FINAL REPORT

PROJECT FORMATION GUIDANCE
FOR
IMPROVEMENT OF POWER INFRASTRUCTURE
IN URBAN AREA OF RAJASTHAN
IN
THE REPUBLIC OF INDIA

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JAPAN INTERNATIONAL COOPERATION AGENCY

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Abbreviation

AC	Alternate Current
ADB	Asian Development Bank
AfD	French Agency for Development
AFDS	Automatic Fault Detection System
AG&SP	Accelerated Generation and Supply Programme
APDRP	Accelerated Power Development and Reforms Programme
AT&C Losses	Aggregate Technical and Commercial Losses
AVR	Automatic Voltage Regulator
AVVN	Ajmer Vidyut Vitran Nigam Ltd.
B/C	Benefit / Cost
BHEL	Bharat Heavy Electricals Ltd.
CDM	Clean Development Mechanism
CPCB	The Central Pollution Control Board
CPI	Consumers Price Index
DC	Direct Current
DEG	Diesel Engine Generator
DFID	Department for International Development
DISCOM	Distribution Company
DMIC	Delhi-Mumbai Industrial Corridor
DMIDC	Delhi Mumbai Industrial Corridor and Development Corporation
DOE	Department of Energy
DRUM	Distribution Reform, Upgrades and Management
DSCR	Debt Service Coverage Ratio
DSM	Demand Side Management
EAC	Expert Appraisal Committee
EB	Early Bird Project
EC	Environment Clearance
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EPC	Engineering Procurement and Construction
ESCO	Energy Service Company
EU	European Union
F/C	Foreign Currency
F/R	Final Report
F/S	Feasibility Study
FIRR	Financial Internal Rate of Return
FY	Fiscal Year
GAIL	Gas Authority of India Ltd.
GDP	Gross Domestic Product
GE	General Electric Company
GNI	Gross National Income
GoR	Government of Rajasthan
GTZ	Gesellschaft fuer Technische Zusammenarbeit

IBRD	International Bank for Reconstruction and Development
Ic/R	Inception Report
IDA	International Development Association
IEA	International Energy Agency
IDC	Interest During Construction
IEEE	The Institute of Electrical and Electronic Engineers
IOCL	Indian Oil Corporation Ltd.
IPP	Independent Power Producer
IRR	Internal Rate of Return
It/R	Interim Report
JBIC	Japan Bank for International Corporation
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
JoVVN	Jodhpur Vidyut Vitran Nigam Ltd.
JV	Joint Venture
JVVN	Jaipur Vidyut Vitran Nigam Ltd.
KEPCO	The Kansai Electric Power Co., Inc.
KfW	Kreditanslat fur Wiederufbau
L/C	Local Currency
LE	Life Extension Programme
METI	Ministry of Economy, Trade and Industry of Japan
MHI	Mitsubishi Heavy Industries Ltd.
MOFA	Ministry of Foreign Affairs of Japan
MOEF	Ministry of Environment and Forest
MOF	Ministry of Finance
MOP	Ministry of Power
MoU	Memorandum of Understanding
NEDO	New Energy and Industrial Technology Development Organization
NIC	Neemrana Industrial Complex
NTPC	National Thermal Power Corporation Ltd.
ODA	Official Development Assistance
OECD	The Organisation for Economic Co-operation and Development
ONGC	Oil and Natural Gas Corporation
PPP	Public Private Partnership
PV	Photovoltaic
PSVR	Power System Voltage Regular
RAPP	Rajasthan Atomic Power Project
RIICO	Rajasthan State Industrial Development & Investment Corporation Ltd.
ROE	Return of Equity
RVPN	Rajasthan Rajya Vidyut Prasaran Nigam Ltd.
RVUN	Rajasthan Rajya Vidyut Utpadan Nigam Ltd.
R&M	Renovation & Modernization Programme
S/S	Substation
SEAC	The Statement Expert Appraisal Committee
SEIAA	The State Environment Impact Assessment Authority
SPCB	The State Pollution Control Board

