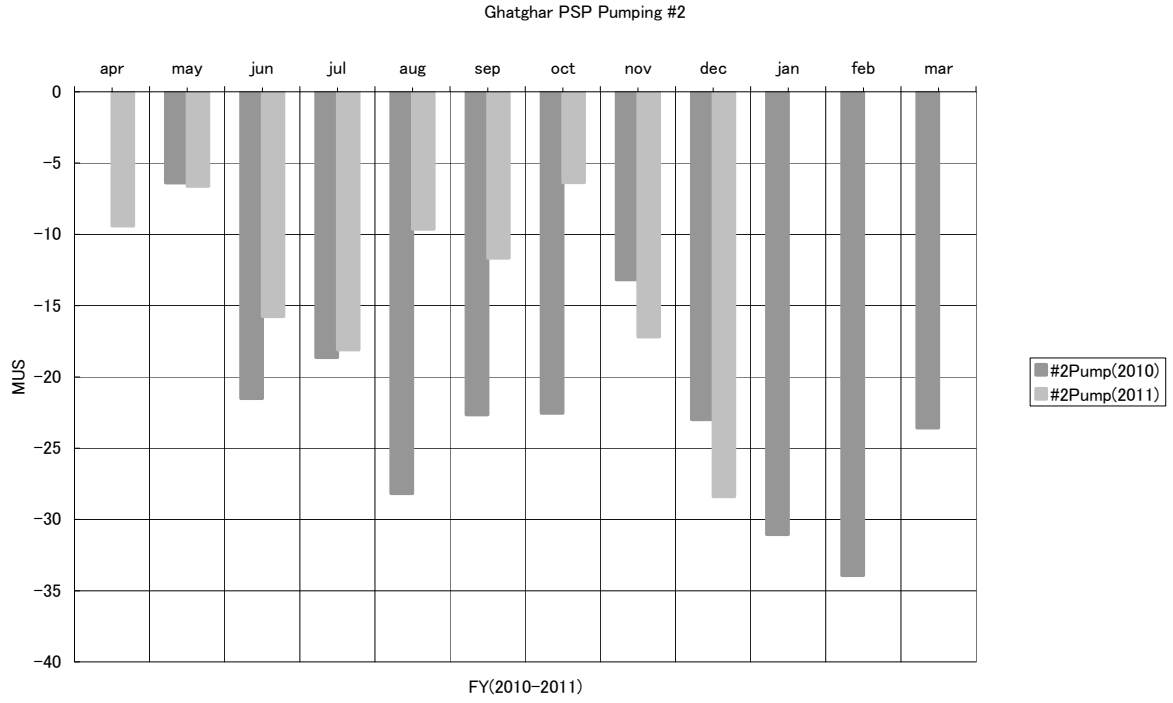
(Source: JICA Study Team, based on GOMWRD)

Figure 5.1.3-5 Ghatghar PSP Generation Hours #2 (FY2010-2011)



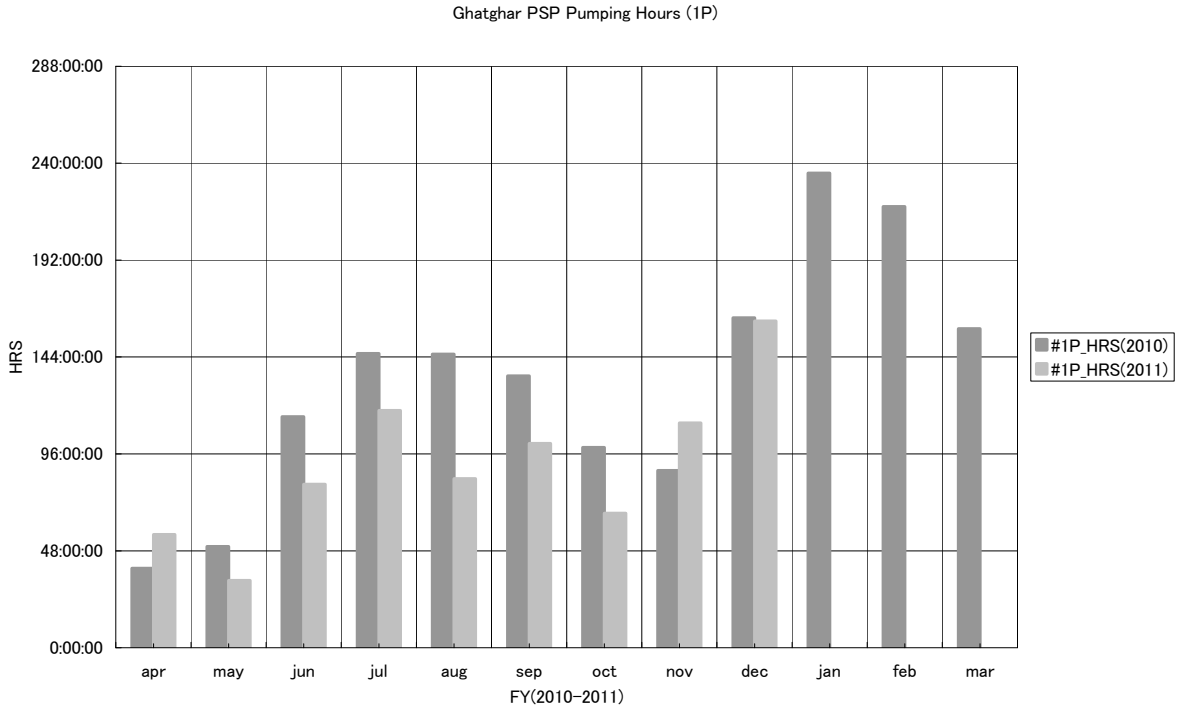
(Source: JICA Study Team, based on GOMWRD)

Figure 5.1.3-6 Ghatghar PSP Pumping #1 (FY2008-2011)



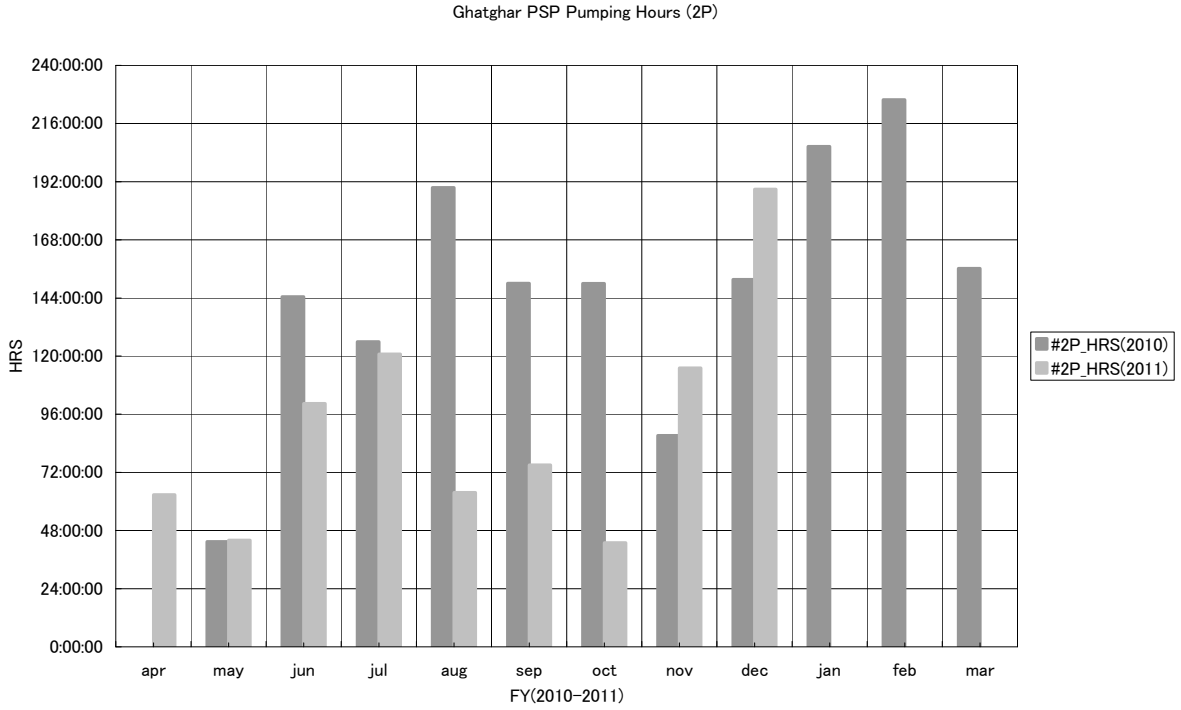
(Source: JICA Study Team, based on GOMWRD)

Figure 5.1.3-7 Ghatghar PSP Pumping #2 (FY2010-2011)



(Source: JICA Study Team, based on GOMWRD)

Figure 5.1.3-8 Ghatghar PSP Pumping Hours #1 (FY2010-2011)



(Source: JICA Study Team, based on GOMWRD)

Figure 5.1.3-9 Ghatghar PSP Pumping Hours #2 (FY2010-2011)

5.1.4 Future scenario of Renewable energy

According to "STU FIVE YEAR TRANSMISSION PLAN FOR THE YEAR 2010-11 to 2014-15" issued by MAHATRANSCO, the total installed capacity of wind power was around 2,526MW at the time 2010/3/31 but .only 10.28% of the total installed capacity, which was equivalent to 260MW, was consideres as firm (dependable) capacity.

In the proposed Wind Generation developer wise for FY2010, grand total wind generation is 5,273MW, 542 MW wind generation (considering 10.28 % PLF) has been considered as a power supply.

802 MW (=260+542) wind generation (considering 10.28 % PLF) has been considered as a power supply, but it is only 4% against to the total peak demand 19120MW in Maharashtra state in 2010-11.

In that report, the power scenario in Maharashtra (including Mumbai) 2010-2015 is carried out.

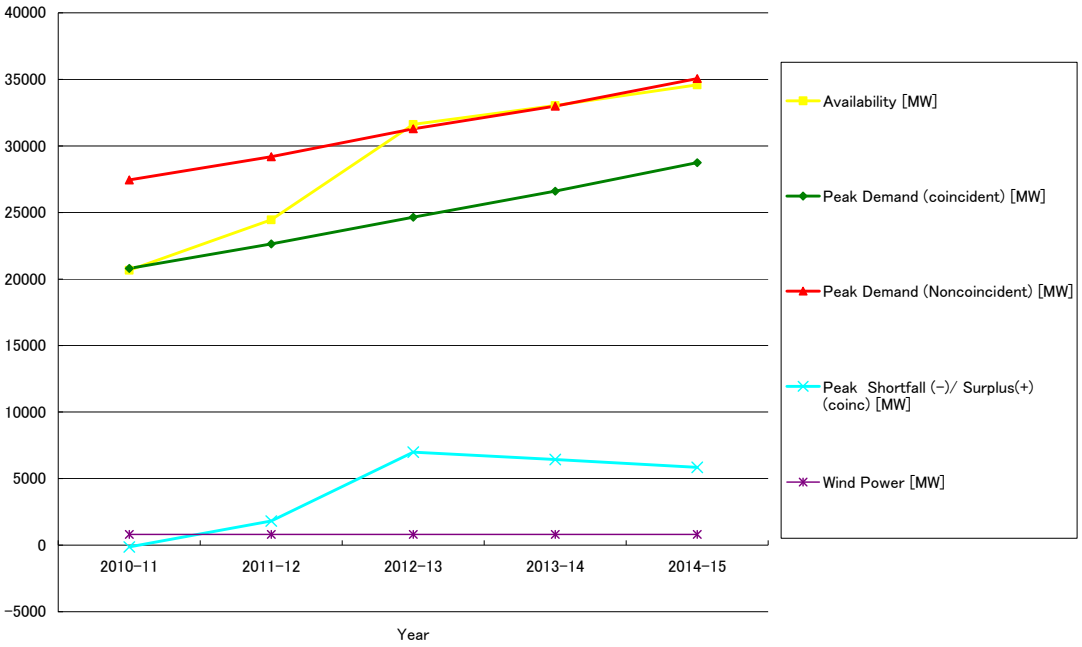
The power supply has grown up year by year (Figure 5.1.4-1), but wind generation does not change during that period (Figure 5.1.4-2).

Generally, it is necessary to prepare equal amount of power supply as spinning reserve for the frequency stabilization when the wind generation is connected to the grid system because of wind power fluctuation.

At the present moment, the ratio of wind generation against to the total capacity in Maharashtra state is not so high. Therefore the existing thermal power generation and the spinning reserve operation of hydro generation are able to compensate the power fluctuation of the grid system except for the peak time.

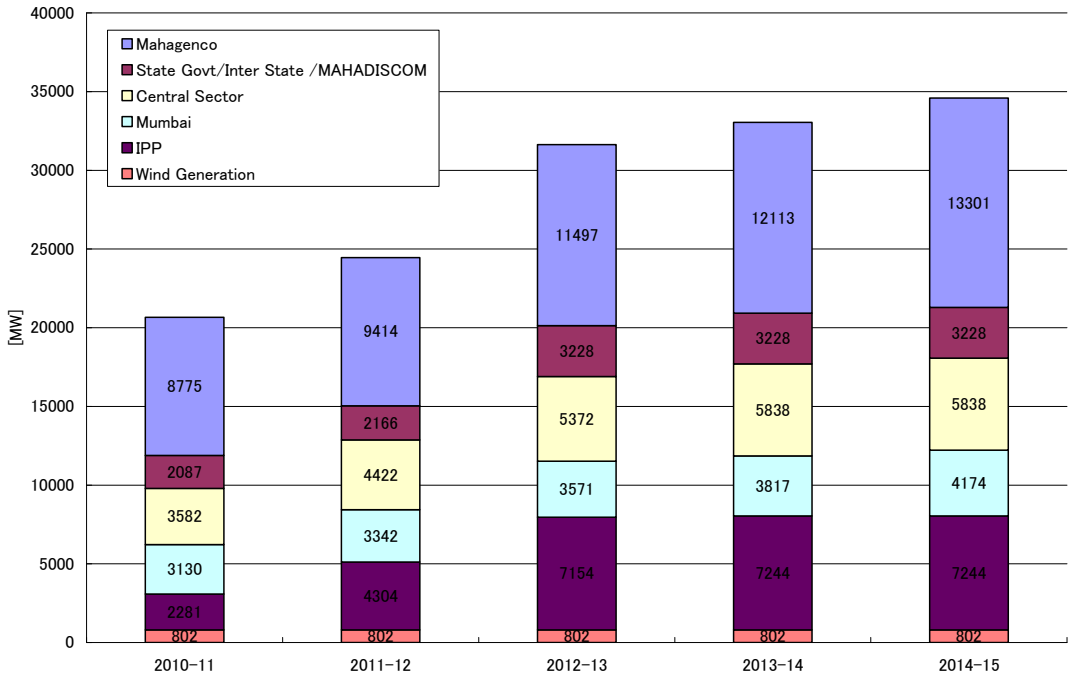
Due to the penalty system named as U.I.CHARGE (Unscheduled Interchange Charge), the network operator has strong motivation to keep frequency stable. In the future, the value of ancillary service of a pumped storage power plant (PSPP) might improve.

But at this moment, as can be seen in Bhira PSP lease contract difficulties, the value of ancillary service of a pumped storage power plant (PSPP) is not evaluated appropriately in the market.



(Source: JICA Study Team)

Figure 5.1.4-1 Present and Future scenario in Maharashtra



(Source: JICA Study Team)

Figure 5.1.4-2 Present and Future scenario in Maharashtra

5.2 Necessary Conditions of Pumped Storage Power Plant (PSPP)

5.2.1 Future Scenario of Renewable Energy

(1) Practical Example of Pumped Storage Power Plant (PSPP) in JAPAN

Pumped storage power plant is to generate electricity by falling water which is pumped up in advance to the higher place from the lower place. The value of electric power varies depending upon the time of demand, and it is high at a peak load and low at an off-peak load. Therefore, it is economical to pump-up water using the surplus power during the off-peak load, and to use the pumped water for generating electricity during a peak load.

In addition to that, Pumped Storage Power Plant (PSPP) has been used as peak electricity because of its high speed response characteristic. Thus, Pumped Storage Power Plant (PSPP) has contributed to the stable frequency and high quality electric power of the grid.

Before the earthquake of 2011.3.11 in Japan, many thermal and nuclear power plants have been planed and constructed one after another with growth of peak demand and have become a mainstream power source.

Table 5.2.1-1 shows the major pumped power stations in JAPAN

Table 5.2.1-1 Major Pumped Power Stations in Japan

Owner	Plant Name	River	Pref	yy/mm	Max output (MW)	Max discharge (m3/s)	Max He (m)	Turbine		
								Capacity (kW)	Type	Unit
Tokyo EPCo	Shintakasegawa	Shinano	Nagano	'81/5	1,280	644	229	336,000	VFR	4
	Imaichi	Tone	Tochigi	'91/12	1,050	240	338	360,000	VFR	3
	Kazunogawa	Fuji Sagami	Yamanashi	'00/6	800	140	714	412,000	VFR	2
Chubu EPCo	Okumino	Kiso	Gifu	'95/11	1,500	375	485.8	250,000	VFR	6
Kansai EPCo	Ohkawachi	Ichikawa	Hyogo	'95/6	1,280	382	394.7	329,000	VFR	2
								331,000	VFR	2
Chugoku EPCo	Matanogawa	Asahi Hino	Tottori Okayama	'96/4	1,200	300	489	309,000	VFR	4
Shikoku EPCo	Hongawa	Yoshino	Kochi	'03/3	615	140	528.4	307,000	VFR	2
Kyushu EPCo	Tenzan	Rokkaku Matsuura	Saga	'87/5	600	140	520	308,000	VFR	2
J-Power	Okukiyotsu dai2	Shinano	Niigata	'96/6	600	154	470	308,000	VFR	1
								310,000	VFR	1
	Shimogou	Agano	Fukushima	'91/5	1,000	314	387	260,000	VFR	4

(Source: JICA Study Team)

(2) Practical example of Pumped Storage Power Plant (PSPP) in JAPAN

Electric power systems both produce (generate) and consume electric power at the same time, and thus are built on a delicate balance between power production and power consumption. The

difference between power production and power consumption is indicated as fractuation of frequency, and power producers (power plants) constantly adjust the amount of electricity generated in response to varying demands for power in order to maintain a balance between them.

Which part of the load curve should be covered by hydroelectric power generation, thermal power generation or nuclear power generation is determined after all factors are considered thoroughly with respect to each type of power generation, including stable supply of electricity, excellent response to load changes, economic efficiency and environmental preservation. This is called “best mix of power sources,” and is an important subject in supplying power.

The present electric power grid systems use nuclear power plants, large-capacity thermal power plants and runoff river power plants as base-load suppliers, and use middle-load power generating thermal power plants or hydroelectric power plants (dam-type power plants, pumped-storage power plants) to cover peak load.

Recent technological progress has improved steam conditions for thermal and nuclear power plants, resulting in higher thermal efficiency and lower generating cost. This is the reason why many thermal and nuclear power plants have been constructed one after another and have become a mainstream power source.

However, such high-temperature, high-pressure type large-capacity thermal and nuclear power plants have the following control-related limitations, and therefore it is desirable to use them as facilities for supplying base-load power.

- They are slow to change power output.
- They take long to start up or stop.
- Their minimum power output is limited due to restricting factors such as thermal stress.
- They are difficult to stop during night.

Peak demand differs considerably from late-night off-peak demand, and thus a proper balance between supply and demand could not be maintained if all thermal and nuclear power plants are operated late at night.

For this reason, there has been a need for pumped-storage power plants, and that with large capacity, which use low-cost electricity available late at night during hours of low power demand to pump water and generate electricity during hours of peak power demand to supply high-value power, and which, in addition, can maximize the advantages of hydroelectric power plants listed below.

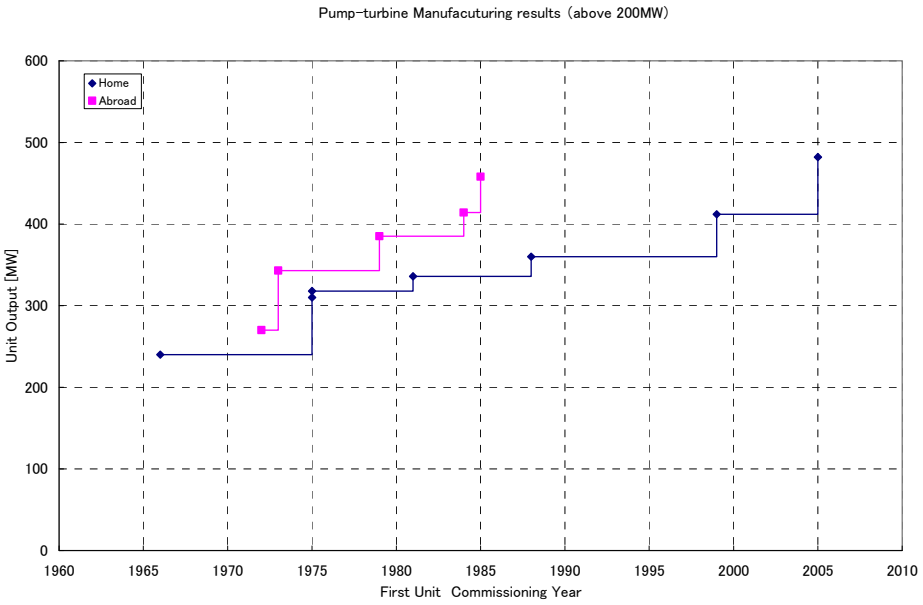
- They are quick to change power output.
- They can be started up or shutdown in a short time.
- They can be operated with minimum power output equivalent to approximately 50% of their maximum power output (pumping).

Accordingly, development of such pumped-storage power plants has been underway to handle

peak electricity demand for the purpose of efficiently operating large-capacity thermal and nuclear power plants.

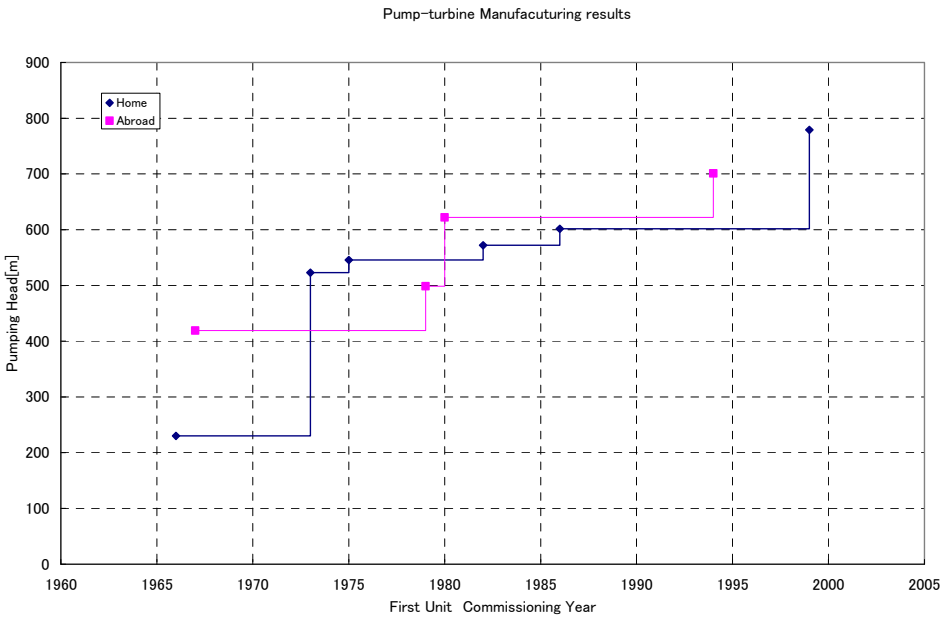
(3) Changes in actual output and maximum pumping head of pump-turbines

Changes in actual output and maximum pumping head of pump-turbines are shown in Figure 5.2.1-1 and Figure 5.2.1-2.



(Source: JICA Study Team)

Figure 5.2.1-1 Changes in Actual Output



(Source: JICA Study Team)

Figure 5.2.1-2 Changes in Actual Maximum Pumping Head

5.2.2 Adjustable Speed Pumped Storage Power System

(1) Purpose of Adjustable Speed Pumped Storage Power System

Generally, the pumped storage power station can be utilized for the energy shift from off-peak time (midnight) to peak time (daytime) by pumping up the water at midnight from the lower reservoir to upper reservoir using the excessive electricity generated by the nuclear and thermal power plants and by generating the power at the daytime using the pumped water. This operation can meet the peak demand at the midday while reducing the imbalance of energy demand between the midnight and the daytime. In addition, the pumped storage power station can provide many ancillary services due to the high speed response for the frequency and voltage fluctuations. On the other hand, it has a limitation not to be usable for frequency control during the pumping operation since the pump input can not be changed by the usual generator-motor, which is the synchronous machine having a constant speed. The traditional way for the frequency control at the midnight was achieved by regulating the output of the thermal power plants. However, the increase of nuclear power generating in the electrical power system and the increase of daily-start-and-stop thermal power plants caused some difficulty for keeping the enough thermal power capacity for frequency control use during the off-peak time. Therefore the adjustable speed pumped storage power system was developed for the frequency control instead of the thermal power plants, which enables the pumped storage plants to control the pump input by regulating the rotation speed of the generator-motor.

(2) History of Adjustable Speed Pumped Storage System in Japan

The development of adjustable speed pumped storage system started in 1980s in Japan and the first adjustable speed generator was realized at the Narude Hydropower Station by Kansai Electric Power Company in 1987. This plant was experimental for demonstrating the adjustable speed machine using the conventional hydropower plant. In 1990, Tokyo Electric Power Company developed the first adjustable speed pumped storage system in the world on Unit No.2 in Yagisawa Pumped Storage Power Plant, which has already more than 20-years operational record. In 1993, Kansai Electric Power Company commissioned the first large pumped storage plant using the adjustable speed technology at Ohkawachi Pumped Storage Power Plant. After the success at the Ohkawachi, many pumped storage plants were also constructed using this technology.

Table 5.2.2-1 shows the situation of the adjustable speed pumped storage system at the present and the operational records of this technology are outstanding in Japan for its long history. J-Power has also two (2) adjustable speed pumped storage power plants at the present together with operational records more than 10 years.

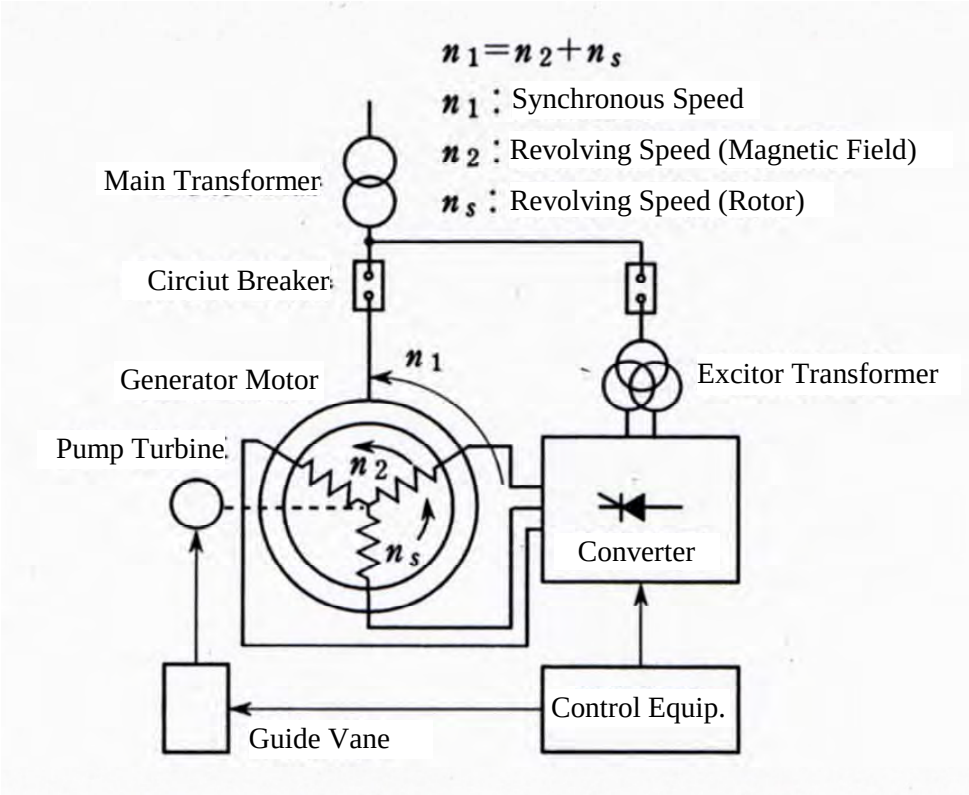
Table 5.2.2-1 Major Adjustable Speed Pumped Storage Power Stations in Japan

No.	Plant Name	Generator Capacity MVA/MW	Rotating Speed min^{-1}	Excitation Method	Owner	Manufacturer Turbine/Generator	Commissioning	Country
	Pilot Plant							
	Narude	22/18.5	190-210	CYC	Kansai EPCo	HITACHI	1987	Japan
	Existing							
1	Yagisawa Unit 2	85/82	130-156	CYC	Tokyo EPCo	TOSHIBA	1990	Japan
2	Takami Unit 2	105/140	208-254	INV-CON	Hokkaido EPCo	MITSUBISHI	1993	Japan
3	Ohkawachi Unit 4	395/388	330-390	CYC	Kansai EPCo	HITACHI	1993	Japan
4	Ohkawachi Unit 3	395/388	330-390	CYC	Kansai EPCo	HITACHI	1995	Japan
5	Shoibara Unit 3	333.3/341	345-405	CYC	Tokyo EPCo	HITACHI/TOSHIBA	1995	Japan
6	Okukiyotsu No.2 Unit 2	345/340	407-450	INV-CON	J-POWER	TOSHIBA	1996	Japan
7	Okinawa seawater	31.5/31.8	423-477	INV-CON	J-POWER	TOSHIBA	1999	Japan
8	Goldisthal(2 units)	331/330	300-345	CYC	Vattenfall	VOITH/ANDRITZ	2002	Germany
9	Omarugawa Unit 4	345/330	576-624	CYC	Kyushu EPCo	HITACHI	2007	Japan
10	Omarugawa Unit 3	340/330	576-624	INV-CON	Kyushu EPCo	MITSUBISHI	2008	Japan
11	Omarugawa Unit 1	345/330	576-624	CYC	Kyushu EPCo	HITACHI	2010	Japan
12	AVCE(1 unit)	195/185.3	576-626	INV-CON	SENG	MITSUBISHI	2010	Slovenia
13	Omarugawa Unit 2	340/330	576-624	INV-CON	Kyushu EPCo	MITSUBISHI	2011	Japan
	Under Construction							
14	Okutataragi Unit 2		285-315	CYC	Kansai EPCo	HITACHI	2013	Japan
15	Okutataragi Unit 1		285-315	CYC	Kansai EPCo	HITACHI	2014	Japan
16	Kyogoku Unit 1	222/230	475-525	INV-CON	Hokkaido EPCo	TOSHIBA	2014	Japan
	Planned							
17	Kazunogawa Unit 3	475/460	480-520	INV-CON	Tokyo EPCo		After 2017	Japan
18	Kazunogawa Unit 4	475/460	480-520	INV-CON	Tokyo EPCo		After 2017	Japan
19	Nant de Drance(4units)				Alpiq, SBB, FMV	ALSTOM	2016	Switzerland
20	Linth-Limmern(4units)				Linth-Limmern AG	ALSTOM	2016	Switzerland
21	Venda Nova III (2units)				EDP	VOITH/SIEMENS	2015	Portugal
22	Kozjak							Slovenija
23	Venda Nova 3							Österreich

(Source: JICA Study Team)

(3) Characteristic of the Adjustable Speed Pumped Storage Power System

Two (2) adjustable speed systems are mainly available for the power generation; one is a DC-link converter-inverter system by connecting the synchronous generator-motor with the grid through the Converter-Inverter system, and another is the use of doubly-fed asynchronous machine. In the electric power industry, the former technology is popular in the wind power generating machine due to the wide range of the variable speed, but the adjustable speed pumped storage system is based on the latter technology because the DC-link is too much costly for the application to the large capacity pumped storage plant. The doubly-fed asynchronous machine has a converter in the rotor circuits (Exciter circuits) for feeding low-frequency AC power. The principle of the system is shown in the Figure 5.2.2-1.