SPS	Special Protection Scheme
TEPCO	The Tokyo Electric Power Co., Inc.
TOR	Terms of Reference
U.K.	United Kingdom
UPS	Uninterruptible Power Supply
USA	United States of America
USAID	The United States Agency for International Development
WACC	Weighted Average Cost of Capital
WB	World Bank
WHmeter	Watt-hour meter

Unit

%	Percentage
A	Ampere
cct	Circuit
db	Decibel
GW	Gigawatt (=1,000 MW = 1,000,000 kW)
GWh	Gigawatt – hour (=1,000 MWh = 1,000,000 kWh)
HP	Horse Power
Hrs	Hours
Hz	Hertz
INR	Indian Rupee
JPY/JPN Yen	Japanese Yen
km	Kilo-meter
km^2	Square kilometer
kV	Kilo Volt
kVA	Kilo Volt Ampere
kW	kilowatt
kWh	Kilowatt - hour
m	Meter
mm	Millimeter
Mtoe	Million tonne of oil equivalent
MVA	Mega Volt Ampere (= 1,000 kVA)
MW	Megawatt (= 1,000 kW)
MWh	Megawatt - hour (= 1,000 kWh)
Nos	Numbers
sq	Square millimeter
TWh	Terawatt - hour (=10^9 kWh)
US$	United States Dollar
V	Volt

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background of Study

In the Republic of India (hereinafter called as India), it has been increasing the demand for infrastructure improvement such as electric power, water services, and traffic in major cities accompanying rapid growth of economy in late years (growth rate of 8.6% in FY 2010). The government of India indicates that investment to infrastructure for the amount of approximately US$ 1,000 billion will be required including private funds in order to keep the annual growth rate of 10% during the 12th five-year plan (2012-2017), but actually infrastructure improvement is delayed because of issues such as political decision-making and complicated systems.

JICA (Japan International Cooperation Agency) has been assisting India with ODA (Official Development Assistance) for the amount of approximately 1,000 billion Japanese Yen in total mainly for power sector of generation, transmission, and distribution of electricity in order to supply stable and sufficient electricity to meet the increasing demand. JICA is planning to provide not only such assistance but project coordination contributing to countermeasures against climate change such as new and renewable energy, energy conservation, etc.

However, India is still facing serious shortage of electricity due to delay of infrastructure improvement as described above. Actually, many Japanese manufacturers in India have to install their own diesel power generators and bear the higher cost of electricity because of frequent power failure and unstable power voltage of public electricity.

The concept of Delhi-Mumbai Industrial Corridor (DMIC) has been agreed between the governmental officials of Japan and India. Beginning with the Yen Credit project for the Mass Rapid Transport System between Delhi and Mumbai, development of infrastructure surrounding the DMIC areas is promoted intensively by private sector's participation and investment under facilitation of both governments.

The Memorandum of Understanding (MoU) among Delhi-Mumbai Industrial Corridor and Development Corporation (DMIDC), Japan External Trade Organization (JETRO) and Japanese companies concerned on the four Feasibility Study (F/S) projects of "Smart Communities and Eco-friendly Townships" has been agreed in December, 2009. The F/S on the multi-sectional improvement of urban infrastructure development such as electric power, water and sewerage, and urban transport has been implemented.

From the perspective of development and improvement of urban infrastructure to sustain economic bases of the DMIC area, stable power supply is essential.

1.2 Objective of the Study

This Study is carried out for which the result is used for forming the cooperation project by JICA considering the situation of power infrastructures, in urban area of the DMIC regions (Delhi, Uttar Pradesh, Haryana, Gujarat, Rajasthan, Madhaya Pradesh, Maharashtra) where the large power demand is expected with the growth of economy in the future, such as generation plant (regardless of power source), transmission and distribution lines, energy saving, method of fund-raising, contribution to measures on climate change. To be more precise, the following study will be conducted.

1) Collection of data and information on power sector infrastructures in the cities and areas of DMIC such as master plan, development program, legal system and legislations from the related organizations, and review those documents and select the issues to be studied considering the necessity and urgency of solutions.