(Source: JICA Study Team)

Figure 5.2.2-1 System Configuration Diagram

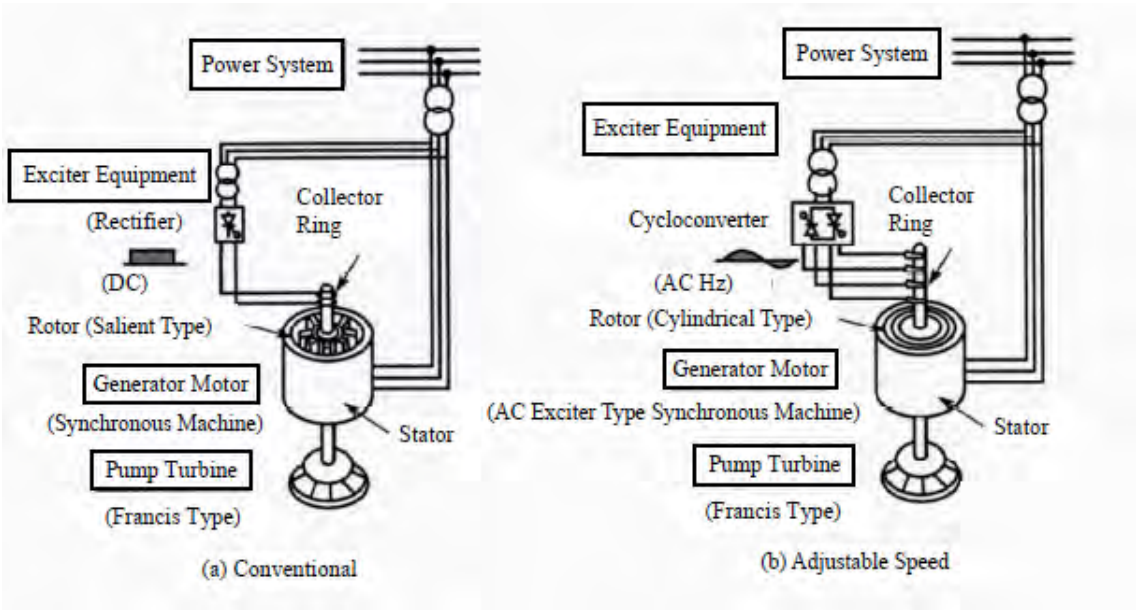
The rotor of the generator-motor is three-phase winding type instead of the DC winding of conventional generator. The converter is connected with the rotor windings and feeds the low-frequency AC power for generating the rotating magnetic field, i.e. the excitation, on the rotor. The rotating speed of the magnetic field on the rotor, which is corresponding to the frequency of the feeding current from the converter, is defined as "n_2" and the rotating speed of the rotor is defined as "n_s". The rotating speed of the composite rotor magnetic field on the stator: "n_1", this magnetic field interacts with the stator coils for the generation, is to be equal to "n_2+n_s".

$$n_1 = n_2 + n_s$$

This n1 is equal to the synchronous speed corresponding to the grid frequency since the stator is synchronized with the grid. This relationship of $n_1=n_2+n_s$ is convertible to $n_s=n_1-n_2$, so the mechanical rotating speed (n_s) of the rotor is controllable because the rotating speed of the rotor magnetic field (n_2), which is corresponded to the converter output frequency, is adjustable although the grid synchronous speed (n_1) is constant.

Because the pump input is nearly proportional with the cube of the rotor speed, i.e. n_s^3, the considerable pump input is to be adjustable even under the small variation of the rotor speed. This fact is a big merit for the doubly-fed asynchronous system to limit the converter capacity within the reasonable size because the converter is very costly.

System comparison between the conventional system and the adjustable speed system is shown in Figure 5.2.2-2 and Table 5.2.2-2.



(Source: JICA Study Team)

Figure 5.2.2-2 System Comparison of Conventional System and Adjustable Speed System

Table 5.2.2-2 Comparison of Conventional System and Adjustable Speed System

No.	Item	Conventional Type	Adjustable Speed Type
1	Rotor current	Direct current	Alternating current
2	Rotating speed	Constant speed	Adjustable speed
3	Excitation method	Thyristor, etc.	Cycloconverter, PWM Inverter
4	Governor free operation	Generation mode only	Both pumping and generating modes
5	Automatic Load Regulator operation	Generation mode only	Both pumping and generating modes
6	Automatic Frequency Control	Generation mode only	Both pumping and generating modes
7	Minimum output at generating mode	About 50% of full load	About 40% of full load or less
8	Pump start	Independent pump starting equipment is necessary for large generator-motor - Large transient pump input fluctuation when there is no pump starting equipment	Reducing pump input at pump start Excitation system is usable as the starter due to the design
9	Performance at system fault	Considerably disturbed by system fault	To contribute to system stability
10	Cost		Many additional costs are necessary, such as winding type rotor, converter system and civil facility for installing the equipment.

(Source: JICA Study Team)

(4) Advantages of Adjustable Speed Pumped Storage System

Advantages of an adjustable speed pumped storage system are shown as follows;

1) Regulating capability of pump input at pumping mode

Pump input can be regulated even during the pumping operation and this means that the frequency control is available during the pumping operation. In addition, the pump input fluctuation at pump start can be reduced by lowering the synchronous speed, thus the influence on the power system can be minimized.

2) Improvement of turbine efficiency at generating mode

Turbine efficiency is improved few percent higher than that of the conventional type (constant speed type) because the turbine is operable under the most appropriate rotating speed for attaining the higher efficiency.

3) Expansion of operational range at generating mode

The operational range at generating mode can be widen from 20% to 40% by lowering the minimum output due to the improvement of turbine efficiency at partial load. This merit contributes for the increase of frequency control range.

4) Expansion of operational head range

The conventional pump-turbine has some limitations in the operational head range due to the cavitation, vibration and other factors. The adjustable speed machine is operable in the wider head range by applying the most suitable rotating speed mitigating those bad effects. This merit permits the larger water level variation in the upper and lower reservoirs, and this means the bigger storage energy is to be available, so it enables the longer operational hours of the plant.

5) Improvement of system stability

Rotor displacement angle can be easily controlled with the high-speed and the high accuracy, so it contributes for keeping the static stability of other connected synchronous generators. Moreover, in case of system disturbance, the adjustable speed machine can improve the transient stability with the rapid regulation of the excitation system.

(5) Necessary conditions of Adjustable Speed Pumped Storage Power System

Recently, due to the introduction of large wind firm power and solar panel power into the electric power system, difficulty of frequency control may have been a problem in some countries.

Because such generation output will quickly fluctuate, stop and start at any time, this problem can not be solved by thermal and nuclear power supply.

Therefore, it is inevitable to solve this problem by pumped storage power plant providing the adjustable speed generator. As for experience in Japan especially, adjustable speed generators have been installed at many power stations amounting to approx. 10 units including those under construction and their operation utility is higher than other single speed units.

On the other hand, an adjustable speed pumped storage power system needs many additional costs, such as winding type rotor, converter system, civil facilities for installing the equipment and so on.

If the merit of an adjustable speed pumped storage power system as mentioned above is estimated as superior to that of conventional one, the adoption of the adjustable speed pumped storage power system will be decided.

5.3 Necessity of Pumped Storage Power

5.3.1 Measures as Peaking Power

Not only in Maharashtra state, the power trade markets have been increasing their shares year on year basis in India, and among all, the Peaking electric powers have been increasing their value in the price term in the market. Furthermore, from various phenomena like increasing "Open Access", the security of Power purchase is the indispensable elements for the economic growth for all industries. The security of keeping peak power supply in Maharashtra especially where the peak demand has been shifting to the daytime and been peaking more sharply, is definitely indispensable.

The sources of the peaking powers in Maharashtra state may be chosen from several options. The installation of more storage type hydropower stations is one option. But in this state with the exception of the enhancement of Koyna hydropower station (being underway), most of the conventional storage type hydropower projects have been already developed and few are remained for enhancement or new developments, although there are still some. The constructions of new gas thermal power stations essentially bear the risks of rising of fuel prices of LNG and natural gas. The import of power from neighboring states is always one option and has been carried out at some amount level but it cannot escape from such risks of high rise price of purchasing power, risks of high dependency on outer supply knowing the neighboring states also needing to meet their own growing demand, not to mention of the necessity of empowerments of the connecting transmission lines between 2 states. The sourcing powers from evolving power trade markets are promising options. But it must accept the high rise purchase price of peaking power in essence.

Maharashtra state suffers more than 20% peak power shortage at present. It expects the sharpening rise of peaking power ever after. The most of the existing power assets are the base load plants of coal thermal power stations. The reserve power was merely 2% (peak demand 21,954MW vs. availability 22,512MW (excl. renewable) at 2011/12). The percentage of hydropower capacity remains only 18% in Maharashtra (lower than Indian average 30%). No new hydropower schemes are planned except a few refurbishments. The present measures meeting power demand is purchase from central power plants, IPP plants, or "load sheddings".

Looking into the power development plan in Maharashtra, it only has developed base load coal thermal power projects in 11th power development plan. In 12th plan again, Maharashtra depends heavily on coal thermal power projects with no hydropower or gas thermal power projects. Even adjacent state Gujarat only plans 1,053MW of gas thermal power projects with fuels secured.

Looking back to the whole India, India plans mainly coal thermal power projects. Gas thermal projects are mainly planned by IPPs assuming TOP (take or pay) contracts. Thus such IPP gas powers are not considered suitable for frequency adjustment or supply demand control. No hydropower projects are planned in 12th plan in western region as a whole. In this way, All India is considered to lack peaking power in the future.

This situation is beginning to be recognized and reflected into regulatory frameworks by the central government. Already tariffs on peak time is set higher (TOD tariff). CERC has proposed a new tariff regulation in favour of PSPP and storage type hydropower plants (concretely, ROE planned raised to 16.5%). It is understood for the central government to value the peaking power source more highly than others in the future.

Maharashtra has options for peaking powers from gas thermal powers and PSPPs. But with a large potential PSPPs in Maharashtra, they can become the competitive sources, which are not expected in other states.

The pumped storage powers in general have to bear the high burdens of their fixed costs. But in Maharastra state, since it benefits itself with a number of geographically advantageous potential sites utilizing the large high water heads between upper and lower reservoir, it is worthy enough for paying attention to develop “realistically economical” sources of pumped power schemes.

Nonetheless, the value of peaking power is definitely considered to be ranked higher than ever in the future, so the pumped power storage scheme should be paid more attention.

5.3.2 Measures against Unstable Power Supply (Renewable Power Sources)

It is noted that the power sources of renewable energy like wind power or solar power is expected to keep growing in Maharashtra state. Maharashtra is one of the states having the large wind power potentials. The introduction of wind or solar power requires the grid stabilization technologies on the other hand, and it is almost difficult to control ad maintain the grid frequency, load output from the sides of the wind power or solar power sources in their nature, that the pumped storage power has the advantages for controlling grid stability. The needs for such power is expected to be arising more and more in the coming ages in meeting and encouraging the renewable sources of power.

5.3.3 Measures as the Grid Stabilization

The large scale grid failures “The Great Indian Outage” on the whole India (3 grid outages out of 5) on 30th and 31st on July, 2012 were considered to have occurred due to the over drawl by the northern states utilities from power lines thus initiating heavy power flow in the line resulting in the cascade frequency drops, power shutdown, thus successive grid collapses (from the preliminary report from the expert committee, 16th Aug., 2012. the study is still continuing). Indian continent geographically consists of wide in East-West wise and North-South wise land areas spotting fuel sources as coals very locally, with inevitably necessitating very long distant transmission lines connecting power supply regions and power consuming regions. Such geodemographical circumstances will not change in the future, thus make the steady and stable grid discipline and operation vitally important in Indian Power sector.

In order for India and Maharashtra state being away from the outages of power plants like this time from frequency drops, it is more expected to have adjustable speed pumped storage power systems for their merits and importance of frequency adjustment capability even in the lowest load demand hours, as well as of their demand and supply control capability by initiating or stopping pumping mode or generation mode in real time, for the load requirement thus eliminating excessive power flow on power lines.

At present India and Maharashtra state as well are in the situation causing frequent routine "load sheddings" from the shortage of power supply.

Both India and Maharashtra are requesting more power for base supply than the peaking powers in their demand supply control phase, than the powers with frequency adjustment function (In other words "Volume of Power" prior to "Quality of Power").

However, it is obvious that power demand curve will get much more steepened that peaking powers will be needed more and more in the very recent coming time. Also, from the lessons from the "blackouts" the other days, power sources for adjusting frequency with demand supply control capability as well, will be required all the more in the near future.

The planned outages ("load sheddings") for long hours have already begun in Maharashtra state due to the power shortage. Mumbai area so far being escaped from them, but has gathered nearly one third of FDIs (Foreign Direct Investments). A number of companies in automotive industry put its base on Maharashtra state (100s of SEZ sites have been registered and some 200 Japanese companies in the state, which is outstanding in India). However, there are few projects of peaking powers in Maharashtra at the moment as mentioned. Considering such measures to maintain the load and frequency stabilization against blackouts, it is well thought that the needs for the "Quality of Power" be further recognized and increased.

In conclusion, the consideration of the Pumped Storage Power as the ever increasing valuable sources of Peaking Powers, as well as measures against unstable sources of power, and as the effective sources of load and frequency stabilization is indispensable. In case of Pumped Storage Power, the geographical and social conditions, not to mention the geological conditions of site locations, control the economical viability of the project. It takes some to 10s years time for the development. Considering these, it requires the developers to start surveys and studies as earlier time as possible and collect the fundamental data in order to enable them to compare and evaluate the project with other sources of energy, not alone the final judgements of the development.

It also requires the study of large scale base power developments as the pumping power source like nuclear power. It also needs the study on the associated transmission lines enhancement plans, expected commencement timings. The analysis of the Power trade market and the expected value of peaking powers in the future is also one of the important elements. All of such studies will enable the future developments of pumped storage schemes as a peak meeting energy source with characteristics

of load following and quick activation/deactivation procedure. Thus it can contribute to the reliability of the Maharashtra state and the western region of India.

Chapter 6

Physiography and Geology of the Study Area

Chapter 6 Physiography and Geology of the Study Area

6.1 Physiography

The study area is located near the border between the Western Ghats and the Konkan coastal region. The Western Ghats show relatively gentle landform on the eastern side, but the western side is very steep and facing the Konkan coastal region with high cliffs that fall abruptly. Therefore, there is a big gap between the Konkan coastal region and the Western Ghats.

Schematic of the landform of the study area and pumped-storage hydroelectric power generation is shown below.

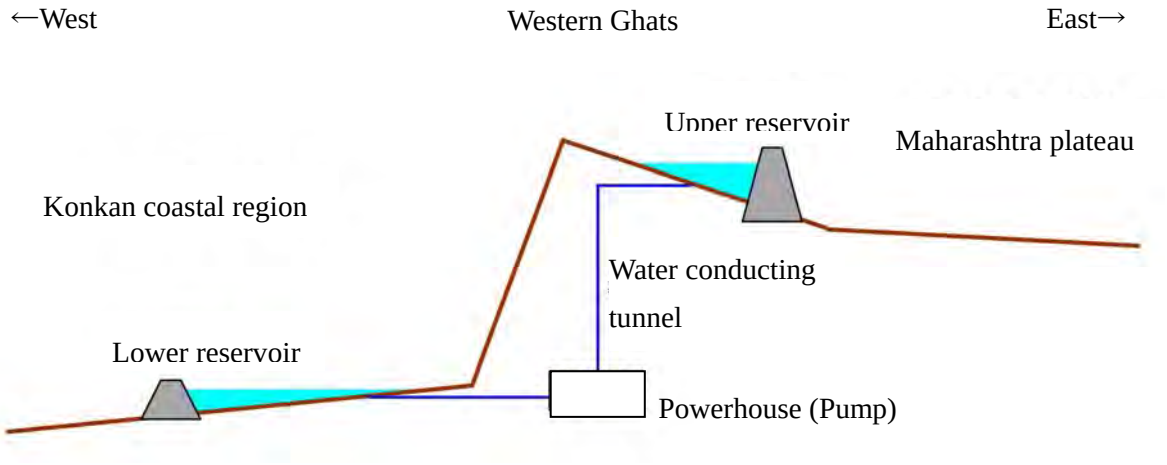


Figure 6.1-1 Schematic of pumped-storage hydroelectric power generation

The elevation of upper reservoir is assumed to be over 600 m and about 100 m for lower reservoir, therefore a gap of some 500 m is expected. Relative to this great gap, the horizontal distance between upper and lower reservoirs is very short, so the landform is considered to be suitable for pumped-storage hydroelectric power generation.

The Western Ghats, proposed sites for upper reservoir, generally shows characteristic step-like landform, but the eastern side and the western side of the divide are very different. The eastern side is relatively smooth and physiologically feasible for construction of dams. The western side, on the other hand, is abrupt and it is almost impossible to construct a dam there.

The proposed sites for lower reservoir in the Konkan coastal region consist of basins, which are surrounded by ridges branching out from the escarpment in the Western Ghats. Because the basins are wide open downstream, they require a very long body for a dam. So they are not always suitable for a dam even though it is not very difficult to construct a dam technologically.

6.2 Geology [1]

6.2.1 Deccan Traps

(1) General features

The Western Ghats, proposed sites for upper reservoir, and the Konkan coastal region, proposed sites for lower reservoir, are different in shape and elevation. But both are located within the distribution of the Deccan Traps, hence they are basically of the same geology (except the extreme southern part of Maharashtra).

The Deccan Traps, which make the characteristic step-like ("Traps" meaning stairs) landscape of the Deccan Plateau, are the representative geology of the Indian Peninsula. They cover an area of about as much as 500,000 km^2.

The Deccan Traps consist of hundreds of layers of basaltic lava that are mainly of the late Cretaceous. The Deccan Traps are remarkable for they are an extremely large geological body.

The lava layers are mostly flat and there are very few folds (practically no fold as for the state of Maharashtra). And the facies of rocks show vary little changes.

The thickness of a lava layer is 40 to 200 m near the source of the flow. The total thickness of the layers altogether is estimated to be over 2,000 m near Mumbai on the Arabian Sea coast, and about 3,000 m at the most in the western part of the Western Ghats. The lava layers gradually decrease in thickness and elevation toward the east.

The Deccan Traps are divided into three sub-groups according to the age (in order from older to newer; Kalsbai, Lonavala, and Wai). Although there are some differences in chemical composition among them, it is difficult to distinguish them with unaided eyes, and there is almost no difference from engineering aspects.

(2) Common rock types

Common rock types of the Deccan Traps are described below.

1) Basalt

The Deccan Traps consist mostly of basaltic lava. Two major types of lava are Pahoehoe and Aa, the former being fluid and having a smooth and ropy surface, and the later being viscous and having a blocky appearance. Both are chemically classified as tholeiite (non-alkaline basalt) in most cases.

In general, a compound flow consisting of numbers of thin lava layers tends to be Pahoehoe, while a simple flow consisting of a thick lava layer tends to be Aa. In western Maharashtra,

[1] Reference "Geology of Maharashtra" (Geological Society of India, 1998)

compound flows are prevailing.

There are two types of basaltic lava for the Deccan Traps; one is the compact basalt with no vesicle and the other is the vesicular basalt. If the vesicles are filled with secondary minerals, it is called the amygdaloidal basalt.

i) Compact basalt

This is the most common type for the Deccan Traps. It is usually homogenous and massive, and also very dense and hard. It commonly has nearly vertical joints. The joints are formed due to contraction while cooling. Generally, faster cooling produces more closely separated joints than slower cooling. Therefore, thinner layers tend to have smaller joint intervals.

Since the compact basalt is hard and resistant to weathering and erosion, and has tendency to fall apart along vertical joints, it often forms cliffs. Also, spheroidal weathering takes place when weathering proceeds along 5 to 6 sided columnar joints and subsequently leaves spheroidal unweathered portions (cores) deep inside. The size of the cores varies from a few centimeters up to about a meter depending on the joint intervals and the intensity of weathering.

ii) Vesicular basalt

This is similar to the compact basalt, but characteristically has vesicles of various sizes and shapes. It may also have nearly vertical tubular gas escape pipes. This type can commonly be found in the upper portion of a lava layer in the western part of the Deccan Traps where compound flows are dominant.

iii) Amygdaloidal basalt

If a vesicle is filled with secondary minerals (such as silicates and zeolites etc.), it is called an amygdale. The amygdaloidal basalt is often formed near flow contacts, and to remark, develops absolutely no joint.

2) Volcanic Breccia

This is a pyroclastic rock, composed of fragments of basalt and basaltic matrix, which derives from explosive eruptions. It is very scarcely distributed in comparison with the basaltic lava.

Volcanic breccia may be altered, with the matrix turned into zeolites by hydrothermal reaction. In such a case, the rock becomes less resistant to weathering and erosion than basaltic lava is, and tends to form gentle slopes. There are caves formed by differential erosion of volcanic breccia embedded between basaltic lava layers.

Figure 6.2.1-1 Compact Basalt

Figure 6.2.1-2 Vesicular Basalt

Figure 6.2.1-3 Amygdaloidal Basalt

Figure 6.2.1-4 Volcanic Breccia

3) Intrusive rock (Dike)

There are many dikes that vertically penetrate the horizontal lava layers in the Deccan Traps. They are generally a few hundreds meter long and 5 to 20 meter wide, but can actually be up to 70 km long and a few hundreds meter wide. One dike may branch off, and also, several dikes may be present in echelon.

The dikes in western Maharashtra are classified in three groups according to their chemical composition and orientation; namely in order from older to younger, the Narmada-Tapi series (ESE-WNW), the Coastal series (N-S), and the Nasik-Pune series (no prevailing orientation). Dominant rock type for each of the three groups is dolerite.

Dikes usually develop joints, and sometimes are brecciated and/or altered at the margin with the surrounding country rock.

4) Others

i) Ash Bed

The ash bed is a layer of clastic material including fragments of scoria and pumice, and recognizable easily on weathered surface.

ii) Green Earth

The green earth is clayey material that is formed horizontally at the bottom of basaltic lava layers. The thickness can be 3 m at the most. It is believed to result from chemical weathering by seeping water from the ground surface. The green earth is basalt in origin, and greenish material like this can be seen in between and/or on the surface of vertical joints and cracks in basalt.

iii) Red Bole

The red bole is a clayey layer that can be seen in between overlapping lava layers. The thickness is about 0.5 m in most cases. In western Maharashtra, the red bole is commonly associated with the amygdaloidal basalt, and sometimes develops stratified internal structure. Similar material can occur in cracks within a single layer of basaltic lava.

The cause of the red bole is believed to be any of the following: tropical weathering same as Lateritization, the heat of overlying lava that altered the surface of weathered lava, and deposition of volcanic ash and lapilli between an older lava layer and a newer one.

iv) Tachylite

Tachylite is hydro-thermally altered vitreous basalt, which has peculiarity of being decomposed into powder when exposed to the air. Tachylite is almost the same as ordinary basalt as long as it is kept from the air, and its distribution is limited.

v) Inter Trappeans

The Inter Trappeans are sedimentary rocks consisting of cherty limestone, shale, conglomerate, sandstone, and so on, which occur in between igneous layers of the Deccan Traps. They are known for the production of fossils from Cretaceous to Paleogene. The existence of such sedimentary rocks indicates that there had been several periods of time with no lava outflow (volcanic activity) that had lasted for certain duration.

The thickness of the Inter Trappeans is generally less than about 30m, and the horizontal continuity is less than about 1km. However, the Inter Trappeans are not distributed in the study area.

6.2.2 Metamorphic Rocks

In the southernmost part of Maharashtra, metamorphic rocks of low- temperature high- pressure type (regional metamorphic rocks), such as crystalline schist and gneiss, are distributed. Their distribution and structure are extremely complicated because of extensive faulting and folding.

These metamorphic rocks are Archean of age and much older than the Deccan Traps. They are generally hard but easily split or break along certain directional planes due to foliation.

6.2.3 Surface Covering Beds

i) Alluvium

Alluvium consists of unconsolidated clay, sand, gravel, and so on; deposited on river floors, flood planes, terraces, and slopes. In the study area, the distribution of these deposits is very scarce.

ii) Laterite

Laterite is a soil type that derives from basalt due to chemical weathering under tropical condition.

It shows typical reddish brown color as a result that silica and base are lost by leaching, and iron and aluminum hydroxides are precipitated on the surface.

6.3 Earthquakes

Seismic zones of India are shown below. Since the study areas fall in seismic zone Ⅲ or Ⅳ, site-specific seismic studies will be mandatory for large dams[2] for the approval of National Committee on Seismic Design Parameters.

(Source: maps of india.com/maps/india/seismiczone.htm)

Figure 6.3-1 Seismic zones map of India

There are two major types of earthquakes. One is interplate type and the other is intraplate type. The former occurs at a plate boundary while the later occurs in the interior of a tectonic plate.

6.3.1 Interplate Earthquakes

The Indian tectonic plate that includes the entire Indian subcontinent is moving northward and pushing the Eurasian tectonic plate. Subsequently, that caused the formation of the Himalayas, the highest mountain range in the world.

At a plate boundary, huge amount of energy is built up, and when it is released, a big earthquake

[2] A large dam is one more than 15m high(above the deepest foundation level) or one between 10m and 15m high satisfying one of the following criteria: (a) more than 500m long; (b) reservoir capacity exceeding $1x10^6$ m^3; (c)spillway capacity exceeding 2,000 m^3/sec

sometimes stronger than M 8 occurs.

In the figure showing seismic zones of India, deeper color indicates more active seismicity. Nepal, Bhutan, and Pakistan, although not colored in this figure, are located near or over the plate boundary. Therefore, seismicity there is highly active just like the northern part of India.

6.3.2 Intraplate Earthquakes

The Indian Peninsula is not located at a plate boundary, so it is seismically not very active in general, but there are some places where seismic activities are relatively high. Such places are distributed in strips, indicating existence of faults.

Intraplate earthquakes are caused by the release of stress built up within a tectonic plate at a fault, where the plate is weaker. In comparison with interplate earthquakes, intraplate earthquakes are smaller in scale (rarely exceed 8.0 on the Richter scale) because the stored stress is smaller. However, they tend to cause severe damages relative to the magnitude because of the shallowness and closeness of focus.

6.3.3 Earthquakes in Maharashtra

In Maharashtra, no interplate earthquake occurs and there has been almost no influence of an interplate earthquake. However, Maharashtra is considered as a relatively active area as for intraplate seismicity.

There are, although not many, earthquakes that did occur in Maharashtra and caused severe damages as listed below.

Table 6.3.3-1 Major Earthquakes in Maharashtra

Name Location	Month / Year	Magnitude	Depth	Casualties	Remarks
Killari (Latur) Western Maharashtra	Sept. / 1993	6.4 Mw	12 Km	approx. 20,000 dead approx. 30,000 injured	reservoir -induced?
Koyna Central Maharashtra	Dec. /1967	6.4 Ms	4 km	at least 180 dead more than 1,500 injured	reservoir -induced?
Koyna Central Maharashtra	Sept. /1967	5.7 Ms	6～10 km	few	reservoir -induced?

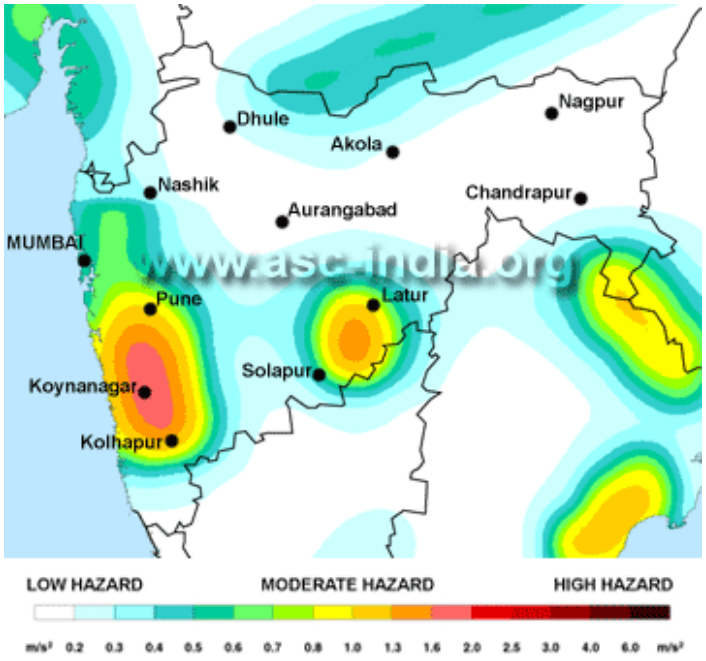
(Source: http://en.wikipedia.org/wiki/1993_Latur_earthquak, http://en.wikipedia.org/wiki/Koyna_earthquake)

There have been arguments that the cause of these earthquakes may be reservoir-induced. That means a reservoir may trigger an earthquake by the water seeping into a fault and/or the weight of it.

The weight of the stored water in a reservoir does not have sufficient energy enough to actually cause an earthquake. Therefore, the source of energy must be naturally occurring stress stored within a tectonic plate, and a man-made reservoir may only trigger the release of the stress. Seismicity around

Koyna area used to be almost inactive before the completion of Koyna dam, but it apparently became more intense after that.

Seismic hazard map of Maharashtra is shown below. The study area lies nearly between Pune and Kolhapur, hence relatively high hazard is expected. Namely, horizontal acceleration may be 0.7 ~ 2.0 m/s^2 (70 ~ 200 gal), inferring moderate hazard. These values for horizontal acceleration fit "5-upper" at the most on the Japan Meteorological Agency Seismic Scale, although they cannot be directly converted because frequency analyses are required.



(Source: http//www.asc-india.org/maps/hazard/haz-maharashtra.htm)

Figure 6.3.3-1 Seismic hazard map of Maharashtra

6.4 Landslides and Falls

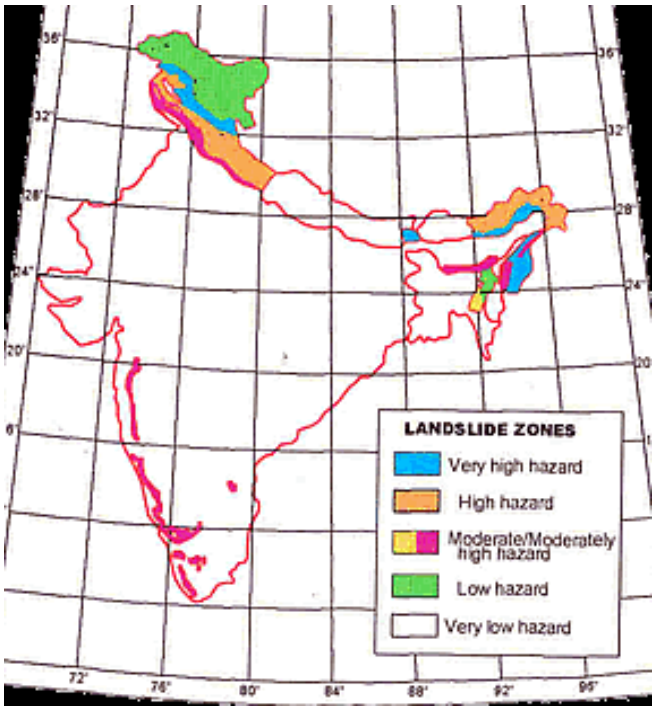
As shown in the figure below, the western part of the Western Ghats is a place of moderately high hazard, because of the precipitous landform.

Examples of 17 landslides and falls that occurred in the years from 2003 to 2004 near the study area show that the places of occurrence are artificial (cut/ banked) slopes in all cases. The causes for most cases were heavy rains in the rainy season, and no landslide or fall occurred during the dry season [3].

In June 2005, a large landslide occurred on a natural slope near Lower Dam of Ghatghar pumped-storage site, Maharashtra's first of this kind. Investigations concluded the cause was record-breaking rainfall and the incident was unpredictable [4].

[3] "Rockfall and subsidence on Mumbai-Pune Expressway" (Kumar, Prasad, Mathur, Kimothi 2010)
[4] "Note on Landslide in the catchment area of the GPSS-Lower Dam" (T.D.Tandale)

The study area is located outside of the zone of moderately high hazard, so the risk of landslides and/or falls may be low especially for natural slopes. Even slopes undergo man-caused changes, it may be possible to lower the risk by taking proper measures.



(Source: http//www.portal.gsi.gov.in/portal/page?_pageid=127,671641&_dad=portal&_schema=PORTAL)

Figure 6.4-1 Landslide zones of India

As for the relation between dams and landslides, it is known that the rapid and large changes in water level may cause landslides on slopes facing a reservoir. However, no such case has been reported in the state of Maharashtra.

There is no report on landslides that have been recognized as currently active and/or repeatedly active in the past, and their movements are being monitored for hazard prevention.

6.5 Examples of Civil Works [5]

The Deccan Traps are generally regarded as a good bedrock, for they are horizontally distributed in a tectonically stable region and consist of hard types.

The following examples may suggest that the geological conditions of the Deccan Traps can have a great influence on the cost of work, but almost no influence on the feasibility.

[5] References: "Role of Engineering Geology in various civil structures" (Kulkarni, Hangekar 2004)
"Engineering Geological Conditions and Tunneling in Deccan Traps" (S.R.Kulkarni 2006)

6.5.1 Tunnels

(1) Railroad tunnels on the Mumbai - Pune line

There are 25 tunnels penetrating the amygdaloidal basalt, and 19 of them are entirely unlined. The amygdaloidal basalt was so stable that blasting was carried out without damaging a pre-existing tunnel when a new tunnel was excavated with a separation of only about 5 meters from the old one.

These tunnels experience no seeping water from the ground even in the rainy season.

(2) Railroad tunnel on the Mankhurd - Belapur line

Rock falls took place at the crown of a tunnel that penetrated a pile of amygdaloidal basalt flows, which had become red and brown, and softer, due to hydrothermal alteration. Lining was discussed first, but only removing of the inappropriate portion was carried out. Investigations revealed that the distribution of the highly altered portion was limited and the surrounding part was sound.

(3) Koyna Hydro Electroc Power Project (stage IV) water conducting tunnel

Rock falls often took place at vertical veins and highly altered zones in closely jointed compact basalt. The tunnel passed through a minor slip, and the cover of 6 m thick collapsed for about 20 m long. This portion was finally daylighted and completed. This is considered to be one of the worst examples of tunneling in the Deccan Traps.

6.5.2 Dams

(1) Koyna Dam

Koyna Dam, crest height 103 m and crest length 807 m, is a concrete (partly masonry) gravity dam completed in 1967. The dominant rock type of its foundation is the compact basalt.

Layers of volcanic breccia and altered basalt had been found near the surface at the central part of the river floor, and they were excavated and replaced by concrete till the depth of 18.3 m.

Other than that, good rocks were distributed over all, and no fault was found within the dam's foundation.

This dam was damaged by the 1967 Koyna earthquake and developed cracks in the body. It was fixed by grouting later and has been in use without any problem since.

(2) Panshet Dam

Panshet Dam, crest height 64m and crest length 1,039 m, is an earth fill - concrete gravity combined dam completed in 1972.

This dam burst in July 1961 shortly after it started storing water, and was restored in later year. The cause of burst was the improper use of concrete blocks for the spillway that was supposed to be protected by reinforced cement concrete. Reinforced concrete actually was not used because of short supply. As a result, the spillway could not withstand the force of water due to the heavy rain.

For now, no geological problem has been found, and no trouble has been reported with this dam.

(3) Warasgaon Dam

Warasgaon Dam, crest height 63 m and crest length 780m, is a masonry dam completed in 1993.

The construction began in 1976, and leakage through the dam body had been reported since. The construction continued taking measures, but the leakage showed a tendency of increase after completion. Plans for fixing the dam are under consideration, yet there is no threat to safety of the dam for now.

The cause of the leakage is lack of impermeability of the dam body, and there is no problem reported for the foundation rocks.

Chapter 7
Environmental and Social Considerations

Chapter 7 Environmental and Social Considerations

7.1 Relevant Authorities

7.1.1 Authority on Environment and Forests[1]

The Ministry of Environment and Forests (MOEF) is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programs.

The primary concerns of the Ministry are implementation of policies and programs relating to conservation of the country's natural resources including its lakes and rivers, its biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution. While implementing these policies and programs, the Ministry is guided by the principle of sustainable development and enhancement of human well-being.

In the Ministry, there are two (2) wings - Environment Wing, and Forest and Wildlife Wing – with 33 divisions. In the Environment Wing, the divisions are implementing activities on environmental issues such as pollution control, climate change, desertification, environmental impact assessment. In Forest and Wildlife Wing, they are implementing activities on s forest conservation, and conservation and survey of natural environment.

The Ministry has subordinate offices (e.g. Forest Survey of India, Botanical Survey of India), autonomous organizations (e.g. Indian Institute of Forest Management, Wildlife Institute of India) and statutory authorities (e.g. Central Zoo Authority) for smooth and efficient implementation of the activities.

7.1.2 Other Authorities

The following authorities are relevant to projects depending on their natures;

- Ministry of Rural Development: land acquisition and resettlement;
- Ministry of Labour and Employment: labor conditions;
- Ministry of Culture: conservation of cultural heritages;
- Ministry of Water Resources: right of water utilization;
- Ministry of Tribal Affairs: protection of rights of tribal people; and,
- Ministry of Social Justice and Empowerment: protection of rights of the scheduled castes and tribes.

[1] Ministry of Environment and Forests (http://moef.nic.in/)

7.2 Relevant Legislations

7.2.1 Policies

The National Environment Policy is the main policy on the environment which builds on the existing policies (e.g. National Forest Policy, 1988; National Conservation Strategy and Policy Statement on Environment and Development, 1992; the Policy Statement on Abatement of Pollution, 1992; National Agriculture Policy, 2000; National Population Policy, 2000; National Water Policy, 2002. Refer to Table 7.2.1-1). It is intended to be a guide to action: in regulatory reform; programs and projects for environmental conservation; review and enactment of legislations by Central, State and Local Governments.

The dominant theme of this policy is that while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods from the fact of conservation, than from degradation of the resource. The policy also seeks to stimulate partnerships of different stakeholders, i.e. public agencies, local communities, academic and scientific institutions, the investment community, and international development partners, in harnessing their respective resources and strengths for environmental management[2].

Table 7.2.1-1 Policies integrated into National Environment Policy, 2006[3]

Relevant policy	Key features	Authority
The National Forest Policy, 1988	The objectives of the policy are to: • maintain environmental stability by preservation or restoration of ecological balance; • preserve natural forests with their genetic resources and biological diversity; • check soil erosion and denudation; • increase the forest cover in the country; and, • meet the forest derived requirements of rural poor and tribal population.	MOEF, and State Department of Forest
The National Conservation Strategy and Policy of Environment and Development, 1992	A comprehensive policy statement, which focuses on the "green" aspects of the environment. Action carried out in this policy is to: • ensure sustainable and equitable use of resources for meeting the basic needs of the present and future generations without causing damage to the environment; • prevent and control further deterioration in land, water and air which constitute our life support systems; • take steps for restoration of ecologically degraded areas and for environmental improvement in our rural and urban	A cross cutting policy statement attempting to develop synergy among players from diverse sectors of development Authorities of these players are not specified.

[2] United Nations Environment Programme (http://ekh.unep.org/?q=node/2348)

[3] The contents are from "JBIC Pilot Study for Project Formation for Identification of Hydropower Projects for Japanese ODA Funding in India, (2008, JBIC) (in Japanese)" unless otherwise indicated.

	settlements; • prevent further damage to and conserve natural and manmade heritage; • ensure that development projects are correctly sited so as to minimize their adverse environmental consequences; • ensure that environment and productivity of coastal areas and marine ecosystems are protected; • conserve nature, the biological diversity, gene pool and other resources; and • protect the scenic landscape, areas of geomorphologic significance, unique and representative biomes and ecosystems and wildlife habitats, heritage sites/structures and areas of cultural heritage of importance.	
The Policy Statement for Abatement of Pollution, 1992	The objectives of the policy are: • Pollution prevention at source; • Encouragement, development and adoption of best available practicable technical solutions; • Adoption of 'polluter pays principle' for pollution prevention and control arrangements; • Focus on protection of heavily polluted areas and river stretches, and • Public participation in decision making.	MOEF, Ministry of Industry, Science and Technology, Ministry of Urban Development and Ministry of Finance
The National Agriculture Policy, 2000[4]	The policy seeks to actualize the vast untapped growth potential of Indian agriculture, strengthen rural infrastructure to support faster agricultural development, promote value addition, accelerate the growth of agro business, create employment in rural areas, secure a fair standard of living for the farmers and agricultural workers and their families, discourage migration to urban areas and face the challenges arising out of economic liberalization and globalization. Over the next two decades, it aims to attain: • A growth rate in excess of 4 percent per annum in the agriculture sector; • Growth that is based on efficient use of resources and conserves our soil, water and bio-diversity; • Growth with equity, i.e., growth which is widespread across regions and farmers; • Growth that is demand driven and caters to domestic markets and maximizes benefits from exports of agricultural products in the face of the challenges arising from economic liberalization and globalization; and, • Growth that is sustainable technologically, environmentally and economically.	Ministry of Agriculture
National Population Policy, 2000	The policy affirms the commitment of the government towards voluntary and informed choice and consent of citizens while availing of reproductive health care services,	National Commission on Population

[4] Department of Agriculture and Cooperation, Ministry of Agriculture, India (http://agricoop.nic.in/)

	and continuation of the target free approach in administering family planning services. It provides a policy framework for advancing goals and prioritizing strategies during the next decade, to meet the reproductive and child health needs of the people of India, and to achieve net replacement levels by 2010. It is based upon the need to simultaneously address issues of child survival, maternal health, and contraception, while increasing outreach and coverage of a comprehensive package of reproductive and child health services by the governments, industry and the voluntary non-government sector, working in partnership.	
National Water Policy, 2002	National Water Policy was adopted in September, 1987. Since then, a number of issues and challenges have emerged in the development and management of the water resources. Therefore, the National Water Policy, 1987, has been reviewed and updated. This policy indicates issues such as Information System; Water Resources Planning; Institutional Mechanism; Water Allocation Priorities, Project Planning, Ground Water Development, Drinking Water, Irrigation, Resettlement and Rehabilitation, Financial and Physical Sustainability, Participatory Approach to Water Resources Management, Private Sector Participation, Water Quality, Water Zoning, Conservation of Water, Flood Control and Management, Land Erosion by Sea or River, Drought-prone Area Development, Monitoring of Projects, Water Sharing / Distribution amongst the States, Performance Improvement, Maintenance and Modernization, Safety of Structures, Science and Technology and Training.	Ministry of Water Resources

The National Rehabilitation and Resettlement Policy, 2007, is the policy for rehabilitation and resettlement of project affected people by the governments. It was approved by the Cabinet on 11 October, 2007, and was published in the Official Gazette and came into force from 31 October, 2007[5] (also refer to "7.2.8 (3) Draft National Land Acquisition and Rehabilitation & Resettlement Bill, 2011" in this report).

7.2.2 Legislations

(1) Relevant acts on environmental issues[6]

Environment (Protection) Act, 1986 (amended 1991): Environment (Protection) Act, 1986 (amended 1991) is the fundamental law in India concerning the environment. In the act, the

[5] Downloaded on 17 August 2012 from the website of Department of Land Resources, Ministry of Rural Development, India. http://dolr.nic.in/rehabilitation_and_resettlement.htm

[6] Information in this section is from the web sites from the related ministries.

environment is defined as water, air and land and the interrelationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro-organism and property.

The objective of the act is to provide the protection and improvement of the environment. It empowers the Central Government to establish authorities charged with the mandate of preventing environmental pollution in all its forms and to tackle specific environmental problems that are peculiar to different parts of the country.

There are important relevant rules and notification as the following:

- The Environment (Protection) Rules, 1986
- The Manufacture, Storage and import of Hazardous Chemical Rules, 1989
- The Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules, 1996
- The Bio-Medical Waste (Management and Handling) Rules, 1998
- The Ozone Depleting Substances (Regulation and Control) Rules, 2000
- The Municipal Solid Wastes (Management and Handling) Rules, 2000
- The Noise Pollution (Regulation and Control) Rules, 2000
- The Hazardous Wastes (Management and Handling) Amendment Rules, 2003
- Prior Environmental Clearance – Notification, 2006

Other relevant acts: Other acts relevant to environmental and social issues are summarized from Table 7.2.2-1 to Table 7.2.2-10.

Table 7.2.2-1 Acts on pollutions

Relevant legislation	Key features
The Water (Prevention and Control of Pollution) Act, 1974, amended 1988	The act was enacted in 1974 to provide for the prevention and control of water pollution, and for the maintaining or restoring of wholesomeness of water in the country. The Act was amended in 1988.
The Air (Prevention and Control of Pollution) Act 1981, amended 1987	The act was enacted in 1981 and amended in 1987 to provide for the prevention, control and abatement of air pollution.
The Public Liability Insurance Act, 1991, amended 1992	The main objective of act 1991 is to provide for damages to victims of an accident which occurs as a result of handling any hazardous substance. The Act applies to all owners associated with the production or handling of any hazardous chemicals.

Table 7.2.2-2 Acts on biodiversity and forest conservation

Relevant legislation	Key features
The Wildlife (Protection) Act, 1972	The Government of India enacted the act with the objective of effectively protecting the wild life of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. The act was amended in January 2003 and punishment and penalty for offences under the Act have been made more stringent. The Ministry has proposed further amendments in the law by introducing more rigid measures to strengthen the Act. The objective is to provide protection to the listed endangered flora and fauna and ecologically important protected areas.
The Biological Diversity Act, 2002	The act was born out of India's attempt to realize the objectives enshrined in the United Nations Convention on Biological Diversity (CBD) 1992 which recognizes the sovereign rights of states to use their own Biological Resources. The act aims at the conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner and through a just process For purposes of implementing the objects of the act it establishes the National Biodiversity Authority in Chennai. Related rules: ▪ The Biological Diversity Rules, 2004
The Indian Forest Act, 1927	The act consolidates the law relating to forests, the transit of forest-produce and the duty leviable on timber and other forest-produce.
The Forest (Conservation) Act, 1980	The Forest Conservation Act 1980 was enacted to help conserve the country's forests. It strictly restricts and regulates the de-reservation of forests or use of forest land for non-forest purposes without the prior approval of Central Government. To this end the Act lays down the pre-requisites for the diversion of forest land for non-forest purposes. Related rules: The Forest (Conservation) Rules, 2003
The Scheduled Tribes and Other Dwellers (Recognition of Forest Rights) Act, 2006	The act recognizes the rights of forest-dwelling Scheduled Tribes and other traditional forest dwellers over the forest areas inhabited by them, and provides a framework for according the same.

Table 7.2.2-3 Other acts on environment issues

Relevant legislation	Key features
The National Environment Appellate Authority Act, 1997	The National Environment Appellate Authority (NEAA) was set up by the Ministry of Environment and Forests to address cases in which environmental clearances are required in certain restricted areas. It was established by the National Environment Appellate Authority Act 1997 to hear appeals with respect to restriction of areas in which any industries, operations or processes or class of industries, operations or processes shall or shall not be carried out, subject to certain safeguards under the Environment (Protection) Act, 1986. The Authority shall become defunct and the Act shall stand repealed upon the enactment of the National Green Tribunal Bill 2009 currently pending in Parliament.
The National Environment Tribunal Act, 1995	In 1995 the Central Government established the National Environment Tribunal (through the National Environment Tribunal Act 1995) to provide for strict liability for damage arsing out of accidents caused from the handling of hazardous substances.

Table 7.2.2-4 Acts on land acquisition, resettlement and rehabilitation

Relevant legislation	Key features
The Land Acquisition Act, 1894 (amended 1984)	The act is intended to legalize the taking up, for public purposes, or for a company, of land which is private property of individuals, and pay equitable compensation therefore calculated at market value of land acquired, plus an additional sum on account of compulsory character of acquisition[7].
The Maharashtra Project Affected Persons Rehabilitation Act, 1999 (2001)	The aim of the act is to consolidate and amend the law relating to the rehabilitation of persons affected by certain projects in the State of Maharashtra[8].

Table 7.2.2-5 Acts on labor conditions

Relevant legislation	Key features
The Factories Act, 1948 (Amended On 1987)	The Act is the principal legislation, which governs the health, safety, and welfare of workers in factories. The act extends to the whole of India. Mines and Railways workers are not included as they are covered by separate Acts. The new act addressed the issues of safety, health, and welfare. Many amendments were aimed to keep the Act in tune with the developments in the field of health and safety. However, it was not until 1987 that the elements of occupational health and safety, and prevention and protection of workers employed in hazardous process, got truly incorporated in the Act.
The Contract Labour (Regulation and Abolition) Act, 1970	The Object of the act is to prevent exploitation of contract labour and also to introduce better conditions of work[9].
The Child Labour (Prohibition & Regulation) Act, 1986	The Act prohibits employment of children in certain specified hazardous occupations and processes and regulates the working conditions in others. The list of hazardous occupations and processes is progressively being expanded on the recommendation of Child Labour Technical Advisory Committee constituted under the Act.

Table 7.2.2-6 Act on water right

Relevant legislation	Key features
The Inter-State River Water Disputes Act, 1956	The main purpose of the act is to protect the interests of a downstream state when water resources available in an upstream state are put to additional use[10].

Table 7.2.2-7 Act on the scheduled castes and tribes

Relevant key legislation	Key features
Scheduled Castes and Scheduled Tribes (Prevention of Atrocities) Act, 1989	The act is to prevent the commission of offences of atrocities against the members of the Scheduled Castes and the Scheduled Tribes, and to provide for Special Courts for the trial of such offences and for the relief and rehabilitation of the victims of such offences and for matters connected therewith or incidental thereto.

[7] The Process of Land Acquisition (Chandan, L., 2008)
[8] The Maharashtra Project Affected Persons Rehabilitation Act, 1999 (Kher, A.R.B., 2009)
[9] http://www.legalserviceindia.com/articles/labour_contract.htm
[10] Interstate river water disputes (IRWD) act (1956) (Sasidhar, N. 2011)

Table 7.2.2-8 Acts on cultural heritages

Relevant key legislation	Key features
The Ancient Monuments Preservation Act, 1904	The act provides effective preservation and authority over the monument particularly those, which were under the custody of individual or private ownership.
The Ancient Monuments and Archaeological Sites and Remains Act 1958	The act provides for the preservation of ancient and historical monuments and archaeological sites and remains of national importance, for the regulation of archaeological excavations and for the protection of sculptures, carvings and other like objects

Table 7.2.2-9 Act on information disclosure

Relevant key legislation	Key features
The Right to Information Act, 2005	The act is to provide for setting out the practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority.

Table 7.2.2-10 Rules on extraction of minor minerals

Relevant key legislation	Key features
Minor Minerals Control and Development Rules, 2010[11]	These rules shall apply to prospecting and quarrying of minor minerals in light of the provision of Prior Environmental Clearance – Notification, 2006. These rules have not come into force yet.

Resolution on a buffer zone around the protected areas by the Indian Board for Wildlife: The Indian Board for Wildlife is the advisory body in the field of wildlife conservation and is headed by the Prime Minister. The resolutions were adopted by the Board on 21 January 2002. Among them, there is one related to buffer zones around the National Parks and Wildlife Sanctuaries as follows: "Lands falling within 10 km. of the boundaries of National Parks and Sanctuaries should be notified as eco-fragile zones under section 3(v) of the Environment (Protection) Act and Rule 5 Sub-rule 5(viii) & (x) of the Environment (Protection) Rules"[12].

(2) International conventions on environmental issues

India is members of various international conventions on environmental issues, and Table 7.2.2-11 shows the status of the important conventions.

[11] Environmental aspects of quarrying of minor minerals – Evolving of Model Guidelines, No. 296/7/2000/MRC (Ministry of Mines, Indian Bureau of Mines, TMP Division 16 May 2011).

[12] The information is from the website of Wildlife Division, MOEF. The Indian Board for Wildlife is now called National Board for Wildlife.

Table 7.2.2-11 International conventions on environmental issues[13]

Title	Status
Atmosphere	
Vienna Convention for the Protection of Ozone Layer	1991 (accession)
United Nations Framework Convention on Climate Change	1993 (ratification)
Waste management	
Basel Convention on the Transboundary Movements of Hazardous Wastes and their Disposal	1992 (ratification)
Nature conservation	
Convention on Biological Diversity	1994 (ratification)
Convention on Wetlands of International Importance Especially as Waterfowl Habitats	1982
Convention on Migratory Species	1983
Convention Concerning the Protection of the World Cultural and Natural Heritage	1946
United Nations Convention to Combat Desertification	1996 (ratification)
Convention of International Trade in Endangered Species of Wild Fauna and Flora	1976 (ratification)

7.2.3 Standards[14]

(1) Water quality standards

Table 7.2.3-1 shows the ambient water quality standards and Table 7.2.3-2 shows the effluent water quality standards.

Table 7.2.3-1 Ambient water quality standards

No.	Parameter	SW-I	SW-II	SW-III	SW-IV	SW-V
1	pH range	6.5-8.5	6.5-8.5	6.5-8.5	6.5-9.0	6.0-9.0
2	Dissolved oxygen	5.0 mg/l or 60% saturation value, whichever higher	4.0 mg/l or 50% saturation value, whichever higher	3.0 mg/l or 40% saturation value, whichever higher	3.0 mg/l or 40% saturation value, whichever higher	3.0 mg/l or 40% saturation value, whichever higher
3	Color and odor	Not noticeable color or offensive odor	Not noticeable color or offensive odor	Not noticeable color or offensive odor assigned to this class	No visible color or offensive odor	None in such concentrations that would impair any usages specifically assigned to this class
4	Floating matters	Nothing obnoxious or detrimental for use purpose	Nothing obnoxious or detrimental for use purpose	Nothing visible obnoxious floating debris, oil slick, scum		
5	Floating materials, oil,				10 mg/l	

[13] The information on each convention is from the website of the convention.

[14] The standards are from Environment (Protection) Rules, 1986, unless otherwise indicated. The rules specify more detailed standards for specific activities such as industry based standards.

No.	Parameter	SW-I	SW-II	SW-III	SW-IV	SW-V
	grease and scum (including petroleum products)					
6	Sludge deposits, solid refuse, floating solids, oil, grease and scum					None except for such small amount that may result from discharge of appropriately treated sewage and/or industrial waste effluents
7	Suspended solids	None from sewage or industrial waste origin				
8	Turbidity		30 NTU	30 NTU		
9	Fecal Coliform		100 / 100 ml (MPN)	500 / 100 ml (MPN)	500 / 100 ml (MPN)	500 / 100 ml (MPN)
10	Biochemical oxygen demand (3 days at 27°C)		3 mg/l		5 mg/l	
11	Oil and grease (including petroleum products)	0.1 mg/l				
12	Heavy metals: Mercury (Hg) Cadmium (Cd) Lead (Pb)	0.001 mg/l 0.001 mg/l 0.01 mg/l				
13	Dissolved Iron (Fe)			0.5 mg/l or less		
14	Dissolved Manganese (Mn)			0.5 mg/l or less		

Note:
SW-I: Salt pans, shell fishing, mariculture and ecologically sensitive zone.
SW-II: Bathing, contact water sports and commercial fishing.
SW-III: Industrial cooling, recreation (non-contact) and aesthetics.
SW-IV: Harbor
SW-V: Navigation and controlled waste disposal.

NTU: Nephelo Turbidity Unit, MPN: Most Probable Number

Table 7.2.3-2 Effluent water quality standards

No.	Parameter	Standards			
		Inland surface water	**Public sewers**	**Land for irrigation**	**Marine coastal areas**
1	Color and odor		-		
2	Suspended solids mg/l, Max.	100	600	200	(a) For process waste water: 100 (b) For cooling water effluent 10 % above total suspended matter of influent
3	Particle size of suspended solids	Shall pass 850 micron IS sieve	-		(a) Floatable solids, Max. 3 mm (b) Settleable solids, Max. 850 microns
4	pH value	5.5 – 9.0	5.5 – 9.0	5.5 – 9.0	5.5 – 9.0
5	Temperature	Shall not exceed 5 °C above the receiving water temperature	-	-	Shall not exceed 5 °C above the receiving water temperature
6	Oil and grease mg/l, Max.	10	20	10	10
7	Total residual chlorine mg/l, Max.	1.0	-	-	1.0
8	Ammoniacal Nitrogen (as N) mg/l, Max.	50	50	-	50
9	Total Kjeldahl Nitrogen (N) mg/l, Max.	100	-	-	100
10	Free Ammonia (NH_3) mg/l, Max.	5.0	-	-	5.0
11	Biochemical Oxygen demand (5 days at 20°C) mg/l, Max.	30	350	100	100
12	Chemical Oxygen demand, mg/l Max.	250	-	-	250
13	Arsenic (As), mg/l Max.	0.2	0.2	0.2	0.2
14	Mercury (Hg), mg/l Max.	0.01	0.01	-	0.01
15	Lead (Pb), mg/l Max.	0.1	1.0	-	2.0
16	Cadmium (Cd), mg/l Max.	2.0	1.0	-	2.0
17	Hexavalent Chromium (Cr+6), mg/l Max.	0.1	2.0	-	1.0
18	Total Chromium (Cr), mg/l Max.	2.0	2.0	-	2.0
19	Copper (Cu), mg/l Max.	3.0	3.0	-	3.0
20	Zinc (Zn), mg/l Max.	5.0	15	-	15
21	Selenium (Se), mg/l Max.	0.05	0.05	-	0.05
22	Nickel (Ni), mg/l Max.	3.0	3.0		5.0

No.	Parameter	Standards			
		Inland surface water	Public sewers	Land for irrigation	Marine coastal areas
23	Cyanide (CN), mg/l Max.	0.2	2.0	0.2	0.2
24	Fluoride (F), mg/l Max.	2.0	15	-	15
25	Dissolved Phosphates (P), mg/l Max.	5.0	-	-	-
26	Sulphide (S), mg/l Max.	2.0	-	-	5.0
27	Phenolic compounds (C_6H_5OH), mg/l Max.	1.0	5.0	-	5.0
28	Radioactive materials: (a) Alpha emitters, Micro curie/ml Max. (b) Beta emitters, Micro curie/ml Max.	 10^{-7} 10^{-6}	 10^{-7} 10^{-6}	 10^{-8} 10^{-7}	 10^{-7} 10^{-6}
29	Bio-assay test	90% survival of fish after 96 hours in 100% effluent			
30	Manganese (Mn)	2 mg/l	2 mg/l		2 mg/l
31	Iron (Fe)	3 mg/l	3 mg/l		3 mg/l
32	Vanadium (V)	0.2 mg/l	0.2 mg/l		0.2 mg/l
33	Nitrate Nitrogen	10 mg/l	-	-	20 mg/l

(2) Air quality standards

Table 7.2.3-3 shows the ambient air quality standards, and Table 7.2.3-4 shows the general emission standards.

Table 7.2.3-3 Ambient air quality standards

No.	Pollutants	Time Weighted Average	Concentration in Ambient Air	
			Industrial, Residential, and Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
1	Sulphur Dioxide (SO_2), µg/m^3	Annual* 24 Hours**	50 80	20 80
2	Nitrogen Dioxide (NO_2), µg/m^3	Annual* 24 Hours**	40 80	30 80
3	Particulate Matter (Size less than 10µm) or PM_{10}, µg/m^3	Annual* 24 Hours**	60 100	60 100
4	Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m^3	Annual* 24 Hours**	40 60	40 60
5	Ozone (O_3), µg/m^3	8 Hours* 1 Hours**	100 180	100 180
6	Lead (Pb), µg/m^3	Annual* 24 Hours**	0.50 1.0	0.50 1.0
7	Carbon Monoxide (CO), mg/m^3	8 Hours* 1 Hour**	02 04	02 04
8	Ammonia (NH_3), µg/m^3	Annual*	100	100

		24 Hours**	400	400
9	Benzene (C_6H_6), µg/m^3	Annual*	05	05
10	Bezo (a) Pyrene (BaP) Particulate phase only, ng/m^3	Annual*	01	01
11	Arsenic (As), ng/m^3	Annual*	06	06
12	Nickel (Ni), ng/m^3	Annual*	20	20
* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring. **NOTE:** Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.				

Table 7.2.3-4 General emission standards

No.	Parameter	Standards Concentration not to exceed (in mg/Nm^3)
1	Particulate Matter (PM)	150
2	Total Fluoride	25
3	Asbestos	4 Fibers /cc and dust should not be more than 2 mg/Nm^3
4	Mercury	0.2
5	Chlorine	15
6	Hydrochloric acid vapor and mist	35
7	Sulphuric acid mist	50
8	Carbon monoxide	1 % max (v/v)
9	Lead	10 mg/Nm^3

(3) Noise level standard[15]

Table 7.2.3-5 shows the ambient air quality standards in respect of noise.

Table 7.2.3-5 Ambient air quality standards in respect of noise

No.	Category of area / zone	Limit in dB (A) Leq.	
		Day time (06:00 am – 10:00 pm)	Night time (10:00 pm – 06:00 am)
1	Industrial area	75	70
2	Commercial area	65	55
3	Residential area	55	45
4	Silence zone	50	40
Note: Silence zone is defined as an area comprising not less than 100 metres around hospitals, educational institutions and courts. The silence zones are zones which are declared as such by the competent authority.			

[15] Information from "The Noise Pollution (Regulation and Control) Rules, 2000".

7.2.4 Clean Development Mechanism[16]

(1) United Nations Framework Convention on Climate Change and India

India is a party to the United Nations Framework Convention on Climate Change. The objectives of the convention are to "cooperatively consider what the parties could do to limit average global temperature increases and the resulting climate change, and to cope with whatever impacts were, by then, inevitable"[17].

To strengthen the developed country commitments under the convention, the Parties adopted Kyoto Protocol in 1997. The Protocol provides for quantified emission limitations and reduction commitments for the developed countries and mechanisms to facilitate compliance with these targets. One of the mechanisms is Clean Development Mechanism (CDM). India acceded to the Kyoto Protocol in August 2002 and one of the objectives of acceding was to fulfill prerequisites for implementation of CDM projects.

(2) Designated National Authority and CDM

Designated National Authority in India is the National Clean Development Mechanism Authority (NCA), which consists of one chairperson from MOEF and eight (8) members from other ministries such as Ministries of External Affairs and Finance. The authority receives projects for evaluation and approval under the guidelines and general criteria.

(3) Approval procedure in India

(i) A project proponent (PP) is required to submit Project Concept Note (PCN) and Project Design Document (PDD) to NCA.

(ii) NCA examines the documents and if there are any preliminary queries the same are asked from PP.

(iii) The PP and his consultants are normally given about 10-15 days' notice to come to a NCA meeting and give a brief presentation regarding their CDM project proposal.

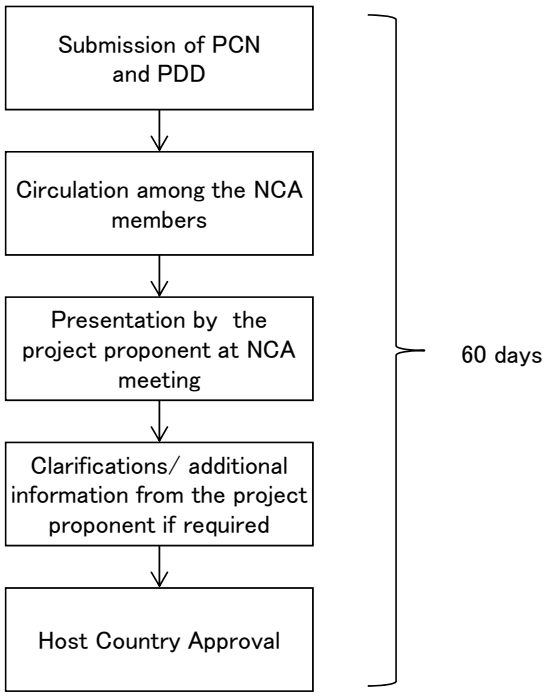
(iv) Members seek clarifications during the presentation and in case the members feel that some additional clarifications or information are required from the PP. The same is informed to the presenter.

(v) Once the members of NCA are satisfied, the Host Country The approval is issued by the Member-Secretary of NCA (Director, Climate Change, MOEF).

The procedure is shown in Figure 7.2.4-1.

[16] Information in this section is basically from the website of CDM India unless otherwise indicated: http://envfor.nic.in/cdm/index_full.htm.

[17] From the website of UNFCCC: http://unfccc.int/essential_background/items/6031.php



(Source: CDM India)

Figure 7.2.4-1 Procedure of CDM approval

(4) Registered CDM hydropower projects in India

92 hydropower projects in India have been registered as CDM projects at United Nations as of 30 April 2012, of which breakdown is shown in Table 7.2.4-1.

Table 7.2.4-1 Registered CDM hydropower projects in India[18]

Type of hydropower project	Number
Run of river	81
Existing reservoir	9
New reservoir	2
Pumped storage	0
Total	**92**

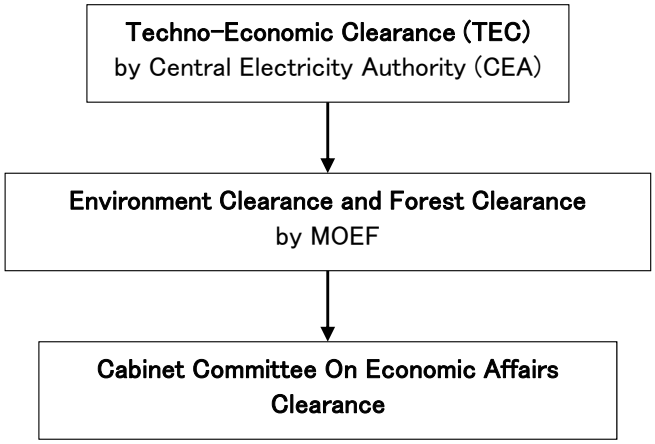
It is difficult to apply the current methodologies of CDM to evaluate pumped storage hydropower project, and it is necessary to develop or revise the methodologies if the pumped storage hydropower project is to be a candidate of CDM project[19].

[18] Institute for Global Environment Strategies, CDM Project Database (01 May 2012).
[19] JBIC Pilot Study for Project Formation for Identification of Hydropower Projects for Japanese ODA Funding in India (2008, JBIC) (in Japanese).

7.2.5 Clearances for Hydropower Projects

(1) Three main clearances for hydropower projects

There are three main clearances for hydropower projects in India. Figure 7.2.5-1 shows these three clearances and the flow.



(Source: JBIC Pilot Study for Project Formation for Identification of Hydropower Projects for Japanese ODA Funding in India (2008, JBIC) (in Japanese).)

Figure 7.2.5-1 Three main clearances for hydropower projects

(2) Guidelines by Central Electricity Authority

A PP of a hydropower project is required to submit a Detailed Project Report to Central Electricity Authority (CEA) to obtain Techno-Economic Clearance.

CEA has "Guidelines for Formulation of Detailed Project Reports for Hydro Electric Schemes, Their Acceptance and Examination for Concurrence (revision 2.0, 2011)". It describes necessary clearances including documents and certificates from concerned authorities and /or companies of which copies CEA requires the PP to submit. They are the followings:

- Letter from the Registrar of Companies indicating that the company has been registered as a Generating Company under Indian Companies Act, 1956;
- Article of Association indicating that generation is one of the objectives of the Company;
- Letter from Competent Government authorizing the company to establish, own and operate generating power plant. The letter must contain the following: location of Project-State, District, Taluka (=Tahsil), Village, longitude and latitude; and capacity of the power plant;
- Land availability certificate from State Revenue Authorities;
- Water availability certificate from State Irrigation Department/ concerned agency;
- Clearance of Ministry of Water Resources/ Central Water Commission as the case may be[20].

[20] Regarding the details of the water right, refer to Figure 7.2.9-1.

In case of inter-state/country aspects, necessary clearance from concerned authority;

- Status of Environmental and Forest Clearances from Ministry of Environment & Forests, Government of India
- Defense clearance (if applicable);
- Consent / Agreement signed between the Generating company and the purchaser(s) (State utility or other buyers). In case of Central Public Sector Undertaking project, the willingness for absorption of power by the beneficiary States/ UTs;
- Recommendation of the State Govt. on the project cost in case of private projects;
- Any other Statutory clearance from Ministries / Departments / Organizations for the specific aspects of the project, wherever required in the proposed project;
- Letter of Comfort from the Transmission Company to provide evacuation system, details of the proposed system and completion schedule; and,
- Letter of Comfort from the Transmission Company to enter into a back to back agreement with the promoter covering risk in case of default/ delay in commissioning by either of the parties.

It also states that the following information is necessary in the Detailed Project Report of the hydropower project.

- For the schemes involving Wildlife Sanctuary/ National Park, recommendations/ approval of Indian Board for Wildlife[21] is necessary.
- Information on rehabilitation and resettlement aspects of the project namely villages /families/ persons affected, details of R&R Plan and its approval by MOEF is required.
- Information on tribal population affected and status of clearance from Ministry of Social Justice and Empowerment / Tribal Affairs is also necessary, if tribal population is affected.

(3) Water Resources Department of Maharashtra

The Water Resources Department of Maharashtra (WRD, Irrigation Department) has been conducting many projects which require clearances and / or letters of no objection from related authorities. For example, the Tarali Irrigation Project obtained them from the following authorities[22]:

- Central Water Commission;
- MOEF;
- Maharashtra Tourism Development Corporation Limited;
- District Industries Center;

[21] It is now called National Board for Wildlife.

[22] From the presentation material of Tarali Irrigation Project for the Expert Committee Meeting of MOEF on 1 February 2004.

- Geological Survey of India;
- Indian Bureau of Mines;
- District Fisheries Department;
- Archaeological Survey of India;
- Groundwater Survey and Development Authority;
- Zoological Survey of India;
- Directorate of Irrigation Research and Development;
- Indian Meteorological Department;
- State Agriculture Department;
- Health Department; and,
- Maharashtra Pollution Control Board.

Although it is an irrigation project, the above-listed authorities can be relevant for a hydropower project. It is recommended to consult with them when a hydropower project is planned.

(4) Clearance from National Committee of Seismic Design Parameters[23]

Large dams which are planned to construct in seismic zone III, IV or VI[24] are required to conduct site specific seismic studies for assessment of design earthquake parameters and to submit a report on the result to the National Committee of Seismic Design Parameters (NCSDP) under the Central Water Commission for the approval. Such dams that are more than 30 m in height in seismic zone II are also required to conduct the studies and to obtain approvals from NCSDP.

A large dam is defined by NCSDP as (1) one is more than 15 m in height (above the deepest foundation level) or (2) one is between 10 m and 15 m in height satisfying one of the following criteria: (a) more than 500 m in length; (b) reservoir capacity exceeding 10^6 m^3 or (c) spillway capacity exceeding 2,000 m^3/sec.

(5) Most necessary clearances in terms of environmental and social considerations

Among these clearances, Environmental Clearance, Forest Clearance, clearances on rehabilitation and resettlement aspects of project, and Clearance from Central Water Commission are the most necessary, and require certain processes. The following sections describe these clearances in detail.

[23] Guidelines for Preparation and Submission of Site Specific Seismic Study Report of River Valley Project to National Committee on Seismic Design Parameters (Central Water Commission, 2011)

[24] Regarding the categorization, refer to Figure 6.3-1 in this report.

7.2.6 Environmental Clearance[25]

(1) Environmental Impact Assessment in India

The Notification on Environmental Impact Assessment (EIA) of developmental projects, 1994, under the provisions of Environment (Protection) Act, 1986, made EIA mandatory for 29 development projects. In 2006, the notification was revised and a new notification on EIA was issued for implementing EIAs for development project in India and in the State of Maharashtra. In the notification 2006, EIA is specified as part of Environmental Clearance (EC) exercise.

In the Notification, 2006, there is no description on Strategic Environmental Impact Assessment (SEA), and, at present, SEA is not mandatory for any development projects in India.

(2) EC procedure based on the Notification, 2006

1) Categories

There are eight (8) major categories, which are divided into 39 projects or activities listed as the Schedule to the notification. The major categories are as follows:

- Mining, extraction of natural resources and power generation (for a specified production capacity);
- Primary Processing;
- Materials Production;
- Materials Processing;
- Manufacturing/Fabrication;
- Service Sectors;
- Physical Infrastructure including Environmental Services; and,
- Building /Construction projects/Area Development projects and Townships.

2) Projects which require EC

The following projects or activities require EC from the concerned regulatory authority, before any construction work, or preparation of land by the project management except for securing the land, starts on the project or activity.

- All new projects or activities listed in the Schedule to the notification;
- Expansion and modernization of existing projects or activities listed in the Schedule to the notification with addition of capacity beyond the limits specified for the concerned sector, that is, projects or activities which cross the threshold limits given in the Schedule, after expansion or modernization; and,
- Any change in product - mix in an existing manufacturing unit included in Schedule

[25] The information of this section is from Prior Environmental Clearance - Notification, 2006.

beyond the specified range.

3) Category A and B

The Schedule specifies criteria to categorize all the projects or activities into Category A or B. Category A is processed at the central level (i.e. MOEF) and Category B is handled at state level (i.e. State Environmental Impact Assessment Authority (SEIAA)).

4) Concerned authorities and their roles

Table 7.2.6-1 shows the concerned authorities and their roles in the EC procedure.

Table 7.2.6-1 Concerned authorities and their roles

Central level	State level	Roles
MOEF	State Environmental Impact Assessment Authority (SEIAA)	They manage the entire process, and grant or reject application based on the environmental considerations.
Expert Appraisal Committee (EAC)	State Level Expert Appraisal Committee (SEAC)	They make specifications of Terms of References (TOR) of EIA, scrutinize EIA report and make recommendations on the application. Eligibility criteria for members are specified by Appendix VI of the notification.
State Pollution Control Board (SPCB) or Union Territory Pollution Control Committee (UTPCC)		They conduct public hearing as part of public consultation.

5) Structure of EIA report

Table 7.2.6-2 shows the generic structure of EIA report specified by Appendix III of the notification.

Table 7.2.6-2 Generic structure of EIA report

No.	Title	Contents
1	Introduction	▪ Purpose of the report ▪ Identification of project & project proponent ▪ Brief description of nature, size, location of the project and its importance to the country, region ▪ Scope of the study – details of regulatory scoping carried out (As per Terms of Reference)
2	Project Description	Condensed description of those aspects of the project (based on project feasibility study), likely to cause environmental effects. Details should be provided to give clear picture of the following: ▪ Type of project ▪ Need for the project ▪ Location (maps showing general location, specific location, project boundary & project site layout) ▪ Size or magnitude of operation (incl. associated activities required by or for the project ▪ Proposed schedule for approval and implementation

No.	Title	Contents
		▪ Technology and process description ▪ Project description. Including drawings showing project layout, components of project etc. schematic representations of the feasibility drawings which give information important for EIA purpose ▪ Description of mitigation measures incorporated into the project to meet environmental standards, environmental operating conditions, or other EIA requirements (as required by the scope) ▪ Assessment of new & untested technology for the risk of technological failure
3	Description of the Environment	▪ Study area, period, components & methodology ▪ Establishment of baseline for valued environmental components, as identified in the scope ▪ Base maps of all environmental components
4	Anticipated Environmental Impacts and Mitigation Measures	▪ Details of investigated environmental impacts due to project location, possible accidents, project design, project construction, regular operations, final decommissioning or rehabilitation of a completed project ▪ Measures for minimizing and / or offsetting adverse impacts identified ▪ Irreversible and Irretrievable commitments of environmental components ▪ Assessment of significance of impacts (criteria for determining significance, assigning significance) ▪ Mitigation measures
5	Analysis of Alternatives (Technology & Site)	▪ In case, the scoping exercise results in need for alternatives: ▪ Description of each alternative ▪ Summary of adverse impacts of each alternative ▪ Mitigation measures proposed for each alternative ▪ Selection of alternative
6	Environmental Monitoring Program	Technical aspects of monitoring the effectiveness of mitigation measures (incl. Measurement methodologies, frequency, location, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules)
7	Additional Studies	▪ Public consultation ▪ Risk assessment ▪ Social impact assessment. R&R Action Plans
8	Project Benefits	▪ Improvements in the physical infrastructure ▪ Improvements in the social infrastructure ▪ Employment potential –skilled; semi-skilled and unskilled ▪ Other tangible benefits
9	Environmental Cost Benefit Analysis	If recommended at the scoping stage
10	Environmental Management Plan (EMP)	Description of the administrative aspects of ensuring that mitigation measures are implemented and their effectiveness monitored, after approval of the EIA
11	Summary & Conclusion	▪ Overall justification for implementation of the project ▪ Explanation of how, adverse effects have been mitigated
12	Disclosure of Consultants engaged	The names of the Consultants engaged with their brief resume and nature of Consultancy rendered

6) Procedure of EC

Categorization exercise of project into Category A or B: Categorization exercise is conducted based on the criteria shown in the Schedule. Table 7.2.6-3 shows the criteria for river valley projects in which hydropower projects are categorized.

Table 7.2.6-3 Criteria for projects related to hydropower development

No.*	Project or activity	Category A (Central level appraisal)	Category B (State level appraisal)	Conditions if any
1 (a)	Mining of minerals	≥ 50 ha of mining lease area Asbestos mining irrespective of mining area	< 50ha ≥ 5 ha of mining lease area	General Condition shall apply. Note Mineral prospecting (not involving drilling) is exempted provided the concession areas have got previous clearance for physical survey.
1 (c)	River valley projects	(i) ≥ 50 MW hydroelectric power generation; (ii) ≥10,000 ha. of culturable command area	(i) < 50 MW ≥ 25 MW hydroelectric power generation; (ii) < 10,000 ha. of culturable command area	General Condition shall apply.

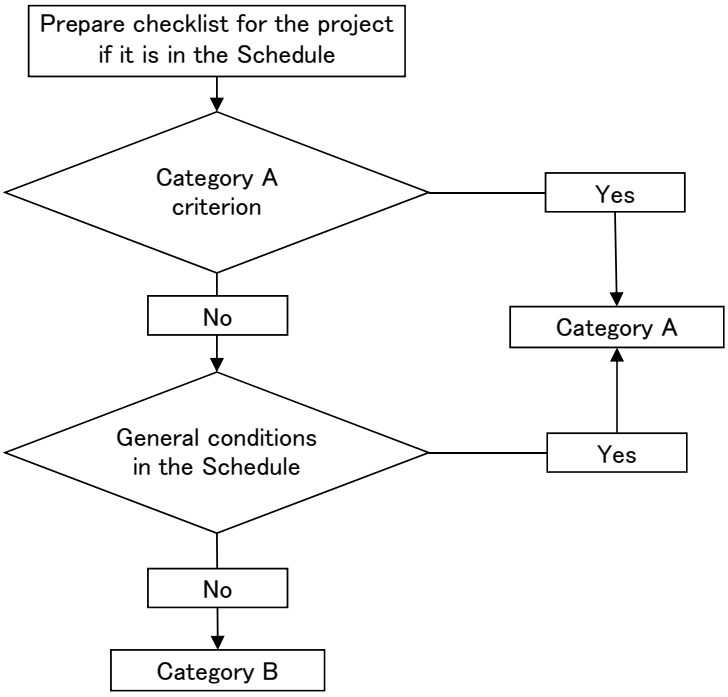
(Note: The number in the table is from the Schedule.)

The General Condition of the Schedule (refer to "Conditions if any" in Table 7.2.6-3) is as follows:

Any project or activity specified in Category 'B' will be treated as Category A, if located in whole or in part within 10 km from the boundary of: (i) Protected Areas notified under the Wildlife (Protection) Act, 1972, (ii) Critically Polluted areas as notified by the Central Pollution Control Board from time to time, (iii) Notified Eco-sensitive areas, (iv) inter-State boundaries and international boundaries.

Regarding a project establishing transmission lines, the project does not need to obtain EC.

The flow of the categorization exercise is shown in Figure 7.2.6-1.



(Source: Notification 2006)

Figure 7.2.6-1 Flow of the categorization exercise

Application for EC: A project proponent (PP) is required to prepare Farm 1 or Form 1 A (checklist of activities and environmental impacts) which are annexed to the notification. Form 1 A is only for construction projects or activities (item 8 of the Schedule). Along with the Form 1, the PP is required to submit a copy of pre-feasibility report of the project.

The documents of Category A project are submitted to and reviewed by MOEF, and those of Category B project are by SEIAA.

Stage I Screening: In case of Category B project, SEIAA categorized the project into Category B 1 or Category B 2. Category B 2 project is not required to conduct EIA study.

The Screening is not applicable for Category A project.

Stage II Scoping: Terms of References (TOR) for the EIA study is prepared by Expert Appraisal Committee (EAC) for Category A project, and by State level Expert Appraisal Committee (SEAC) for Category B 1 project.

The PP conducts the EIA study based on the TOR, and prepares Draft EIA report / Environmental Management Plan (EMP).

Stage III Public Consultation: Public Consultation consists of “public hearing” at the site or in its close proximity (district wise) and “obtaining responses in writing from other concerned persons” to reflects all necessary concerns to the project activities and design.

Public hearing is conducted by State Pollution Control Board (SPCB). In case of Category B 1 project, public hearing is conducted if it is necessary. For obtaining responses in writing, the concerned regulatory authority and the SPCB[26] ask responses from such concerned persons by placing on their website or other means.

After the Public Consultation, the PP prepares the final EIA/EMP report. In case of Category A project, the final EIA/EMP is submitted to MOEF for its review.

Stage IV Appraisal: In case of Category A project, the final EIA/EMP report is submitted to EAC. In case of Category B project, the final EIA/EMP report of B 1 project or the application form of B 2 project is submitted to SEAC. Each authority scrutinizes the document to make recommendations.

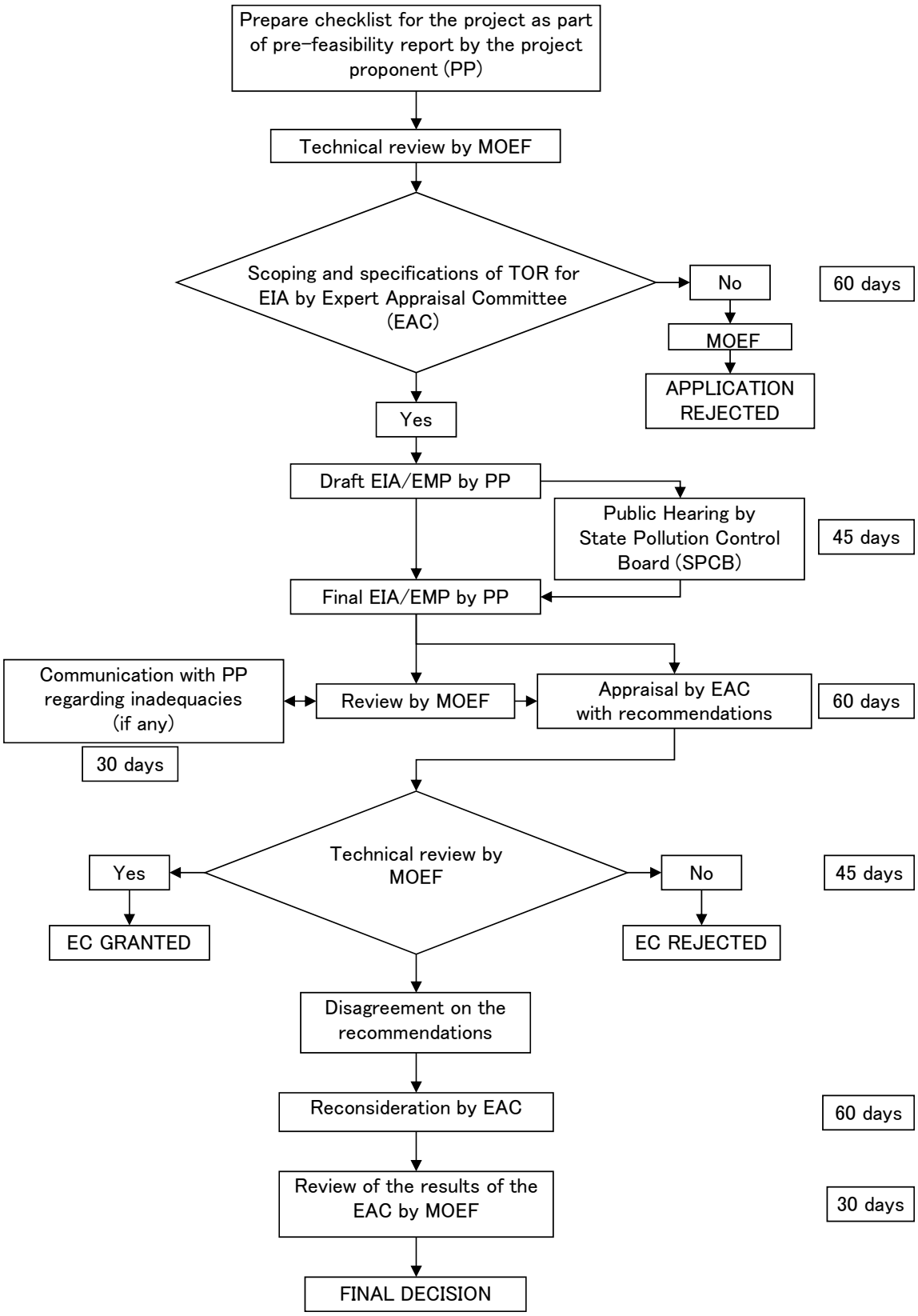
Grant or rejection of EC: In case of Category A project, the EIA documents with EAC's recommendations are submitted to MOEF, and MOEF makes its decision on granting or rejecting the EC for the project.

In case of Category B project, the documents with SEAC's recommendations are submitted to SEIAA for their decision.

Disagreement by the regulatory authority: In case that the regulatory authority (MOEF or SEIAA) disagrees with the recommendations of EAC or SEAC, the regulatory authority can request EAC or SEAC to reconsider the case.

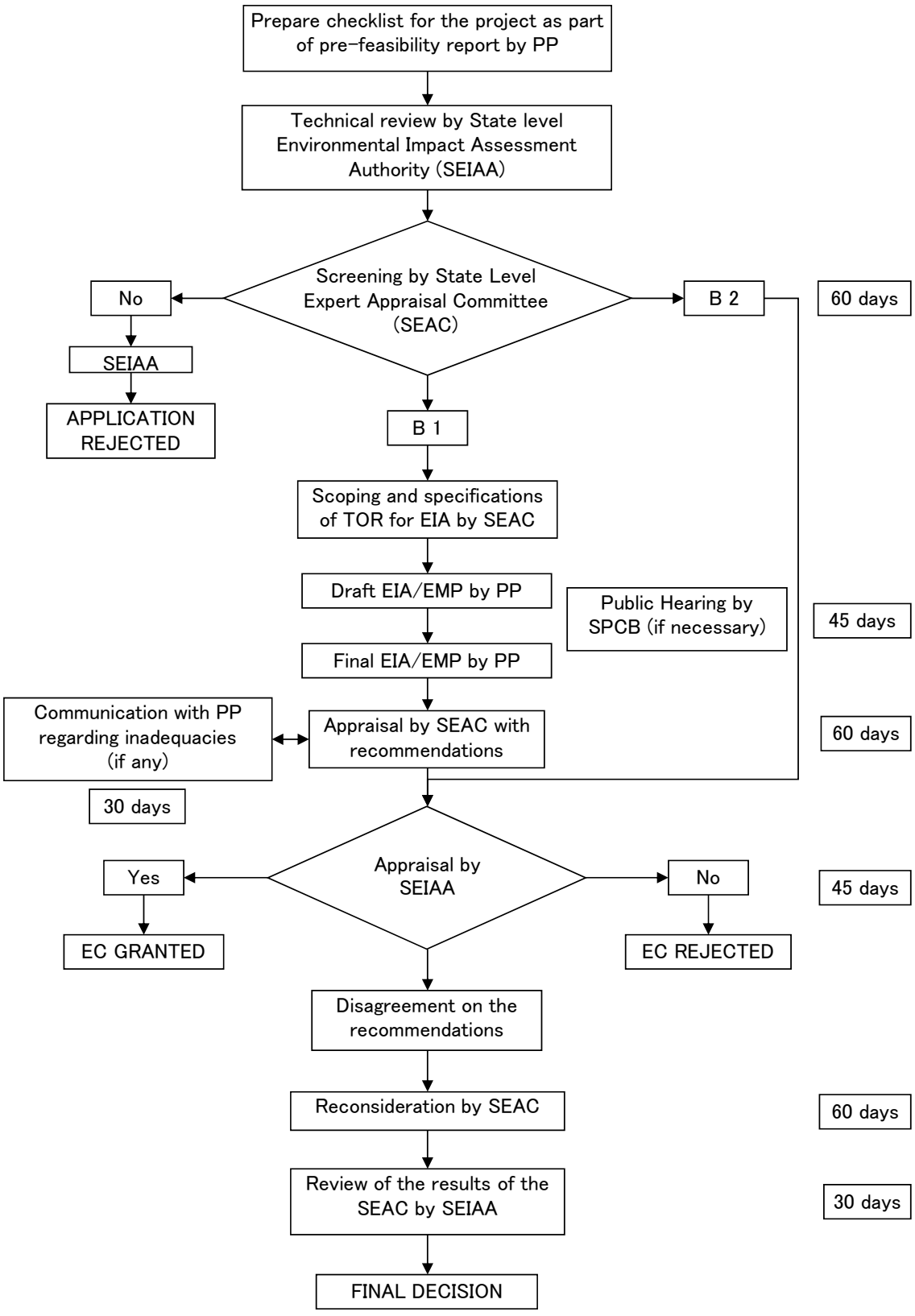
Figure 7.2.6-2 and Figure 7.2.6-3 show the EC procedure of Category A and Category B project respectively.

[26] In case of projects in the Union Territory, Union Territory Pollution Control Committee (UTPCC) conducts the task.



(Source: Notification 2006)

Figure 7.2.6-2 EC procedure of Category A project



(Source: Notification 2006)

Figure 7.2.6-3 EC procedure of Category B project

7) Validity of EC

The "Validity of Environmental Clearance" is meant the period from which an EC is granted by the regulatory authority to the start of production operations by the project or activity. The EC shall be valid for a period of ten years in the case of River Valley projects.

8) Post EC Monitoring

The project management body is required to submit half-yearly compliance reports in respect of the stipulated prior environmental clearance terms and conditions in hard and soft copies to the regulatory authority concerned, on 1 June and 1 December of each calendar year. All such compliance reports are regarded as public documents.

(3) Status of EC procedure of other similar projects in Maharashtra

Malshej Ghat Pumped Storage Scheme (PSS) (600 MW)[27]: As submission of the final EIA report is valid until August 2012, Tehri Hydro Development Corporation Limited (THDC) has requested the Deputy Chief Minister of the State for expeditious approval of the Cabinet of the Government which is mandatorily required for submission of Form A for forest clearance.

Humbarli PSS (400 MW): The PSS is located on the fringe area of Konya Wildlife Sanctuary. The total requirement of land of the sanctuary is 70.80 ha. The State Wildlife Board recommended for conducting survey and investigation works of the PSS in June 2011, and the proposal was forwarded to National Board for Wildlife in August 2011.

After approval of TOR for EIA/EMP studies, a comprehensive EIA/EMP studies are in the process of award.

Ghadghar (250MW): WRD implemented the project. It was planned before Environment (Protection) Act, 1986, and was not required to conduct an EIA under the act. WRD acquired the following clearances[28]:

- Environmental Clearance: MOEF cleared the project in June 1985 (No.J-11015/1/04/KNU.5 dtd.1-6-1985);
- Forest Clearance: MOEF cleared the project in May 1992 (No./8-47/ 90.F.C. dt.7th May-1992);
- Clearance from Planning Commission: In November 1993 by CEA and in August 1994 by Planning Commission Government of India;
- Clearance under Wildlife (Protection) Act, 1972 (Amendment 1991): The project area of the upper portion was cleared from the Kalsubai (Harishchandragad) Wildlife Sanctuary on 17 April 1997; and,

[27] Information on Malshej Ghat and Humbarli PSSs are from the web site of THDC (http://www.thdc.gov.in/English/Scripts/Project_Smallhydro.aspx). The information is as of March 2012.

[28] Field Training Report on Ghadghar Hydropower Project (2008).

- Application of provisions of Rehabilitation Act: The provisions of the Maharashtra Project Affected Persons Rehabilitation Act 1986 were applied in December 1994 by WRD.

7.2.7 Forest Clearance[29]

(1) Forest (Conservation) Act, 1980, and Forest Clearance

Forest (Conservation) Act, 1980, is a regulatory mechanism to protect its rich biodiversity and natural heritage and to permit only unavoidable use of forest land for various developmental purposes. For the smooth implementation of the act, MOEF published "Handbook of Forest (Conservation) Act, 1980 (with amendments made in 1988), Forest (Conservation) Rules, 2003 (with amendments made in 2004) Guidelines and Clarifications (up to June, 2004)". All procedure of Forest Clearance (FC) for diverting forest land for non-forest purposes (i.e. development projects) in the country including the State of Maharashtra are processed and granted according to the handbook.

Regarding "forest land" in the act, the Supreme Court order define "The term "forest land" occurring Section 2, will not only include "forest" as understood in the dictionary sense, but also any area recorded as forest in the Government record irrespective of its ownership" (Supreme Court order dated 12.12. 1996 in WP No. 202/1995).

Regarding diversion of forest land for non-forest purposes in National Parks and Wildlife Sanctuaries, MOEF advised, on 4 May 2001, the State Governments not to submit any proposal for diversion of forest land in these protected areas under the act without seeking prior permission of the Supreme Court based on the two Supreme Court orders: the order dated 13.11.2000 on WP No. 337/1995; and another one dated 14.2.2000 in WP No. 202/1995. The Supreme Court also passed orders on Wildlife (Protection) Act, 1972, stating that no permission under Section 29 of the act should be granted without getting approval of the Standing Committee of Indian Board for Wildlife[30] (the order dated 09.05.2002 in WP No. 337/1995). In view of the above understandings, although diversion of forest land for non-forest purposes in the protected areas are theoretically possible, it is not easy to obtain permission and approval from related authorities.

(2) FC procedure based on the handbook

1) Concerned authorities and their roles

Table 7.2.7-1 shows the concerned authorities and their roles in the FC procedure.

[29] The information of this section is from "Handbook of Forest (Conservation) Act, 1980 (with amendments made in 1988), Forest (Conservation) Rules, 2003 (with amendments made in 2004) Guidelines and Clarifications (up to June, 2004)"

[30] It is now called National Board for Wildlife.

Table 7.2.7-1 Concerned authorities and their roles

Authority and position	Roles
CENTRAL LEVEL	
Regional Chief Conservator of Forests	To examine the documents from Principal Chief Conservator of Forests / Nodal Officer or State Chief Conservator of Forests. To conduct a site inspection if the forest area is over 100 ha.
Forest Advisory Committee	It consists of members from MOEF, Ministry of Agriculture, and three non-official members who shall be experts one each in mining, civil engineering and development economics. To examine the documents from Regional Chief Conservator of Forests.
STATE LEVEL	
Deputy Conservator of Forests (district)	To examine the documents from PP and to examine the concerned forest in the field.
Chief Conservator of Forests (territory)	To examine the documents from Deputy Conservator of Forests.
Principal Chief Conservator of Forests (Nodal Officer)	To examine the documents from Chief Conservator of Forests.
State Chief Conservator of Forests	To examine the documents from Principal Chief Conservator of Forests / Nodal Officer.
State Advisory Group	It consists of representative of the State Government from Revenue Department, Forest Department, Planning and /or Finance Department and concerned Department whose proposal is being examined. To examine the documents from Regional Chief Conservator of Forests or State Chief Conservator of Forests.

2) Conditions for diversion of forest land

Project which requires diversion of forest land for non-forest purposes, the following general and standard conditions are imposed by MOEF to minimize the impact on forest land:

General conditions:

(i) Legal status of forest land to remain unchanged;

(ii) Compensatory afforestation as per guidelines;

(iii) Transfer and mutation of non-forest land in favor of Forest Department, if applicable;

(iv) Notification of such land as reserved forest / protected forest under the India Forest Act, 1927;

(v) User agency to provide fuelwood preferably alternate fuel to the laborers and the staff working at the site so as to avoid any damage & pressure on adjacent forest areas;

(vi) The forest land shall not be used for any purpose other than that specified in the proposal;

(vii) Demarcation of lease area to be done on the ground at project cost using four feet high reinforced cement concrete pillars with serial numbers, forward & back bearings and distance from pillar to pillar;

(viii) Rehabilitation of Project affected families, if any; and

(ix) Environmental Clearance if required.

Standard conditions for hydro and irrigation proposals:

(i) Catchment Area Treatment Plan[31] for medium and major projects[32];

(ii) Minimum requirement of forest land for canals;

(iii) Afforestation along the reservoir & canals;

(iv) No tree felling between Full Reservoir Level (FRL) and FRL−4 meters; and,

(v) Free water for forestry related projects.

3) EC and FC

According to the handbook, EC should be applied for separately and simultaneously with FC if it is required for the project.

4) Reserved forests and FC

The handbook states that reserved forests are considered as good forest with rich biodiversity and being kept intact. It therefore recommends that any proposal for diversion in reserved forests should be very carefully examined and detailed justification after exhausting all alternatives for locating the project in this forest area should be given while forwarding the proposal.

5) Contents of proposal for FC

A PP is required to submit a proposal containing the items described in Table 7.2.7-2.

Table 7.2.7-2 Contents of the proposal

1. Project details.	
	(i) Short narrative of the proposal and Project/Scheme for which the forest land is required; (ii) Map showing the required forest land, boundary of adjoining forest on a 1:50,000 scale map; (iii) Total cost of the project; (iv) Justification for locating the project in the forest area; (v) Cost-benefit analysis (to be enclosed); and, (vi) Employment likely to be generated.
2. Purpose-wise break-up of the total land required	
3. Details of displacement of people due to the project, if any:	
	(i) Number of families; (ii) Number of Scheduled Castes/Scheduled Tribe families; and, (iii) Rehabilitation plan. (to be enclosed).
4. Whether clearance under Environment (Protection) Act, 1986 required? (Yes/No).	
5. Undertaking to bear the cost of raising and maintenance of compensatory afforestation and/or penal compensatory afforestation as well as cost for protection and regeneration of Safety Zone, etc. as per the scheme prepared by the State	

[31] Catchment Area Treatment Plan is formulated to manage the catchment area of project to reduce run-off soil into a reservoir as much as possible. It is prepared by PP.

[32] Regarding the size of dams, MOEF uses the definition by PP. Since the Government of Maharashtra defines a small hydropower project as the one under 25 MW, medium and major projects are understood to be the ones over 25 MW. The definition is stated in "State Hydel Power Policy For Development Of Small Hydro Power Projects through Private Sector Participation: Government Resolution No. PVT-1204/(160/2004)/HP dated 15 September 2005".

Government (undertaking to be enclosed).
6. Details of Certificates/documents enclosed as required under the instruction.

6) Compensatory Afforestation

Compensatory Afforestation is considered to be one of the most important conditions for de-reservation or diversion of forest land for non-forest purposes. The land area for the compensatory afforestation is identified by the state forest department. PP is required to pay the cost of afforestation and Net Present Value (NPV) of the forest land.

Since the compensatory afforestation scheme is site specific, cost of afforestation depends on species, type of forest and site. Deputy Conservator of Forests (DCF) investigates a proposed site and estimates the cost of the afforestation scheme. There is an example of a road project in Pune District which required three (3) ha of forest. Based on the investigation of DCF in May 2011, an estimation of the compensatory afforestation was made at Rs. 131,181 /ha[33].

NPV of forest land is provided by Central Empowered Committee, India, as shown in Table 7.2.7-3.

Table 7.2.7-3 NPV / ha for each forest type (in Rs./ha)[34]

Eco-Value class	Very Dense Forest	Dense Forest	Open Forest
Class I	1,043,000	939,000	730,000
Class II	1,043,000	939,000	730,000
Class III	887,000	803,000	626,000
Class IV	626,000	563,000	438,000
Class V	939,000	845,000	657,000
Class VI	991,000	897,000	699,000

The forests in the Western Ghats are classified as Dense Forest or Open Forest under Class I according to the Forestry Department, Pune. NPV of the forests depends on a proposed site of hydropower project[35].

7) Procedure of FC

Investigation by Deputy Conservator of Forests: A PP submits a proposal to DCF (district level), and DCF examines the proposal and investigates the site. The main items to be investigated by DCF are the following:

- Species-wise (scientific names) and diameter class-wise enumeration of trees. In case of irrigation/.hydro projects enumeration at FRL, FRL −2 m and FRL −4 m;

[33] Information is from the Forest Department Territory Office, Pune, interviewed on 1 August 2012.

[34] Supplementary Report in IA No.826 in IA No. 566 Regarding Calculation of Net Present Value (NPV) Payable on Use of Forest Land of Different Types for Non-Forest Purposes (Central Empowered Committee, 2007)

[35] Information is from the Forest Department Territory Office, Pune, interviewed on 28 March and 1 August 2012.

- Whether forms part of important natural area such as National Park, Wildlife Sanctuary, Biosphere Reserve, Tiger Reserve, elephant corridor. If so, the details of the area and comments of the Chief Wildlife Warden to be annexed;
- Whether any rare/endangered/unique species of flora and fauna found in the area. If so details to be annexed;
- Whether the requirement of forest land as proposed by the user agency in the proposal is unavoidable and barest minimum for the project. If so, recommended area item-wise with details of alternatives examined; and,
- Details of compensatory afforestation scheme.

The report by DCF is attached to the proposal, and all documents are sent to Chief Conservator of Forests (territory) and to Principal Chief Conservator of Forests (Nodal Officer) (PCCF/Nodal).

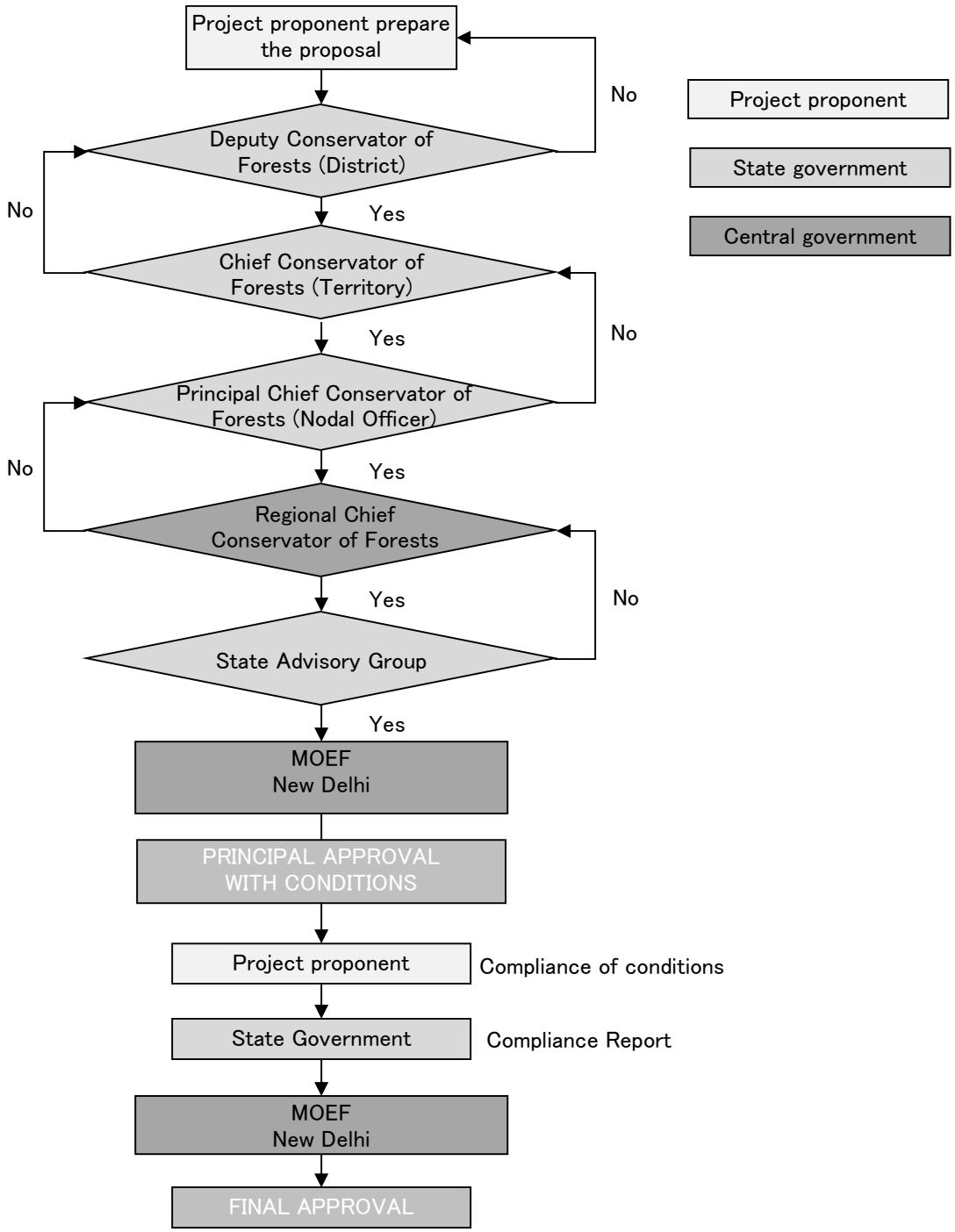
Different procedures depending area required: The procedure from PCCF/Nodal level is different depending on the area of the project.

- Area less than 5 ha: Documents are sent to Regional Chief Conservator of Forests (RCCF), and to State Advisory Group (SAG) for examination. With recommendations of SAG, MOEF receives the documents. After examination of the documents, MOEF issues principal approval with conditions.
- Area from 5 ha to 40 ha: Documents are sent to State Chief Conservator of Forests (SCCF) and to SAG for examination.
- Area over 40 ha: Documents are sent to SCCF, RCCF, and to Forest Advisory Committee (FAC) for examination. If the area is over 100 ha, FAC requests RCCF to conduct site inspection for investigating the site in details.

Approval: MOEF receives the documents from SAG or FAC with their recommendations. After examination of the documents, MOEF issues principal approval with conditions.

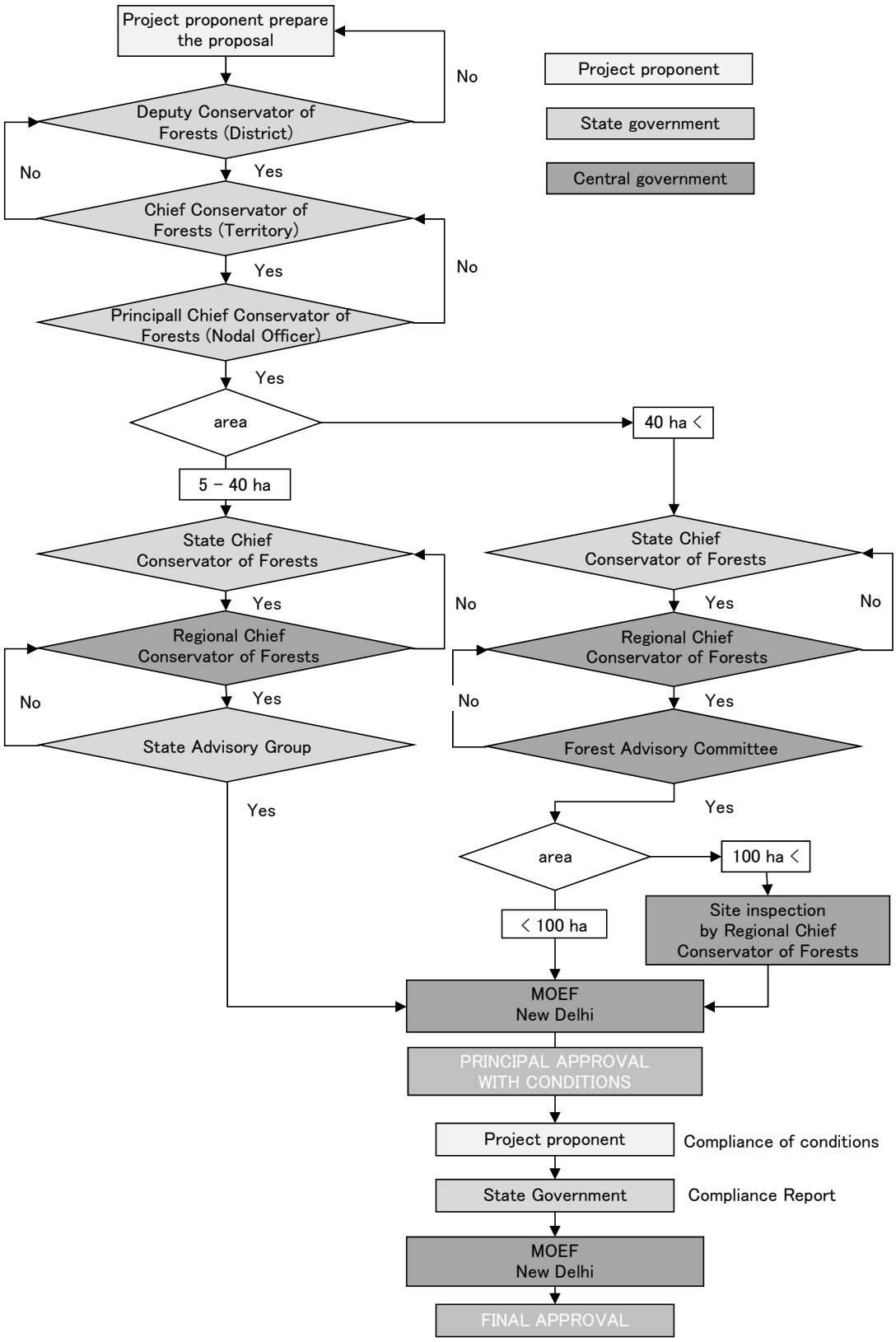
After the principal approval, the PP is required to examine the conditions and send the compliance report to the state. The state submits the compliance report to MOEF and MOEF gives the final approval of FC to the PP.

Figure 7.2.7-1 and Figure 7.2.7-2 show the FC procedures in case of area less than 5 ha and area over 5 ha respectively.



(Source: Handbook of Forest (Conservation) Act, 1980 (with amendments made in 1988), Forest (Conservation) Rules, 2003 (with amendments made in 2004) Guidelines and Clarifications (up to June, 2004))

Figure 7.2.7-1 FC procedure in case of area less than 5ha



(Source: Handbook of Forest (Conservation) Act, 1980 (with amendments made in 1988), Forest (Conservation) Rules, 2003 (with amendments made in 2004) Guidelines and Clarifications (up to June, 2004))

Figure 7.2.7-2 FC procedure in case of area over 5ha

(3) Development under forest (underground development)

All development projects under forest such as a road tunnel and a hydropower project (e.g. power house) need FC[36].

7.2.8 Land Acquisition, Rehabilitation and Resettlement

(1) Legislation on land acquisition, rehabilitation and resettlement

The Land Acquisition Act, 1894, is the principal act that provides for the compulsory acquisition of land for projects for public purpose through public funds. There is not a national act on rehabilitation and resettlement.

The Government of India presented its national rehabilitation and resettlement (R&R) policy in 2006, and submitted "The Draft National Land Acquisition and Rehabilitation & Resettlement Bill" in 2011. It is therefore understood that the Government of India tries to integrate land acquisition and R&R into one act.

On the other hand, each state had taken measures to solve problems induced by land acquisition and adopted policies which were compatible to the social and political pressures existing from time to time.

The Maharashtra Resettlement of Project Displaced Persons Act of 1976 came into force from 11 March 1977. The act has been further amended to effectively implement R&R. R&R in Maharashtra is implemented under the Maharashtra Project Affected Persons Rehabilitation Act, 1999. However land acquisition in the state is covered by the Land Acquisition Act, 1894, and its subsequent amendments.

Since land acquisition and R&R usually happen concurrently, coordination among the relevant authorities and PP is one of the most important activities. While project plan is being prepared, R&R plan should be simultaneously prepared and constitute part of the project itself.

(2) Procedure of land acquisition and R&R in Maharashtra

1) Land acquisition in Maharashtra[37]

Administrative mechanism: The Revenue and Forest Department of the State Government is responsible for taking over the lands for public purpose under the Land Acquisition Act, 1894.

Functions of the Revenue Department of the Revenue and Forest Department are described as follows: its main tasks are recovery of revenue; measuring of lands (land records); and registration of land alienations. Among them, recovery of revenue is the most important task.

[36] Information is from the Forest Department Territory Office, Pune, interviewed on 28 March and 1 August 2012.
[37] The information of this section is from "Land Acquisition Act, 1894".

All the powers in respect of revenue matters are delegated to the Collector[38]. He is the Head of the Revenue Administration and acts as the coordinating officer amongst all officers of the Government Departments in the district. He is empowered to convert the use of land from one purpose to another purpose, and to award compensation under the act.

According to Maharashtra Agricultural Lands (ceiling and holding) Act 1961, a particular ceiling limit is fixed in each district. Thus excess lands can be taken over by the State Government by paying compensation, and disposal of such surplus lands is to be made by the Collector.

For the purpose land acquisition, Special Land Acquisition officers (SLAO; in the grade of Deputy Collector) are appointed and they are given the specific task of land acquisition activity under Land Acquisition Act. Although the powers and functions under this are delegated to SLAOs, the Collector exercises his control over SLAOs and takes review of work done by them.

Procedure of land acquisition: The procedure of land acquisition is described as follows:

(i) A PP is required to prepare detailed plan of the project and tentative drawings showing approximate area of lands to be acquired and information such as concerned villages and project affected persons (PAPs). And the PP submits the documents to the Collector (and/or SLAO).

(ii) A preliminary notification and powers of officers are published in Official Gazette and in two (2) daily local newspapers (at least one in regional language) for public notice that the land is being or required to be needed for public purpose. The date of this notification is regarded as "Cut-off Date".

(iii) Joint Measurements are to be conducted by SLAO, the PP and land owner. The estimated value of land is to be assessed by the Collector and relevant officers. Structures are assessed by the PP, agricultural products and fruit trees by Agricultural Department, trees having forest value by Forest Department. These costs are taken as provisional compensation, and final compensation is paid after declaration of the award.

(iv) Land owner can make objection of land acquisition to the Collector or SLAO. Objections shall be made to the Collector or SLAO in writing by concerned person within 30 days after the issue of the preliminary notification.

(v) Declaration that land is required for public purpose in Official Gazette and 2 daily local newspapers (at least one in regional language), which is a conclusive evidence that the land is needed for public purpose.

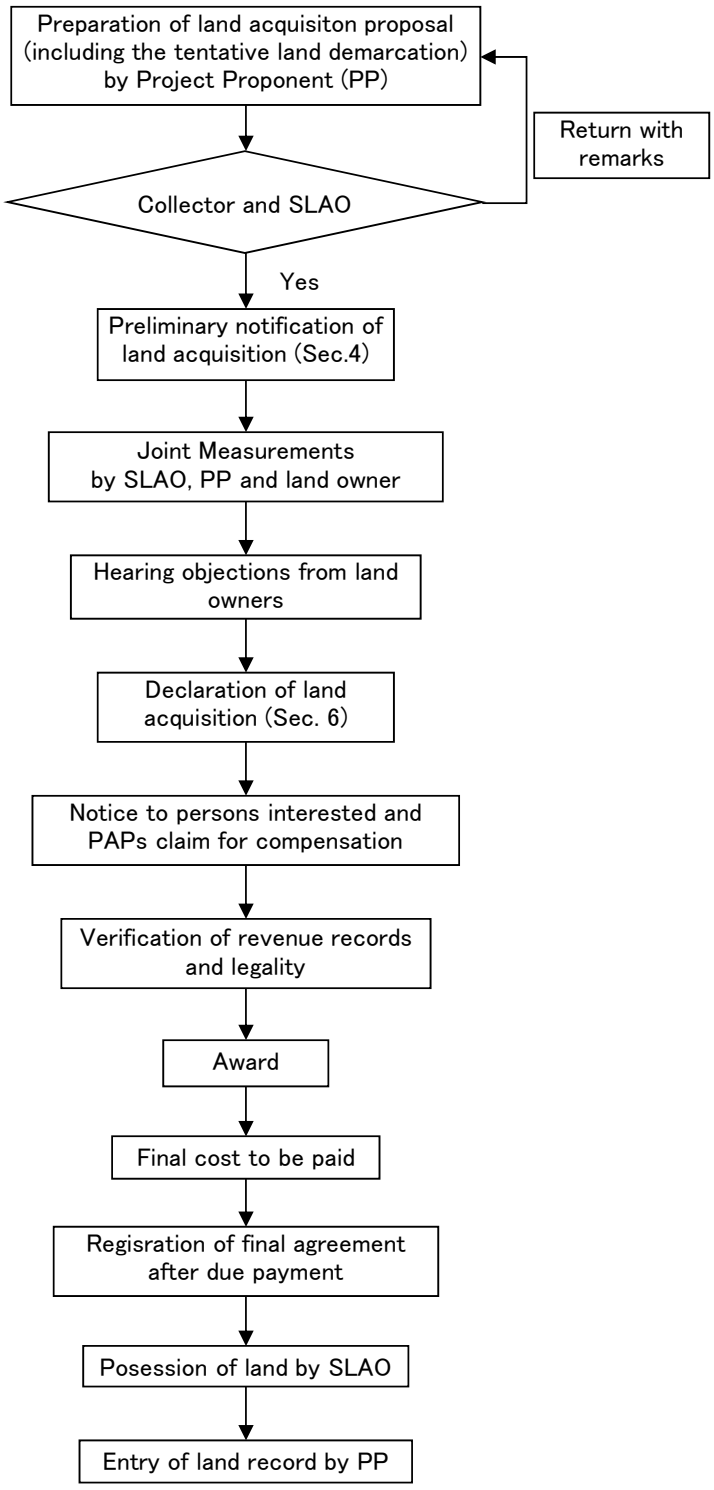
[38] In regard to administration of Indian Forest Act 1927, ultimate responsibility for administration of Forest Department lies with Collector, and Deputy Conservator of Forest is his assistant for the purpose except matters relating to technique of forestry.

(vi) Detailed notices are given to all concerned persons to the land, and revenue records and legality of each land are verified.

(vii) Awards are given to the PAPs and the compensation costs are paid. It includes solatium (30% of the total compensation).

(viii) After registration of the land is made to SLAO, the land is entered to the land record of the PP.

Figure 7.2.8-1 shows the procedure of land acquisition. Section numbers in the figure indicate the sections in the act. The detailed step-by-step procedure corresponding with the related sections of the act is attached as Appendix 7.



(Source: Land Acquisition Act, 1894)

Figure 7.2.8-1 Procedure of land acquisition

2) R&R in Maharashtra[39]

Maharashtra Project Affected Persons Rehabilitation Act, 1999: The act shall preliminarily apply to all irrigation projects where affected area is more than 50 ha or benefitted area exceeds 200 ha or if village gets affected, but it applies to all projects including hydropower development project which have the same conditions.

Basic compensation scheme for PAPs: The State shall provide at the project cost, following public facilities to PAPs in the new villages.

- Drinking water facility (dug well, bore well or piped water supply);
- School with playground;
- Community Building (Chavdi or Samajmandir);
- Internal and approach Roads;
- Electric supply;
- Cremation or as the case may be, burial ground;
- Open built-up gutters;
- Public latrines;
- Land for cattle stand;
- Land for pick-up shed for Maharashtra State Road Transport Corporation bus services;
- Land for threshing floor (khalwadi);
- Pasture land (if Government land is available); and,
- Land for market and future expansion of village.

Alternate land of 80 ares (a) from command of a project in an irrigation project or land prepared by the Revenue Department is allotted to each PAP with additional area of 40 a for every three additional members subject to ceiling of 2 ha and 80 a. Each landless labor is allotted 40 a of land. PAP wise grant of land and plot (for house) to PAPs in rehabilitation villages are shown in Table 7.2.8-1.

An eligible PAP gets a plot of land in a new village and Rs.10,000 as a special grant for construction of house on such a plot. However, PAPs who agree with living in the new villages are required to pay 65 % of compensation award paid under the Land Acquisition Act, 1894.

[39] The information from this section is from "Maharashtra Project Affected Persons Rehabilitation Act, 1999".

Table 7.2.8-1 Land and plot (for house) to PAPs in rehabilitation villages

PAP	Area of Land	Area of Plot
1) An agriculturist		
a) if the number of members of his family does not exceed five.	80 a	370 m^2
b) if the number of members of his family exceeds five	An additional land area of 40 a for every three additional members subject to the ceiling of 2 ha and 80 a in aggregate.	An additional area of 185 m^2 for every three additional members subject to the ceiling of 740 m^2 in the aggregate.
2) A landless labor (i.e. non-agriculturist)		
a) if the number of members of his family does not exceed five	40 a	185 m^2
b) if the number of members of his Family exceeds five.	An additional area of 20 a for every three additional members subject to the ceiling of 80 a in aggregate.	An additional area of 92.5 m^2 for every three additional members subject to the ceiling of 370 m^2 in the aggregate.

Administrative mechanism: From the Revenue Department side, the Commissioner of Revenue Division[40], the Collector of District and Deputy Director Resettlement implement rehabilitation program, co-ordinate and supervise the work of rehabilitation of PAPs, monitor the progress of the work of providing amenities by the project authority, and disbursement of grants. District Resettlement Officer (DRO) from Deputy Collectors is appointed to handle the details of R&R on the ground.

PP furnishes details of affected area and benefitted area of the project to the revenue authorities for issuing notification, and provides amenities in the new village and ensures completion of rehabilitation in advance of the construction stages of the project.

Procedure of R&R: The procedure of R&R is described as follows:

(i) A PP prepares R&R proposal and submits to the Collector. The Collector publishes the preliminary notification of R&R.

(ii) Hearings from the PAPs are conducted to collect objections and suggestions, and the Collector submits the report to the Regional Commissioner. The Regional Commissioner publishes the detailed notification of R&R.

(iii) Within six (6) months from the detailed notification, the Collector prepares the R&R proposal and publishes the notification of the proposal.

(iv) The PAPs are required to decide whether they move to the proposed village or not.

(v) DRO prepares the detailed list of the PAPs who move to the new village with their names, number of family members to determine the resettlement area required.

[40] Divisional Commissioner is the chief controlling authority under the direction of the State Government.

(vi) The PP and Town Planning Department (TPD) calculate the resettlement area for the PAPs for finalizing the resettlement area (new village).

(vii) The Collector and DRO acquire the land for the new village, and DRO and TPD design the details of the new village considering public facilities listed in the previous lines (such as drinking water facility).

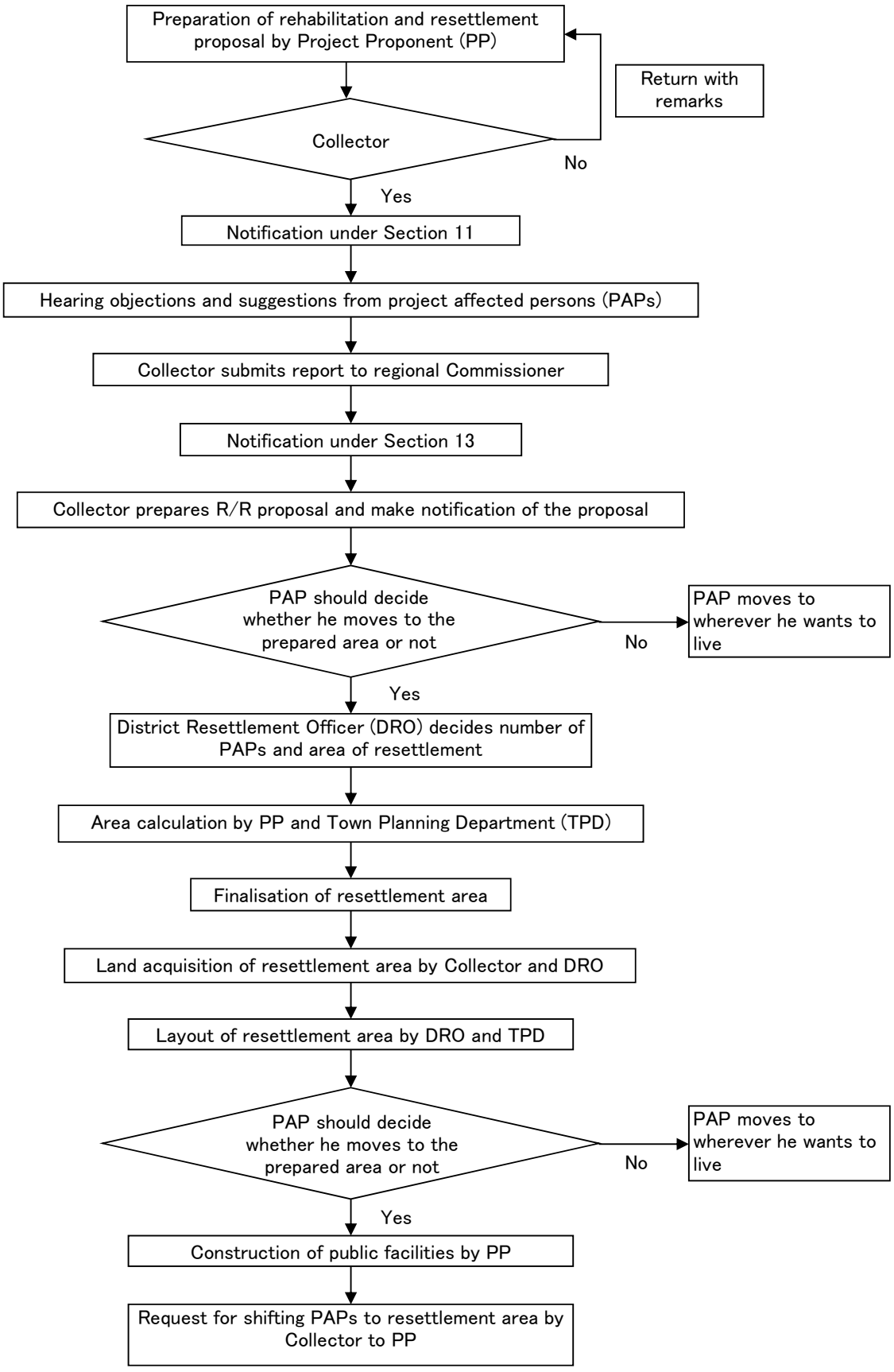
(viii) The PAPs are required to decide whether they move to the proposed village or not. Those who decide to move to the new village are obliged to pay 65% of the compensation award, and they receive Rs. 10,000 for construction of house in the new village.

(ix) The public facilities listed are constructed by the PP.

(x) The Collector requests the PP to transport the PAPs to the new village.

Figure 7.2.8-2 shows the procedure of R&R. Section numbers in the figure indicate the sections in the act.

Grievance Redress mechanism: The State Government can form a committee to deal with complaints from PAPs if required. In the act, there are not any provisions which specify institutional grievance redress mechanism except hearing from PAPs to form R&R plan. During the Study, it is not confirmed that there is a post-project monitoring mechanism on status of livings of PAPs by the state or PP.



(Source: Maharashtra Project Affected Persons Rehabilitation Act, 1999)

Figure 7.2.8-2 Procedure of R&R

(3) Draft National Land Acquisition and Rehabilitation & Resettlement Bill, 2011

As described in "(1) Legislation on land acquisition, resettlement and rehabilitation", the Government of India submitted "The Draft National Land Acquisition and Rehabilitation & Resettlement Bill" in 2011.

The important points on the bill are summarized as follows[41]:

(i) This is the first national / central law on the subject of resettlement and rehabilitation of families affected and displaced as a result of land acquisition;

(ii) The bill is submitted to respond heightened public concern on land acquisition issues, and absence of a national law to provide for resettlement, rehabilitation and compensation for loss of livelihoods; to solve the problem of outdated law, the Land Acquisition Act, 1894; and to respond the concerns of farmer and those whose livelihoods are dependent on the land being acquired while facilitating land acquisition for industrialization, infrastructure and urbanization;

(iii) The bill defines "public purpose" and "urgency clause";

(iv) Affected families involve both land owners and livelihood losers (including landless);

(v) Minimum compensation for land (including assets attached to the land and solatium), rehabilitation and resettlement packages for land owners and livelihood losers are prepared;

(vi) Institutional structure from the central to project levels is established for implementing the activities;

(vii) Safeguards against indiscriminate acquisition are established; and,

(viii) Transparency mechanism is prepared.

"Overview of the Bill" by the Government is presented in a tabular form in Appendix 8.

The Parliament Standing Committee on Rural Development published a report on the bill – 31 Report of the Standing Committee[42] – on 5 May 2012. Based on the comments and suggestions from the various, the Committee took evidences the selected associations/bodies of the farmers, the Industry, State Governments, Central Ministries including the Nodal Department i.e. the Department of Land Resources (Ministry of Rural Development) and the Ministry of Law and Justice, and held several meetings to consider and adopt the draft of the report on the bill in May 2012.

The discussions on the bill in the Central Government including its validity on the ground are still continued as at the end of September 2012.

[41] Based on "Overview of the Draft Bill" attached with "The Draft National Land Acquisition and Rehabilitation & Resettlement Bill (27 July 2011, Ministry of Rural Development)".

[42] http://dolr.nic.in/dolr/downloads/pdfs/Land %20Acquisition, %20Rehabilitation%20and%20Resettlement%20Bill%202011%20-%20SC(RD)'s%2031st%20Report.pdf

(4) WRD (Irrigation Department) and its experiences in land acquisition and R&R

WRD (Irrigation Department) has implemented various projects which involved land acquisition and R&R. The list of these projects is shown as Appendix 9.

(5) Irrigation / hydropower projects and inland commercial fishery

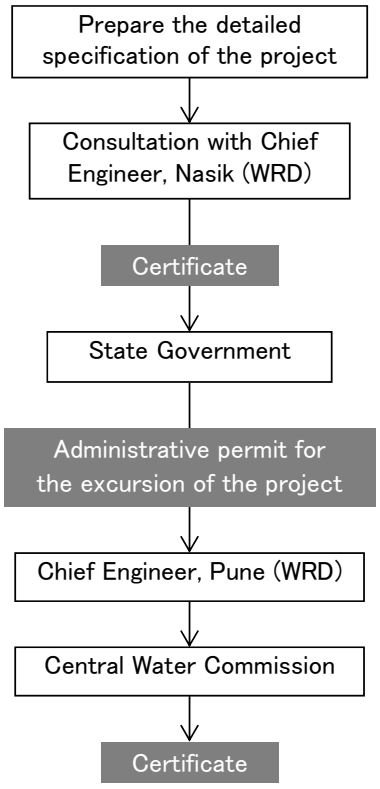
The inland commercial fishery activities in the state are mainly confined to lakes, ponds and artificial reservoirs[43]. Many small rivers are dried up during the dry season, and there are not many commercial fishery activities in the rivers. However the Department of Fishery, Maharashtra, recognizes the rivers are important resources of fishery.

At the moment, irrigation / hydropower projects are regarded as not giving negative impacts on the fishery, and usually providing opportunities for fishery in reservoirs.

7.2.9 Water Utilization Right

(1) Procedure for certificate to use water[44]

The procedure for certificate to use water for a hydropower project in Maharashtra is shown in Figure 7.2.9-1.



(Source: JICA Study Team)

Figure 7.2.9-1 Process of application to use water for a hydro power project in Maharashtra

[43] Website of Department of Fisheries, Government of Maharashtra.
[44] Based on the interviews at WRD, Pune, in April 2012.

(i) WRD prepares documents describing project in details and submits them to the Chief Engineer, Nasik.

(ii) The Chief Engineer examines the contents of the documents. In the case when interstate water right is concerned, the Chief Engineer examines them based on the Krishna Water Disputes Tribunal I report.

(iii) The Chief Engineer issues the certificate of water utilization right for the project.

(iv) The State Government issues the administrative permit for the excursion of the project to the Chief Engineer, Pune.

(v) If the project is subject to funding from the central government, the Chief Engineer, Pune, submits the detailed documents of the project to the Central Water Commission to obtain certificate of the water right.

(2) Legislation on interstate water right

Interstate River Water Disputes Act, 1956 was enacted to resolve the water disputes that would arise in the use, control and distribution of an interstate river or river valley.

(3) Krishna water disputes

Krishna River and its basin[45]**:** It originates in Maharashtra. It then runs for a distance of 299 km (186 miles) in Maharashtra, 483 km (300 miles) in Karnataka and 576 km (358 miles) in Andhra Pradesh before it joins to the Bay of Bengal. There are 42 km (26 miles) of common length (sharing with two states), and the total length of the Krishna River is 1,400 km (870 miles). Total area of the river basin with 28 main tributaries is 258,948 km^2 (99,980 square miles). Table 7.2.9-1 shows areas of the river and its related states.

Table 7.2.9-1 Krishna River basin and related states

State	Area of river basin area
Maharashtra	69,425 km^2 (26.8 %)
Karnataka	113,271 km^2 (43.8 %)
Andhra Pradesh	76,252 km^2 (29.4 %)

Krishna water disputes[46]**:** The Krishna Water Disputes Tribunal (KWDT I or Bachawat Tribunal) was constituted by April 1969 issued by the Government of India for adjudication the water disputes regarding Krishna River and its river valley in Maharashtra, Karnataka and Andhra Pradesh. KWDT I gave its first report on December 1973, and further report on May 1976 containing the final order of the Tribunal.

[45] The Report of the Krishna Water Disputes Tribunal with the Decision, Volume I (Government of India, 1973). The report uses the yard-pound system and the Study Team converts distances and areas in the metric system.

[46] The text of this part is extracted and summarised from "Water Resources Department, Karnataka State Government, Annual Report 2010-2011"

Under Scheme 'A', the allocations are shown in Table 7.2.9-2.

Table 7.2.9-2 Water allocation for each state under KWDT I

State	Share in thousand million cubic feet
Maharashtra	560
Karnataka	700
Andhra Pradesh	800
Total	2060

The Tribunal also allocated the return flow of 70 thousand million cubic feet (tmcf) as, 25 tmcf to Maharashtra, 34 tmcf to Karnataka and 11 tmcf to Andhra Pradesh. KWDT I had also devised the Scheme 'B' to allocate surplus waters available in the Krishna Basin. Under the Scheme 'B', the basin states were earmarked the shares, in the surplus waters available above 2,130 tmcf, as per the following percentages: Maharashtra 25%; Karnataka 50%; and Andhra Pradesh 25%.

All the three basin states respectively filed letter of Complaint for constituting a Water Dispute Tribunal in the matter of sharing of surplus water of Krishna River Basin before the Government of India. Considering the complaints of the basin states, the Central Government issued a Notification on 2 April 2004 constituting the Krishna Water Disputes Tribunal (KWDT II).

KWDT II gave its report on 30 December 2010 based on the availability and estimated quantity of water. Table 7.2.9-3 shows the allocation of water to each state.

Table 7.2.9-3 Water allocation for each state under KWDT II

State	**Share in tmcf**
Maharashtra	666
Karnataka	911
Andhra Pradesh	1,001
Total	2,578

The party states sought certain clarifications under the act over certain issues raised in the report of KWTD II. The Tribunal was yet to clarify them. The state of Andhra Pradesh filed Special Leave Petition before the Supreme Court challenging the KWTD II report, and the case is in progress.

7.3 Western Ghats Ecological Expert Panel[47]

7.3.1 Objectives of Western Ghats Ecological Expert Panel

MOEF constituted the Western Ghats Ecology Expert Panel (WGEEP) on 4 March 2010 because of the importance of the Western Ghats. The expected functions of WGEEP are the following:

- To assess the current status of ecology of the Western Ghats region;
- To demarcate areas within the Western Ghats Region which need to be notified as ecologically sensitive and to recommend for notification of such areas as ecologically sensitive zones under the Environment (Protection) Act, 1986;
- To make recommendations for the conservation, protection and rejuvenation of the Western Ghats Region; and,
- To recommend the modalities for the establishment of Western Ghats Ecological Authority under the Environment (Protection) Act, 1986 which will be a professional body to manage the ecology of the region and to ensure its sustainable development with the support of all concerned states.

7.3.2 Recommendations and proposal from WGEEP

WGEEP submitted their report to MOEF in 2011, and MOEF officially requested the stakeholders' comments /views on 23 May 2012.

The important points of the report are the followings:

- WGEEP has designated the entire Western Ghats as an Ecologically Sensitive Area (ESA) and, assigned three levels of Ecological Sensitivity to different regions of it to conserve the ecosystems in the Western Ghats region. These are termed as Ecologically Sensitive Zone 1 (ESZ1), Ecologically Sensitive Zone 2 (ESZ2) and Ecologically Sensitive Zone 3 (ESZ3);
- Existing Protected Areas are treated as a fourth separate category but given the status of ESZ1,
- WGEEP proposes guidelines/summary recommendations for sector--wise activities in each ESZ; and,
- WGEEP recommends establishment of the Western Ghats Ecological Authority (WGEA) as the Apex multi-statal authority for regulation, management and planning of all activities impacting all categories of ecologically sensitive zones within the states of the Western Ghats namely Gujarat, Goa, Maharashtra, Karnataka, Tamil Nadu and Kerala, and shall be constituted under the relevant provisions of the Environment Protection Act, 1986.

[47] The texts of this section are extracted and summarized from "Report of the Western Ghats Ecological Expert Panel Part I (MOEF, 2011)".

Table 7.3.2-1 and Table 7.3.2-2 show the proposed guidelines and summary recommendations for the power/energy (hydropower activities are included) and quarry and sand mining sectors in each ESZ. WGEEP also proposes these for other sectors such as water use, agriculture, forests and biodiversity and transport. Table 7.3.2-3 and Figure 7.3.2-1 show Talukas assigned to ESZs in the State of Maharashtra.

Table 7.3.2-1 Proposed guidelines and summary recommendations for the hydropower projects in each ESZ

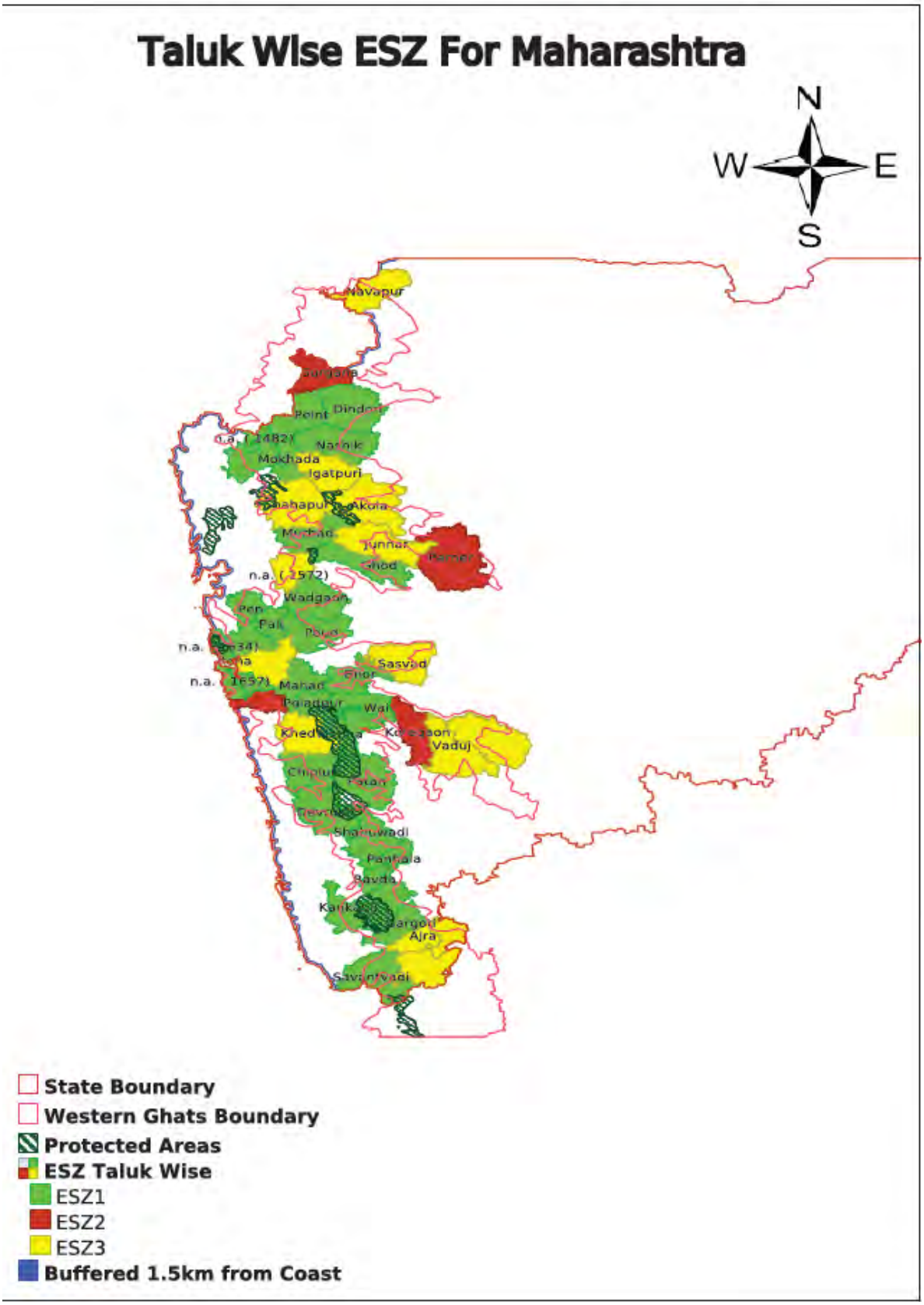
<table>
<tr><th>ESZ 1</th><th>ESZ 2</th><th>ESZ 3</th></tr>
<tr><td colspan="3">No diversion of streams/ rivers allowed for any power projects and if already existing, to be stopped immediately.
Catchment area treatment in a phased manner following watershed principles; continuous non-compliance of clearance conditions for three years would entail decommissioning of existing projects.
Dams and thermal projects that have crossed their viable life span (for dams the threshold is 30-50 years) to be decommissioned in phased manner.
All project categories to be jointly operated by local self governments and Power Boards with strict monitoring for compliance under DECs. (The District Ecology Committees)</td></tr>
<tr><td>Allow run of the river schemes with maximum height of 3 m permissible which would serve local energy needs of tribal/ local communities / plantation colonies subject to consent of gram sabha and all clearances from WGEA, SEA and DECs.
No forest clearance or stream diversion for new projects.
Run of the river schemes not allowed in first order or second order streams.
Promote small scale, micro and pico hydropower systems, that are people owned & managed and are off grid.
New small hydropower projects (10 MW and below) are permissible.</td><td>Small bandharas permissible for local and tribal community use /local self government use.
No new dams above 15 m or new thermal plants permissible.
New hydro projects between 10 - 25 MW (up to 10 m ht) permissible.
All project categories subject to very strict clearance and compliance conditions through SEA and DECs of WGEA.
Have run off the river hydropower projects but after cumulative impact study of the river basin is done.</td><td>Large Power plants are allowed subject to strict environmental regulations including:
1. cumulative impact assessment studies;
2. carrying capacity studies;
3. minimum forest clearance (norms to be set by WGEA); and,
4. based on assessment of flows required for downstream needs including the ecological needs of the River.
Existing Power plants subject to strict regulation and social audit.
For already existing dams reservoir operations to be rescheduled for allowing more water downstream.</td></tr>
</table>

Table 7.3.2-2 Proposed guidelines and summary recommendations for the quarry and sand mining projects in each ESZ

ESZ 1	ESZ 2	ESZ 3
Where exists should be controlled effectively for environmental and social impacts immediately. No new licenses to be given for quarry and sand mining.	Upgradation possible /permitted subject to strict regulation and social audit.	Existing and new quarry and sand mining should be under strict regulations and social audit and without affecting tribal rights.

Table 7.3.2-3 Talukas assigned to ESAs in the State of Maharashtra

District	Talukas assigned to ESZ 1	Talukas assigned to ESZ 2	Talukas assigned to ESZ 3
Ahmednagar		Parner	Akola
Kolhapur	Radhanagari, Gargoti, Shahuwadi, Panhala, Bavda		Ajra, Chandgad, Gadhinglaj
Nandurbar			Navapur
Nashik	Nashik, Peint, Dindori	Surgana	Igatpuri
Pune	Ghod, Paud, Bhor, Wadgaon		Junnar, Sasvad
Raigarh	Mhasla, Pali, Poladpur, Roha, n.a. (1657), Pen, Mahad, n.a. (1634)		Mangaon, n.a.(1572)
Ratnagiri	Devrukh, Chiplun	Mandangarh	Khed
Satara	Medha, Patan, Mahabaleshwar, Wai	Koregaon	Vaduj, Dahivadi
Sindhudurg	Kankauli, Savantvadi		
Thane	Murbad, Mokhada, n.a.(1482), Jawhar		Shahapur



(Source: Report of the Western Ghats Ecological Expert Panel Part I (2011))

Figure 7.3.2-1 Talukas assigned to ESAs in the State of Maharashtra

The report also recommends that MOEF should not give EC and FC to the following two hydropower projects: the Athirappilly project in the Kerala State and the Gundia project in the Karnataka State. This is because both project sites fall in ESZ 1 and also give negative impacts to the surrounding social environment at each project site.

Chapter 8

Candidate Projects

Chapter 8 Candidate Projects

8.1 Selection of Candidate Projects

8.1.1 Existing Candidate Sites

The Study team extracted the candidate sites for survey out from the existing candidate sites in the "Master Plan Study (1998)" and the new sites discussed in this Study. 32 sites were selected in "Master Plan Study (1998)" and 3 sites among them were selected as the promising sites at the time. However no progresses on those sites have been observed since then. The reasons are considered as follows.

The base load power sources have been put higher priority as the power demand growth were significant than ever expected. (GSDP growth marked more or less 10% in 2000s that urged the development of pure new base load power than pumped storage hydropower schemes)

The acquisitions of forest clearance (FC) for the 3 selected sites were difficult (Especially recently FC approval processes has restricted the development strictly that made the progresses of those technically suitable sites difficult.

The existing candidate sites out of "Master Plan Study (1998)" are shown the table below. As more than 10 years have passed since the previous study all these 32 sites have been reviewed again.

Table 8.1.1-1 Candidate Sites in "Master Plan Study (1998)"

	Site	Capacity (MW)	Head (m)	Effective reservoir capacity ($10^6 m^3$)	
				Upper	Lower
1	Ulhas	600	548	4.80	4.80
2	Sidgarh	350	649	2.20	2.20
3	Amba	500	541	4.28	4.28
4	Pinjal	30	129	1.34	1.34
5	Kengadi	160	293	2.50	2.50
6	Kalu	300	545	2.50	2.50
7	Jalond	1,000	576	7.50	7.50
8	Kolmanpada	250	450	2.36	2.36
9	Chornai	480	461	4.55	4.55
10	Savitri	1,000	630	6.50	6.50
11	Madhaliwadi	500	508	4.80	4.80
12	Vaitarni	360	466	3.36	3.36
13	Morawadi				
14	Gadgadi	200	632	1.34	1.34
15	Aruna	440	584	3.28	3.28
16	Kharari	420	613	2.94	2.94
17	Kundi	1,200	600	8.92	8.92
18	Jalware	440	552	3.57	3.57
19	Tillariwadi				
20	TillariForebay	720	550	5.83	5.83
21	Marleshwar	1,200	665	8.68	8.68
22	Valvand	1,200	546	9.36	9.36
23	Shemi	60	185	1.6	1.60
24	Kudanbudrak	450	354	5.53	5.53
25	Kaudoshi	400	448	3.95	3.95
26	Kumbhavde	630	363	7.60	7.60
27	Mundirichi	750	659	5.00	5.00
28	Virdi	660	717	4.00	4.00
29	Bamnoli	1,320	662	8.70	8.70
30	Kinjale	420	642	2.93	2.93
31	Khakharwadi	660	505	5.67	5.67
32	Hevale	960	551	7.64	7.63

(No.13 eliminated due to un-accessibility, No.19 eliminated due to small scale)

(Source: Master Plan Study (1998))

8.1.2 New Candidate Sites

During the study the new candidate sites have also been selected through the data collection and the discussions with the counterpart. The prospecting sites were searched from the Konkan area by dividing it into several geographically prospecting areas. As a result 4 new areas were extracted:

- New No.1 Panshet (4*350MW)
- New No.2 Warasgaon (4*250MW)
- New No.3 Varandh Ghat (2*250MW)
- New No.4 Nandgaon (2*250MW)

The site locations are shown in Figure 8.1.2-1.

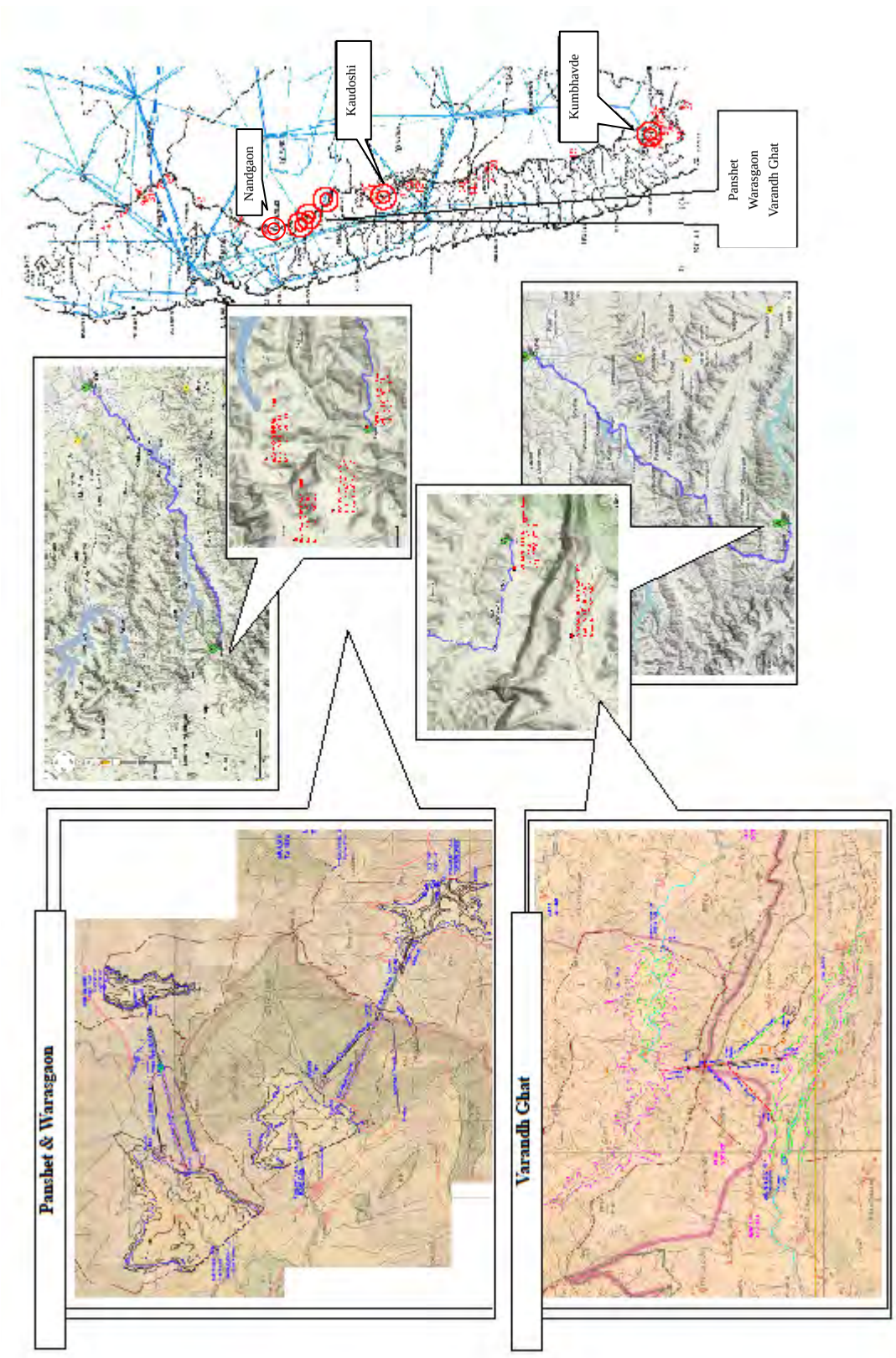


Figure 8.1.2-1 Candidate Sites Location

8.2 Site Selection Criteria

8.2.1 1st Screening

The site selection for reconnaissance survey was carried out from totaling 36 candidate sites (32 existing sites and 4 new sites).

Generally, the evaluation criteria that should be considered are those elements:

- Environmental and Social Considerations:
  Divisions such as Recorded Forest, National Parks, Effects on endangered species, effects on submerged areas (forest, agricultural lands, fisheries, resettlements, cultural heritages, tribal people, roads)
- Economics:
  Preliminary evaluation on the project economies from the historical background data of project costs (construction cost per generation capacity (Inidian Rupee per KW).
- Geology:
  Important but preliminary geological information (such as rock conditions as hardness, weathering, faulting, permeability etc.)
- Site Access
- Transmission lines (distances to the lines)

The below is the example for such evaluation at Master Plan stage Study.

Environmental & Social Criteria
Resettlements
* Larger Impact
* Medium Impact
* Smaller Impact
Forests Affected by Submergence
*Larger
*Medium
*Smaller
Recorded Forests
*Reserved Forests
*Protected Forests
*Unclassed Forests
Protected Lands
*National Parks
*Sanctuaries

Preliminary Economics
Project Cost per KW
*Higher
*Medium
*Lower

Preliminary Geology
*Faults proximity to damsite
*Thick deposits on damsite
*Soft rock foundations
*Hard & Impermeable foundations
*Others

Transmission Lines
*Further Distant
*Medium Distant
*Shorter Distant

Access Roads
*Longer
*Medium
*Shorter

In this Study, it is considered to convey the 2 stages evaluations on the selection of the promising sites.

- Selection of the sites for reconnaissance site survey:
  As a first screening, the criteria such as Environmental and Social Considerations, Preliminary Economics of the site, and Preliminary Geology are settled and applied to the sites.
  After the evaluations on the sites, the Sites for the reconnaissance survey shall be chosen. (8.3)
- Selection of the most promising sites
  Next, After the actual site reconnaissance survey were done, together with the evaluation on "Site Accesses" and "the Transmission lines", the most Promising Site(s) for the development shall be selected. (Chapter 9).

However actually when we commenced the Study, It was discovered that "most of the candidate sites" are still within or borders of the "Reserved Forests". The Reserved Forests are considered to be hard to proceed on the development after the interviews of the Maharashtra government's environmental office or of the counter part personnel.

Also the areas close (within 10km) to the "National Parks" or "Sanctuaries" are also difficult to go on.

Considering such discoveries, We have come to apply the Environmental and Social Criteria listed below "First ", before doing the any other1st Screening, so that the Candidates Sites are eliminated.

- Reserved Forest
- National Park, Sanctuary
- Important Bird Areas (IBAs)

The result of selection is shown in Table 8.2.1-1.

These criteria simply have eliminated :

- 24 Reserved Forest sites
- 9 National Park and Sanctuary sites
- 4 Important Bird Areas (IBAs)

Thus the following 5 sites have been remained for the further consideration such as "Economics of the Site", or "Geology". (Note that the generating capacity is to be revised in the 8.2.3).

- No.25 Kaudoshi (400MW)
- No.26 Kumbhavde (630MW)
- New No.1 Panshet (1,400MW)
- New No.2 Warasgaon (1,000MW)
- New No.3 Varandh Ghat (500MW)

Table 8.2.1-1 The result of site selection for reconnaissance survey

	Location	MW	Upper Dam		Lower Dam		District	Forest	Upper Reserved Forest Area (ha) (1998MP)	Lower Reserved Forest Area (ha) (1998MP)	National Park, Sanctuary	Important Bird Areas IBAs)	1st ellimination
			Latitude	Longitude	Latitude	Longitude							
1	Ulhas	600	18° 51'22.69"N	73° 27'23.62"E	18° 52'5.16"N	73° 24'33.45"E	Raigarh	reserved F.	10	26	none	none	Eliminated
2	Sidghar	350	19° 8'35.65"N	73° 33'37.67"E	19° 8'6.93"N	73° 32'1.59"E	Thane	reserved F.	20	14	none	IBA	Eliminated
3	Amba	500	18° 37'41.08"N	73° 23'59.17"E	18° 37'31.54"N	73° 20'15.24"E	Raigarh	reserved F.	20	20	none	none	Eliminated
4	Pinjal	30	19° 49'51.17"N	73° 23'41.24"E	19° 48'48.00"N	73° 23'2.67"E	Thane	reserved F.	7	3	none	none	Eliminated
5	Kengadi	160	19° 41'17.46"N	73° 32'20.17"E	19° 40'32.13"N	73° 31'19.11"E	Thane	reserved F.		27	none	none	Eliminated
6	Kalu	300	19° 24'45.12"N	73° 45'57.44"E	19° 22'58.66"N	73° 45'16.66"E	Thane	reserved F.	54	15	none	none	Eliminated
7	Jalond	1,000	19° 26'33.33"N	73° 43'6.90"E	19° 24'42.55"N	73° 42'40.84"E	Thane	reserved F.	88		none	none	Eliminated
8	Kolmanpada	250	19° 34'26.23"N	73° 37'37.06"E	19° 33'59.27"N	73° 36'42.68"E	Thane	reserved F.	35	7	none	none	Eliminated
9	Chornai	480	19° 32'45.89"N	73° 37'55.99"E	19° 33'2.78"N	73° 36'19.15"E	Thane	reserved F.	56	10	none	none	Eliminated
10	Savitri	1,000	17° 58'55.85"N	73° 39'26.98"E	17° 58'3.43"N	73° 35'42.33"E	Raigarh	reserved F.	40	39	none	none	Eliminated
11	Madhaliwadi	500	17° 38'15.96"N	73° 42'26.89"E	17° 38'2.53"N	73° 40'5.29"E	Ratnagiri	reserved F.	23	10	Koyna wildlife sanctuary	IBA	Eliminated
12	Vaitarni	360	17° 36'28.13"N	73° 43'25.88"E	17° 36'0.29"N	73° 41'40.92"E	Ratnagiri	reserved F.	25	15	Koyna wildlife sanctuary	IBA	Eliminated
13	Morawadi		Excluded from the study in MP 1998 due to accessesibility								Koyna wildlife sanctuary	IBA	Eliminated
14	Gadgadi	200	17° 8'24.82"N	73° 43'42.12"E	17° 8'42.23"N	73° 40'13.44"E	Ratnagiri	reserved F.	2		near Chandoli Sanctuary	none	Eliminated
15	Aruna	440	16° 26'17.63"N	73° 53'52.08"E	16° 25'29.86"N	73° 48'7.92"E	Shindhudurg	reserved F.	27	23	none	none	Eliminated
16	Kharari	420	15° 51'48.47"N	74° 7'39.62"E	15° 48'40.01"N	74° 7'20.41"E	Shindhudurg	reserved F.		25	none	none	Eliminated
17	**Kundi**	1,200	17° 6'4.11"N	73° 44'27.06"E	17° 6'42.61"N	73° 42'49.38"E	Ratnagiri	none	65	40	near Chandoli Sanctuary	none	Eliminated
18	Jalware	440	15° 39'54.73"N	74° 8'46.06"E	15° 45'58.20"N	74° 4'44.96"E	Shindhudurg	reserved F.	34		none	none	Eliminated
19	Tillarowadi		Excluded from study in MP 1998 due to small development scale								none	none	Eliminated
20	Tillari Forebay	720	15° 48'27.07"N	74° 11'2.87"E	15° 48'36.80"N	74° 9'35.66"E	Shindhudurg	reserved F.	24	50	none	none	Eliminated
21	**Marleshwar**	1,200	17° 5'13.17"N	73° 44'58.84"E	17° 2'57.77"N	73° 46'20.42"E	Ratnagiri	none			near Chandoli Sanctuary	none	Eliminated
22	Valvand	1,200	18° 50'23.45"N	73° 25'2.46"E	18° 51'28.53"N	73° 23'52.17"E	Raigarh	reserved F.	78	67	none	none	Eliminated
23	Shemi	60	15° 49'45.42"N	74° 0'24.00"E	15° 47'50.73"N	74° 1'31.78"E	Shindhudurg	reserved F.	12		none	none	Eliminated
24	Kudanbudrak	450	17° 52'59.09"N	73° 31'46.52"E	17° 52'26.59"N	73° 32'1.53"E	Ratnagiri	reserved F.		15	none	none	Eliminated
25	**Kaudoshi**	400	17° 47'9.57"N	73° 35'56.98"E	73° 34'16.69"E	73° 32'1.53"E	Ratnagiri	none			none	none	
26	**Kumbhavde**	630	15° 51'43.35"N	74° 3'28.60"E	15° 50'38.42"N	74° 1'32.02"E	Shindhudurg	none			none	none	
27	Mundirichi	750	15° 39'39.46"N	74° 12'35.65"E	15° 35'56.24"N	74° 12'54.65"E	Outside of state	none			none	none	Eliminated
28	Virdi	660	15° 40'12.64"N	74° 5'38.00"E	15° 38'48.82"N	74° 4'11.66"E	Outside of state	none			none	none	Eliminated
29	**Bamnoli**	1,320	17° 4'51.00"N	73° 45'45.13"E	17° 3'39.95"N	73° 46'42.02"E	Ratnagiri	none			near Chandoli Sanctuary	none	Eliminated
30	Kinjale	420	17° 10'57.14"N	73° 42'21.73"E	17° 10'55.51"N	73° 40'29.19"E	Ratnagiri	reserved F.	12		near Chandoli Sanctuary	none	Eliminated
31	Khakharwadi	660	19° 30'47.13"N	73° 40'36.20"E	19° 29'53.62"N	73° 39'34.68"E	Thane	reserved F.	30		none	none	Eliminated
32	Hevale	960	15° 49'48.34"N	74° 9'21.83"E	15° 48'34.10"N	74° 9'29.33"E	Shindhudurg	reserved F.	32	50	none	none	Eliminated
1	**Panshet**	1400	18° 20'15.24"N	73° 27'3.10"E	18° 21'27.68"N	73° 24'36.70"E	Pune, Raigad	none			none	none	
2	**Warasgaon**	1000	18° 23'11.94"N	73° 26'8.46"E	18° 22'10.93"N	73° 23'41.48"E	Pune, Raigad	none			none	none	
3	**Varandh Ghat**	500	18° 11'46.15"N	73° 37'15.85"E	18° 10'27.91"N	73° 34'53.60"E	Pune, Raigad	none			none	none	
4	Nandgaon	500	18° 38'8.92"N	73° 23'23.08"E	18° 40'21.09"N	73° 21'37.64"E	Shindhudurg	reserved F.	6		none	none	Eliminated

8.2.2 Environmental and Social Consideration

(1) Criteria for environmental and social considerations

The criteria for the Study are identified to cover both important environmental and social points such as scale of involuntary resettlement. Table 8.2.2-1 shows the criteria.

Table 8.2.2-1 Criteria for environmental and social considerations

Environmental and social criteria
Involuntary resettlement
1. No resettlement is the best 2. Less than 200 people is better 3. More than 200 people is a big impact
Inundated forest area
1. No inundation is the best 2. Less than 40 ha is better 3. More than 40 ha is a big impact
Inundated agricultural lands
1. No inundation is the best 2. Less than 35 ha*is better 3. More than 35 ha is a big impact
Endangered species
Habitats for them or not Recorded or not
Recorded forests
Reserved forests: Within or not
Protected areas and important habitats
National Parks or Sanctuary: Within or not
Important Bird Areas: Within or not
Cultural heritages and/or religious sites
Exist or not
Mining concession
Exists or not

*Note: 0.87 ha is the average area of those who have less than 2 ha of arable land in the State of Maharashtra. An area of 35 ha is about the total land area of 40 households.

(2) Criteria for the selection of reconnaissance survey sites

The selected five (5) candidate sites by the 1st screening are evaluated by the desk study based on the selected criteria in Table 8.2.2-1 as follows:

- Recorded forests;
- Protected areas and important habitats;
- Cultural heritages and/or religious sites; and,
- Mining concession.

For other criteria, sufficient information is not available to evaluate each site. During the site survey, information of other criteria is to be collected as much as possible.

(3) Results of the evaluation

Reserved forests: The same result as the 1st screening: the five (5) candidate sites do not overlap with the reserved forests.

Protected areas and important habitats: the same results as the 1st screening: the five (5) candidate sites do overlap with neither protected areas (National Parks and Wildlife Sanctuaries) nor the Important Bird Areas.

Cultural heritages and/or religious sites: All candidate sites are neither close to nor within the World Cultural Heritage sites. Regarding local heritages, they are to be confirmed by the site survey.

Mining concession: According to the list in the Notification (NO.MLV/MISC/270/2007/96) by Directorate of Geology and Mining, Government of Maharashtra, Nagpur on 07/01/2008, there is no mining concession in the candidate sites except for the Kumbhave site. The Taluka where the Kumbhave site is located have some mining concessions such as silica sand, chromium and nickel.

The results are summarized in Table 8.2.2-2.

Table 8.2.2-2 Evaluation of reconnaissance survey sites

No.	Site name	Remarks for the criteria	Evaluation
1	Panshet	None	○
2	Warasgaon	None	○
3	Varandh Ghat	None	○
4	Kaudoshi	None	○
5	Kumbhavde	There are some mining concessions in the Taluka.	△

Explanation of evaluation

○ No major problem may be expected

△ Some problems may be expected

× Major problems may be expected

8.2.3 Economic Evaluation

Project Costs for selected five candidate site by 1st screening are evaluated. Project cost calculation is carried out according to “The Chapter 6 of Guideline and Manual for Hydropower Development Vol. 1 Conventional Hydropower and Pumped Storage Hydropower, March 2011, JICA”. Main features of projects are decided by following procedure.

(1) Three candidate sites planned by WRD; Phanset, Warasgaon, Varandh Ghat, and two candidate sites from “Master Plan Study on Pumped Storage Hydroelectric Power

Development in Maharashtra State, India; March 1998, JICA; Kaudoshi and Kumbhavde, are subject to the economic evaluation done in this chapter. All of those five candidate sites are located in areas out of wildlife sanctuaries and reserved forests.

(2) Catchment area is measured on obtained topographic maps of which scales are 1/25,000 or 1/50,000.

(3) Reservoir capacity curve is made to measure areas at every contour on topographic map, of which interval is 10 m on a map of 1/25,000 scale and 20 m on that of 1/50,000 scale.

(4) Sediment level is determined under conditions such as for 100 years period, 714 m3./km2/year of specific yield (150acre-ft/100miles/year), horizontal deposit.

(5) Minimum Draw Down Level (MDDL） is set at 12 m above from Sediment level.

(6) Full Reservoir Level (FRL) is determined considering topographic feature of every candidate site, and 30 m of maximum draw down depth limited from slope stability around reservoir.

(7) Effective capacity is taken between FRL and MDDL.

(8) Dam crest is set at 7 m above from FRL considering over-flow depth at spill way and free board.

(9) Based on a weekly operation pattern, the generating operation for Td (hours) defined by following formula is done from Monday to Friday; consequently, water level of Upper Reservoir lowers to MDDL on Friday. On Saturday, generating corresponding to daily pumping operation is done. On Sunday, only pumping up operation is done to FRL. Refer to Figure 8.2.3-1.

$$T_d = (T - J)/D + J$$

Where,

Td : Possible daily generating hours (6.75 hours)

T : Continuous generating capability (storage capacity of pond; 13.5 hours)

J : Possible daily generating hours related to possible daily pumping hours (6.5 hours)

D : Number of days using weekly regulating portion of reservoir capacity (5-day)

(10) Pumping discharge is determined to divide an effective capacity by pumping hours on Sunday. Generating discharge is determined as 85% of pumping discharge based on experiences of past pumped storage schemes.

(11) Rate water level in upper reservoir as well as that in lower reservoir, is set as a water level corresponding to half of effective capacity, which can be roughly assumed to reduce one-third of available depth from FRL as calculated by following formula.

$$RWL = FRL - 1/3 \cdot (FRL - MDDL)$$

Where,

RWL	:	(Upper and Lower Reservoir) Rated Water Level (E.L.-m)
FRL	:	(Upper and Lower Reservoir) Full Reservoir Level (E.L-m)
MDDL	:	(Upper and Lower Reservoir) Minimum Draw Down Level (E.L.-m)

(12) Gross Head is calculated as upper reservoir rated head minus lower reservoir head, and effective head is calculated as gross head minus head loss which is assumed 8 % of gross head.

(13) Maximum output is defined by following formula

$$P = g \cdot \eta \cdot Qp \cdot He$$

Where,

P	:	Output (kW)
G	:	Gravity Acceleration (m/s^2)
η	:	Combined Efficiency of Pump/Turbine (=85%)
Qp	:	Generating Discharge (m^3/s)
He	:	Effective Head (m)

(14) Unit capacity of Pump/Turbine is from 200MW to 400MW.

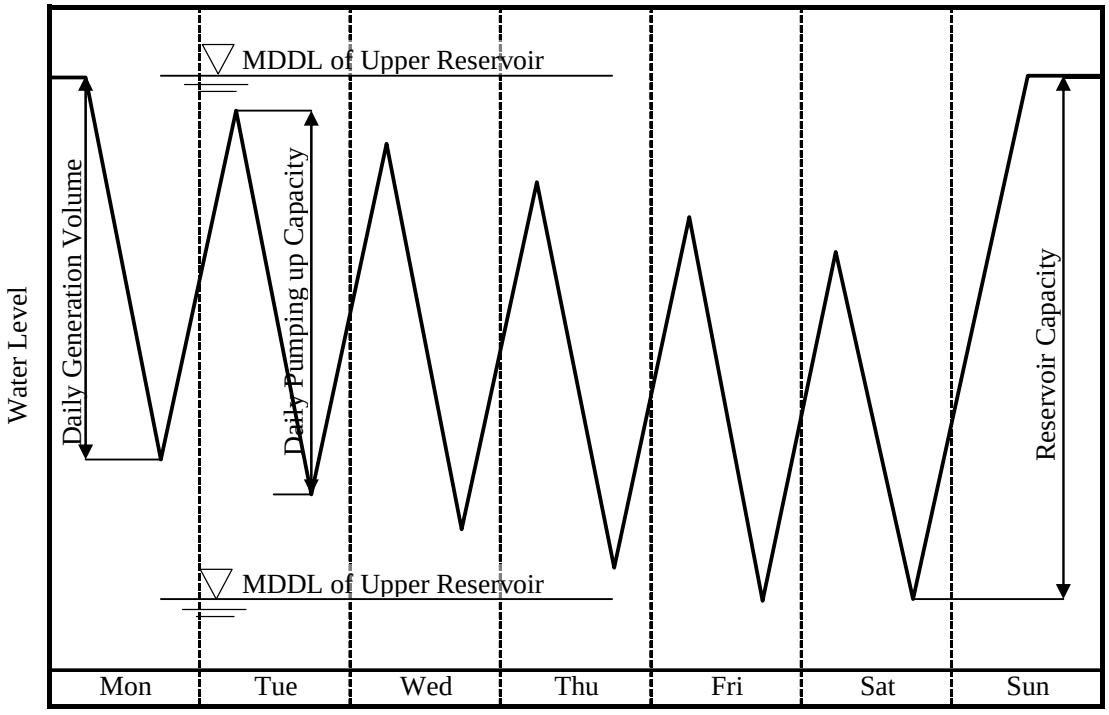


Figure 8.2.3-1 Weekly Reservoir Operation

In addition, following rules are applied to determination of layout of structures and structural parameters.

(1) Inner diameter of headrace tunnels and tailrace tunnels is determined so that water flow velocity is around 6.0 m/s in headrace tunnel and around 5.0 m/s in tailrace tunnel, respectively. As for penstock tunnel, the diameter is also determined so that water velocity is around 10.0 m/s.

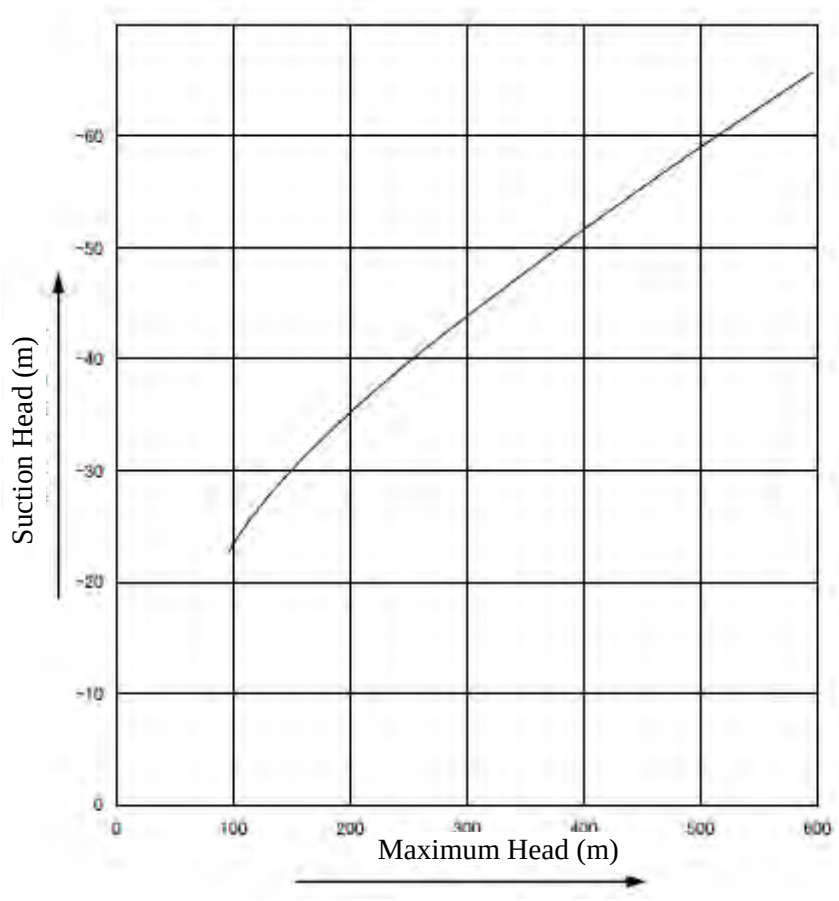
(2) Intake (center of headrace tunnel) elevation and outlet (center of tailrace tunnel) elevation are set so that 1.5 times of tunnel inner diameter can be assured from MDDL.

(3) Surging Tank is to be adopted in case that length of headrace tunnel, as well as tailrace tunnel, is more than 500 m.

(4) Inclined penstock is considered and its inclined angle is fixed as 45°.

(5) 100 m of horizontal length is arranged to both penstock tunnel and tailrace tunnel in upstream or downstream sections from powerhouse cavern.

(6) Setting elevation of pump/turbine is determined so that suction head shown in Figure 8.2.3-2 can be assured.



(Source: Guideline and Manual for Hydropower Development Vol. 1 Conventional Hydropower and Pumped Storage Hydropower, March 2011, JICA)

Figure 8.2.3-2 Suction Head and Maximum Head

As for unit rates for civil works and hydro-mechanical works, unit rates for price level in 2012 are applied to project cost estimation in this chapter, which are provided by WRD. Each unit rate are as shown in Table 8.2.3-1.

Table 8.2.3-1 Unit Rates for Cost of Civil and Hydro-Mechanical Works

Item	unit	Price	Remarks
Excavation			
Common	INR/m^3	100	for Open excavation
Rock	INR/m^3	500	for Open excavation
Tunnel	INR/m^3	2,671	for Horizontal Tunnel
Penstock	INR/m^3	3,450	for Inclined Tunnel, Surge Shaft
Underground	INR/m^3	1,930	for Powerhouse Cavern
Embankment			For fill type dams
Rock	INR/m^3	675	
Filter	INR/m^3	825	
Core	INR/m^3	825	
Concrete			
Mass	INR/m^3	4,066	for RCC Dam
Open	INR/m^3	4,670	for Structure (Intake, Outlet, etc)
Lining	INR/m^3	4,670	for Tunnel
Filling Concrete	INR/m^3	4,100	for Aournd Steel Liner, new one
Foundation	INR/m^3	4,500	not needed
Plug in	INR/m^3	4,500	not needed
Powerhouse	INR/m^3	5,520	for Sub-structure in Powerhouse, new one
Masonry			
UCR masonry	INR/m^3	2,500	
Colg. Masonry	INR/m^3	3,000	
Reinforcing Bar	INR/ton	59,150	
Hydro-Mechanical			
Gate	INR/ton	126,000	
Penstock	INR/ton	270,000	
Trashrack	INR/ton	105,000	

General features of 5 candidate sites and calculated project cost (construction cost per kW) is shown in Table 8.2.3-2.

Table 8.2.3-2 Outline of Project and Construction Cost (to be revised)

No.		25	26	1	2	3
	Unit	Kaudoshi	kumbhavde	Phanshet	Warasgaon	Varandh Ghat
General Feature						
Installed Capacity	MW	300	500	1,400	1,000	1,100
Unit Capacity	MW/unit	300	250	350	250	275
Number of Units	unit	1	2	4	4	4
Generating Dischrge	m^3/s	95.62	183.98	281.89	209.67	220.37
Effective Head	m	403.88	333.04	517.65	500.79	508.45
Generating Hours	hours/day	6.89	6.89	6.89	6.89	6.89
Upper Reservoir						
FRL	EL.-m	617	816	734	692	658
MDDL	EL.-m	590	797	707	663	652
Effective Depth	m	27	19	27	29	6
R.I.W.L	EL.-m	608	810	725	682	656
Gross Capacity	MCM	5.7	9.94	16.22	12.14	36.06
Effective Capacity	MCM	3.95	7.6	13.7	10.19	10.71
Dam Type	-	RCC	RCC	RCC	RCC	RCC
Dam Height	m	61	50	69	58	44
Crest Length	m	220	220	530	520	620
Lower Reservoir						
FRL	EL.-m	179	454	167	140	105
MDDL	EL.-m	149	435	153	134	100
Effective Depth	m	30	19	14	6	5
R.T.W.L	EL.-m	169	448	162	138	103
Gross Capacity	MCM	7.84	11.82	20.54	25.36	24.14
Effective Capacity	MCM	3.95	7.6	13.73	10.36	10.58
Dam Type	-	RCC	RCC	RCC	RCC	RCC
Dam Height	m	63	48	50	37	43
Crest Length	m	440	270	1350	1720	620
Waterways						
Headrace Length	m	1579	1600	917	823	627
Headrace Dia.	m	4.5	6.3	5.95	5.15	5.25
Penstock Length	m	837	716	995	987	981
Penstock Dia.	m	3.5	4.9	4.6	4	4.1
Tailrace Length	m	1600	1700	1300	2050	1200
Tailrace Dia.	m	4.95	6.9	6.5	5.65	5.75
Construction Cost	INR/kW	71,527	43,636	52,594	54,216	44,556

8.2.4 Geology

For the 5 sites screened out of the 36 after the first screening, feasibility of dam construction is discussed from geological aspects.

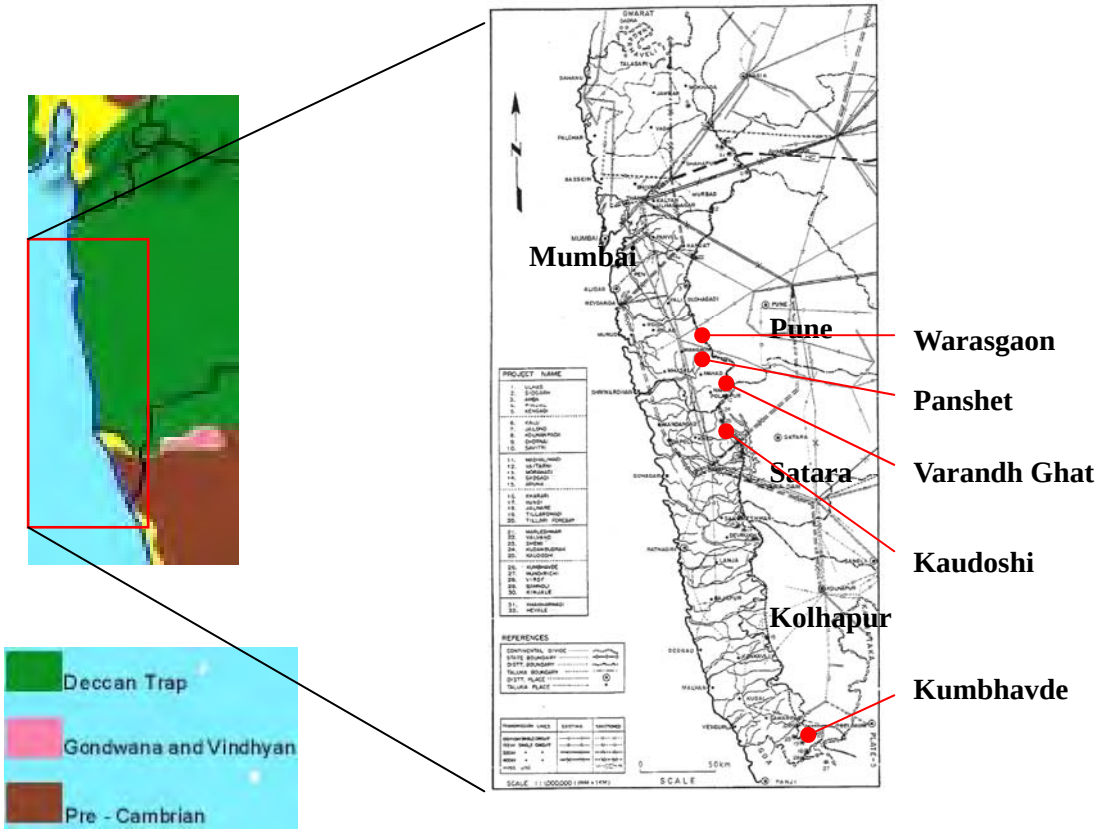


Figure 8.2.4-1 Location and geology of study sites

(1) Geological criteria for a preferable site

i) Solidness of the ground

This primarily means that the geological formations consist of hard rock types. In some cases, deterioration takes place to the extent not to be considered as partial or local. Therefore, in addition to the primary hardness, softening of rocks due to regional weathering, alteration, faulting, and else must be taken into consideration.

It is preferable that the rockhead is dispersed evenly at a shallow depth. Therefore, simple structure without inclination, folding, and faulting is suitable. Also, isotropy, few facies changes, small thickness of covering layers are important.

ii) Low permeability of the ground

Permeability is influenced by the existence and continuity of porosity in the ground. In general, the softer soils and rocks are the more porosity they have, subsequently being permeable. So it

is possible to estimate the permeability of a certain geological body, to some extent, judging from the age and consisting materials.

The permeability of rocks is more dependent on cracks or fractures, which have been acquired afterwards, than porosity with which the rocks have been formed. In other words, permeability is greatly influenced by the openness of the cracks or fractures through which water passes.

(2) Desk study results

The evaluation of the sites was based on the Geological Quadrangle Maps issued by Geological Survey of India. The scale of these maps is basically 1:250,000, and it is the largest scale available for published references. However, duplication of these maps is strictly prohibited.

Since there were not enough information about weathering, alteration, and permeability, the desk study considered the primary petrologic features of the rocks such as hardness, homogeneity, discontinuity, and porosity.

The four out of the five selected sites, other than Kumbhavde, are located within the thickest distribution of the Deccan Traps. The Deccan Traps consist mainly of hard and dense basaltic lava layers. They have almost no fault and fold, and the layers are nearly horizontal. Therefore, sufficient strength and low permeability for dam foundation are expected. And it is concluded that there must be no grave problem for the construction of dams as for the four sites.

On the other hand, Kumbhavde is far from the other 4 sites and is located at the boundary between the Deccan Traps and metamorphic rocks in the southernmost part of Maharashtra. According to “Master Plan Study on Pumped Power Storage Hydroelectric Power Development in Maharashtra State (Mar., 1998)”, metamorphic rocks were distributed at the lower dam site of Havele, which is near Kumbhavde. Geological condition of Kumbhavde is expected to be similar to Havel.

Metamorphic rocks typically show anisotropy and fissility, indicating strong influence by faulting and faulting. This is the reason metamorphic rocks are generally considered inferior to the Deccan Traps. However, metamorphic rocks are usually hard and dense, and the 1998 report pointed out no serious problem for Havel site.

Even the Deccan Traps are not free from problems. For example, the 1998 report pointed out the existence of tachylite, which would decompose on exposure to the air, for Marleshwar site. Incidentally, distribution of tachylite is not considered here, because it is usually sporadic and small in size, so it is unlikely to cause a serious problem. Also, it is difficult to detect the distribution concretely.

From the reasons described above, the 5 sites selected from the first screening are evaluated as the following.

Table 8.2.4-1 Evaluation of study sites

No.	Site name	Reservoir: Geology	Remarks	Evaluation
1	Warasgaon	Upper: Deccan Trap Lower: Deccan Trap	Mainly Basaltic rocks	○
2	Panshet	Upper: Deccan Trap Lower: Deccan Trap	Mainly Basaltic rocks	○
3	Varandh Ghat	Upper: Deccan Trap Lower: Deccan Trap	Mainly Basaltic rocks	○
4	Kaudoshi	Upper: Deccan Trap Lower: Deccan Trap	Mainly Basaltic rocks	○
5	Kumbhavde	Upper: Deccan Trap Lower: Metamorphic rocks	Metamorphic rocks may be present at a shallow depth of the upper reservoir	△

Explanation of evaluation

○ No major problem is expected

△ Some problems are expected

× Major problems are expected

Major problems are not expected for any of the 5 sites, hence each site is thought to be feasible for the construction of dams from geological aspects. Note that Kumbhavde is relatively less preferable, and the remaining 4 sites are equally favorable.

8.3 Site Selection for Reconnaissance Survey

Based on the evaluations on the each factors and after the negotiation with the counterpart, the latter 3 sites out of the 5 screened candidate sites were selected for the reconnaissance survey.

The reason for these sites (Panshet, Warasgaon, and Varandh Ghat) are :

- Their scale of the power capacity : relatively larger
- Preliminary estimate of geology : no particular issues anticipated
- Preliminary economic feasibility : with project cost/MW relatively smaller

From the evaluation work, the Varandh Ghat was evaluated to have a higher generation capacity than initially proposed (from 500MW to be increased up to 1,100MW).

Table 8.3-1 Evaluation Result

No.		25	26	1	2	3
Project Name		**Kaudoshi**	**kumbhavde**	**Phanshet**	**Warasgaon**	**Varandh Ghat**
		All 1st screened in (8.2.1)				
Installed Capacity	MW	300	500	1,400	1,000	1,100
Environmental and Social Considerations		○	○	○	○	○
Economic Evaluation	INR/kW	71,527	43,636	52,594	54,216	44,556
Evaluation of Geology		○	△	○	○	○

The site reconnaissance survey was conducted for these 3 sites (Chapter 9). The preliminary design is to be refined later on (Chapter 10).

- New No.1 Panshet (1,400MW)
- New No.2 Warasgaon (1,000MW)
- New No.3 Varandh Ghat (1,100MW)

Chapter 9

Site Survey on Candidate Sites

Chapter 9 Site Survey on Candidate Sites

9.1 Accessibility to Sites

Accessibility to 5 cansidate sites is to be evaluated in this chapter. Considering transportation of various plant equipment and so on, evaluation is done on the basis of the distance from Mumbai. Difinte evaluation to each site is mentioned as follows.

9.1.1 Panshet

(1) Upper Reservoir

Planned upper reservoir is located in Daspar Village in Pune District and total distance from Mumbai is 226 km as summarized in Table 9.1.1-1.

Table 9.1.1-1 Access to Panshet Upper Dam

	Start	Parting/Goal	Road	Distance (km)
1	Mumbai	Pune	Munbai-Pune Express Way (NH4)	166 km
2	Pune	Site	Karve Rd, Nilkantheshwar Rd	60 km
			Total	226 km

After parting from National Highway 4, the route to the site consists of 60 km of local roads. Study Team stared from Pune in the site survey conducted in the first mission. It was found that local roads were totally paved road, and there were not any major problems to accessibility to the site.

(2) Lower Reservoir

Planned Lower reservoir is located in Sakalyachiwadi Village in Raigad District and total distance from Mumbai is 165 km as summarized in Table 9.1.1-2.

Table 9.1.1-2 Access to Panshet Lower Dam

	Start	Parting/Goal	Road	Distance (km)
1	Mumbai	Indapur	NH 66, NH17	139 km
2	Indapur	Site	SH 97, Kadape Jite Rd	26 km
			Total	165 km

After parting from National Highway 17, the route to the site consists of 26 km of State Highway and local road. Study Team stared from Pune in the site survey conducted in the first mission, and it was found that final 10 km to the site was unpaved. Although rather bad road consition, such as rough road surface and locally steep gradient, etc, were observed, the study team could pass total way with sedan-type cars. Other than this matter, there are not any major

problems to accessibility to the site.

Road map from Mumbai is as shown in Figure 9.1.1-1.

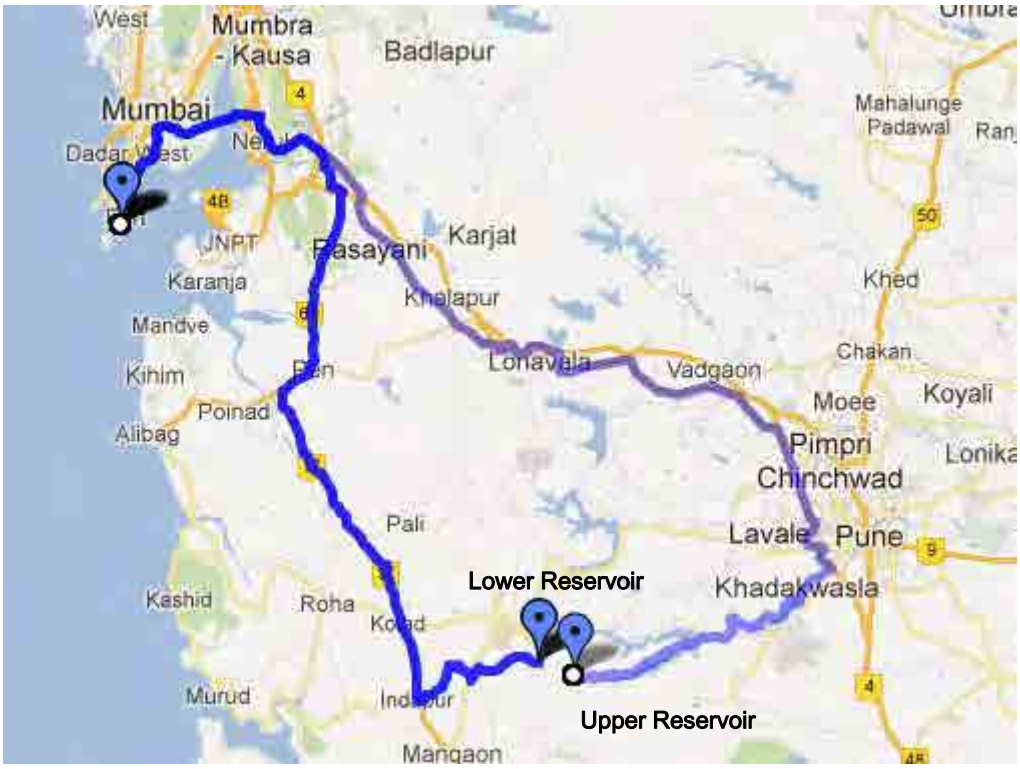


Figure 9.1.1-1 Road Map to Panshet Upper Reservoir and Lower Reservoir

9.1.2 Warasgaon

(1) Upper Reservoir

Planned Lower reservoir is located in Dhamanhol Village in Pune District and total distance from Mumbai is 228 as summarized in Table 9.1.2-2.

Table 9.1.2-1 Access to Warasgaon Upper Dam

	Start	Parting/Goal	Road	Distance (km)
1	Mumbai	Pune	Munbai-Pune Express Way (NH4)	166 km
2	Pune	Site	Paud Rd, SH 57(Temghar Ravasa Rd)	62 km
			Total	228 km

After parting from National Highway 4, the rout to the site consists of 62 km of State Highway 57 and local road. Study Team stared from Pune in the site survey conducted in the first mission, and it was found that final 10 km to the site was unpaved; however, the study team could pass total way with sedan-type cars. Therefore, there are not any major problems to accessibility to the site.

(2) Lower Reservoir

Planned Lower reservoir is located in Umbardi Village in Raigad District and total distance from Mumbai is 166 km as summarized in Table 9.1.2-2.

Table 9.1.2-2 Access to Warasgaon Lower Dam

	Start	Parting/Goal	Road	Distance (km)
1	Mumbai	Indapur	NH 66, NH17	139 km
2	Indapur	Site	SH 97, Kadape Jite Rd	27 km
			Total	166 km

Since planned area of Lower Reservoir is located around 1km beyond Panshet Lower Reservoir, accessibility to the site is almost same condition with that of Panshet.

Road map from Mumbai is as shown in Figure 9.1.2-1.

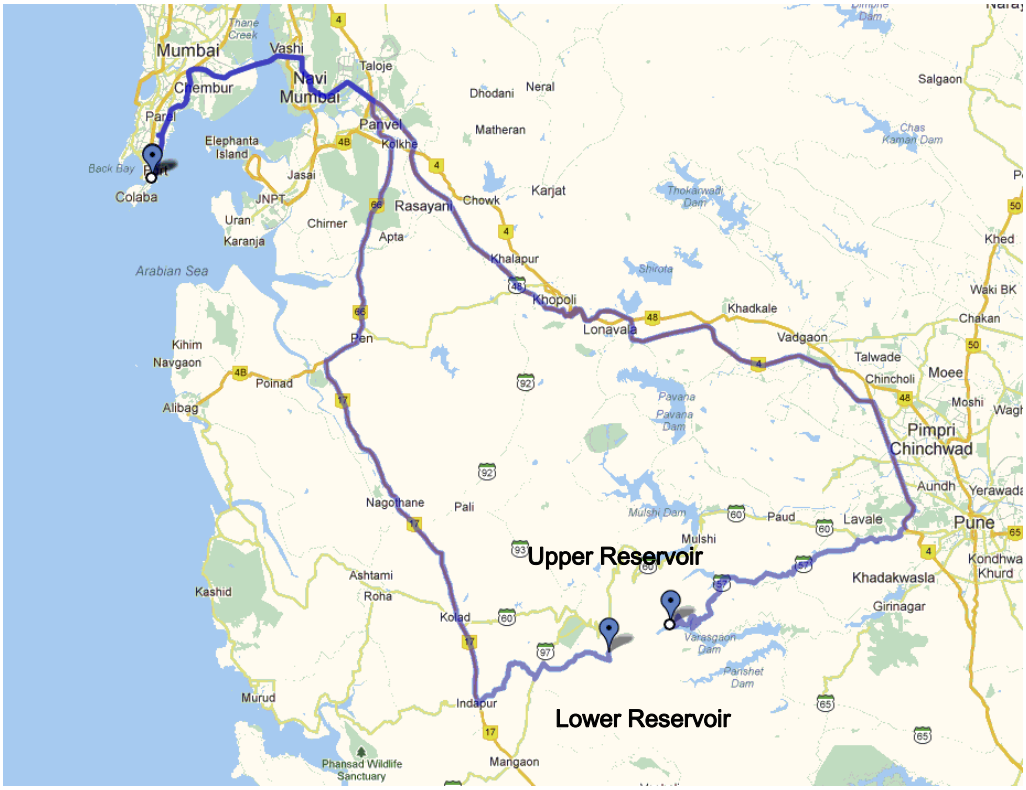


Figure 9.1.2-1 Road Map to Warasgaon Upper Reservoir and Lower Reservoir

9.1.3 Varandh Ghat

(1) Upper Resewrvoir

Planned Upper Reservoir is located in Nigademose Village in Pune District and total distance from Mumbai is 227 km as summarized in Table 9.1.3-1.

Table 9.1.3-1 Access to Varandh Ghat Upper Dam

	Start	Parting/Goal	Road	Distance (km)
1	Mumbai	Pune	Munbai-Pune Express Way (NH4)	170 km
2	Pune	Site	Sinhagat Rd	57 km
			Total	227 km

After parting from National Highway 4, the route to the site consists of 57 km of local road. Study Team stared from Lower Reservoir site in the site survey conducted in the first mission and it was found that there are many sections unpaved in 57 km of Sinhagat Road; however, the study team could pass total way with sedan-type cars. Other than this matter, there are not any major problems to accessibility to the site.

(2) Lower Reservoir

Planned Upper Reservoir is located in Ranewadi Village in Raigad District and total distance from Mumbai is 206 km as summarized in Table 9.1.3-2.

Table 9.1.3-2 Access to Varandh Ghat Lower Dam

	Start	Parting/Goal	Road	Distance (km)
1	Mumbai	Rajewadi	NH 66, NH17	187 km
2	Rajewadi	Site	SH 70, local road	19 km
			Total	206 km

After paritng from National Highway 17, the route to the site consists of 19 km of State Highway and local road. Study Team stared from Mahad in the site survey conducted in the first mission and it was found that final 10 km parting from State Highway 70 was unpaved road; however, the study team could pass total way with sedan-type cars. In addition, local buses passing through the said unpaved road was also observed. Other than this matter, there are not any major problems to accessibility to the site.

Road map from Mumbai is as shown in Figure 9.1.3-1.

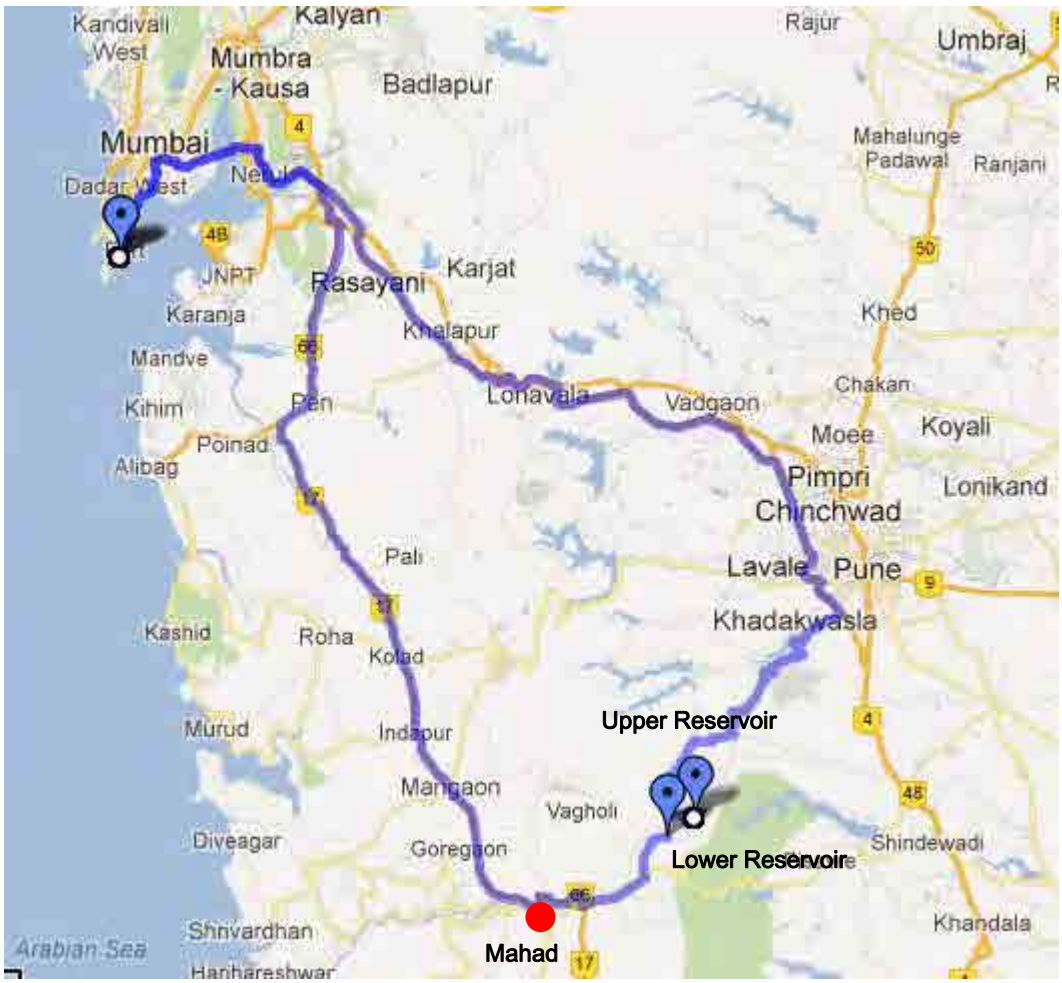


Figure 9.1.3-1 Road Map to Varandh Ghat Upper Reservoir and Lower Reservoir

9.1.4 Kaudoshi

(1) Upper Reservoir

Total distance from Mumbai to the site is 288 km as summarized in Table 9.1.4-1. The site survey was not done to this site.

Table 9.1.4-1 Access to Kaudoshi Upper Dam

	Start	Parting/Goal	Road	Distance (km)
1	Mumbai	Khed	NH 66, NH 17 (Mumbai-Goa Road)	235 km
2	Khed	Site	Shirgaon Uchat Road, etc	53 km
			Total	288 km

According to the map information, after parting from NH 17, route to the site consists of 53 km of Shiragaon Uchat Road, etc. Especially, there seems to be a section with narrow width and along a high cliff, which may make difficult to transporte plant equipment, etc. Accessibility to the site may be inferior as compared with other sites judging from the study on the map.

(2) Lower Reservoir

Total distance from Mumbai to the site is 258 km as summarized in Table 9.1.4-2. The site survey was not done to this site.

Table 9.1.4-2 Access to Kaudoshi Lower Dam

	Start	Parting/Goal	Road	Distance (km)
1	Munbai	Khed	NH 66、NH 17 (Mumbai-Goa Road)	235 km
2	Khed	Site	Shirgaon Uchat Road	23 km
			Total	258 km

As long as it is judged on the map, any roads do not exist to the site for final a few kilo-meters. Except this matter, there seem not to be any major problems to accessibility to the site.

Road map from Mumbai is as shown in Figure 9.1.4-1.

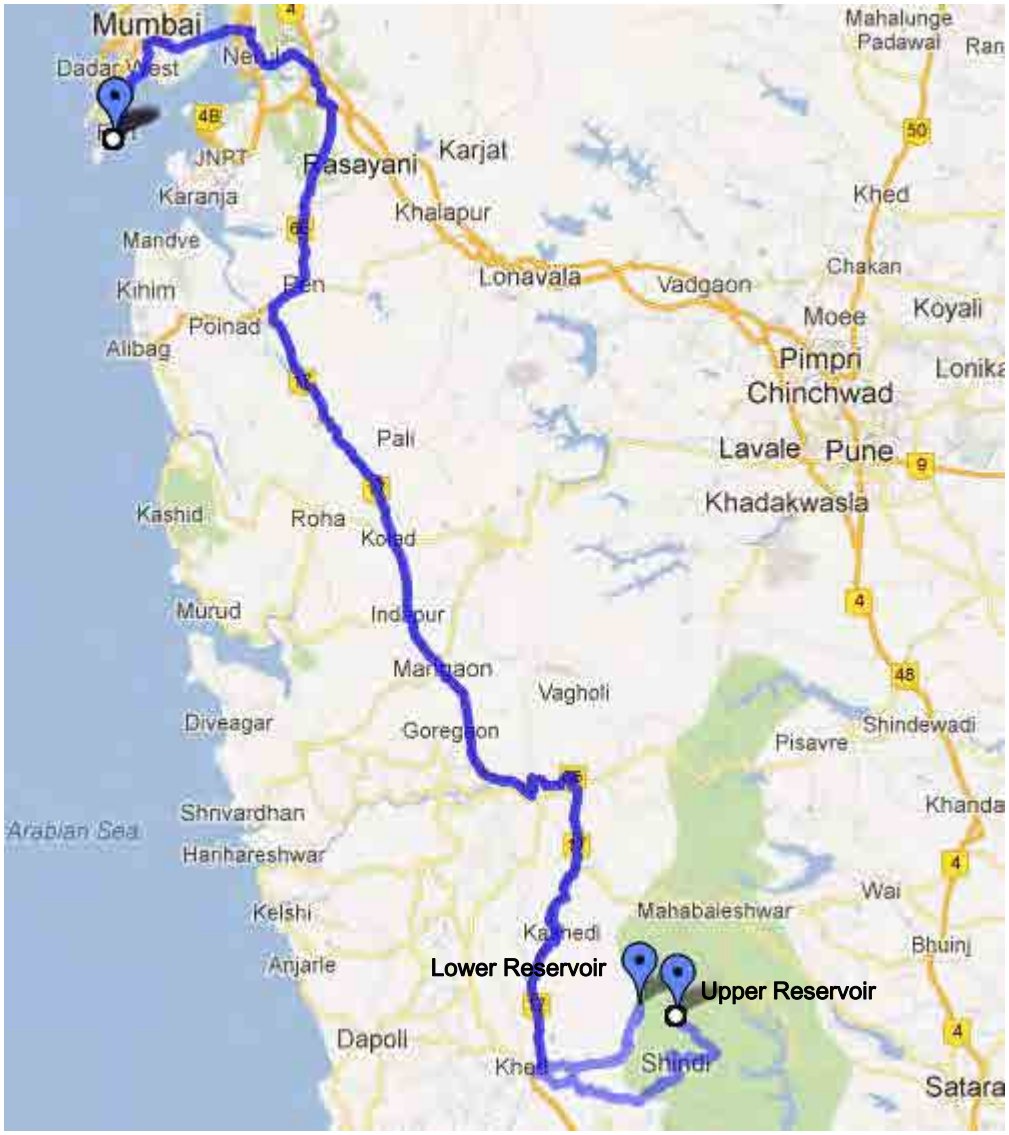


Figure 9.1.4-1 Road Map to Kaudoshi Ghat Upper Reservoir and Lower Reservoir

9.1.5 Kumbhavde

(1) Upper Reservoir

Total distance from Mumbai to the site is 522 km as summarized in Table 9.1.5-1. The site survey was not done to this site.

Table 9.1.5-1 Access to Kumbhavde Upper Dam

	Start	Parting/Goal	Road	Distance (km)
1	Munbai	Tavandi	Pune Express Way, Pune - Bangalore High Way (NH4)	435 km
2	Tavandi	Amboli	Sate HW135, 121 (Nipani-Ajra Link Road)	72 km
3	Amboli	Site		15 km
			Total	522 km

As long as it is judged on the map, there seem not to be any major problems to accessibility to the site.

(2) Lower Reservoir

Total distance from Mumbai to the site is 563 km as summarized in Table 9.1.5-2. The site survey was not done to this site.

Table 9.1.5-2 Access to Kumbhavde Lower Dam

	Start	Parting/Goal	Road	Distance (km)
1	Munbai	Tavandi	Pune Express Way, Pune - Bangalore High Way (NH4)	435 km
2	Tavandi	Swantwadi	Sate HW135, 121 (Nipani-Ajra Link Road)	101 km
3	Swantwadi	Bifurcation	NH 66 (Mumbai-Goa Rd), SH124	15 km
	Bifurcation	Site		12 km
			Total	563 km

As long as it is judged on the map, there seem not to be any major problems to accessibility to the site.

Road map from Mumbai is as shown in Figure 9.1.5-1.