2) To improve the issues selected in 1) above, propose the advanced Japanese technologies which can be applicable to the cooperation projects to be supported by JICA.

3) Considering the technologies proposed in 2) above and the result of interview survey of the authorities concerned, propose specifically the cooperation projects which are to be feasible to be implemented in the objective city and/or area.

1.3 Approach for the Study Execution in Terms of Technical Side

(1) Select the objective area where the Japanese affiliated-firms are expected to move in and also suitable to contribute to improve the power infrastructures

The objective areas in this Study are the urban areas and regions of DMIC (Delhi, Uttar Pradesh, Haryana, Gujarat, Rajasthan, Madhaya Pradesh, and Maharashtra).

As the study period is limited to only five (5) months and each State has different policy on power sector development, and the development and improvement of power infrastructures are done by the respective States, it is necessary to determine the objective area before commencement of the Study.

Neemrana Industrial Area in Rajasthan and its surrounding area were selected here as the objective area for the Study taking into account of the following reasons.

1) Japanese-affiliated firms are expected to move in.

- The Neemrana Industrial Area of Rajasthan State is designated as the recommended area for investment in DMIC.
- The Neemrana Industrial Area is located along the national road No.8 connecting Delhi with Nhava Sheva Port and is about 120 km from Delhi. The area is near Delhi and quite convenient, thus, the investment from Japan will be expected.
- The Neemrana Industrial Area is the first industrial area in India exclusively developed for Japanese-affiliate firms, and more than 20 firms decided to establish the factories in the industrial area.

2) This area is necessary to improve the power infrastructures.

- India falls into a chronic deficit of power supply. As of February, 2006, power demand was 575 billion kWh, while the supply capacity was only 528 billion kWh, i.e. 47 billion kWh (8.3%) short in power supply. In the Neemrana area, power interruption occurs several times a month without a prior notice.
- Surplus rate of power supply in Rajasthan State only at about 5%, which is far below the desirable surplus of 25 to 35%.
- In Rajasthan State, several industrial areas are being developed other than Neemrana area, therefore, the stable power supply becomes a big issue.

(Source: JETRO/METI 2006 Report)

Power system in India covers a large supply area and the voltage levels of the trunk lines are composed of AC 500kV/275kV lines and DC 500kV lines. However, to cope with the upgrading of social life of people and the rapid increase of power demand, the expansion of power system is planned to be implemented.

Infrastructures for logistics, etc. are well developed in the areas within the DMIC. It is expected further growth and development in the future if more Japanese-affiliated firms established factories in those areas. There are many Japanese-affiliated firms establishing factories or decided to move in to the Neemrana Industrial Complex (NIC), however, the quality of electricity is lower than expected by these firms. The development of the new power plant for the NIC is proceeding to address low quality of electricity. On the other hand, it is also expected that the quality of power supply from the existing power plants will be improved. To cope with such an issue, it is necessary to propose the Project introducing an advanced technology for system stabilization and setting out to construct the power system which will meet the requirements of consumers for the development of effective power system.

(2) In formation of the Project, Private-Public-Partnership is considered to be a principle and roles of each player are clarified

Improvement of power infrastructures is divided into two approaches, i.e. "Improvement on Power Supply Capacity (building-up of facility)" and "Improvement of Quality of Electricity". To meet the increasing power demand and to support the economic growth in Rajasthan, the local government of Rajasthan decides a policy to promote private investments in power sector. In case the installed capacity of thermal power plant is over 125MW and more than 50% of generation is supplied to the grid system in Rajasthan, the local government gives incentives of tax holiday, priority water use rights, etc.

Under such circumstances, a group of Japanese consortium has just commenced a feasibility study for a smart community project for the NIC composed of power, water treatment and logistics information technology. Therefore, the improvement of power supply capacity leaves the private investment.

(3) Considering the dissemination of applied advanced technology, select the sustainable technologies in conformity with the needs of the area

Japan has a lot of advanced technologies on the improvement of quality of electricity from the viewpoints of technical (hard and soft), financial, durability and maintenance.

In Rajasthan State, the improvement of power system is very necessary for the stable power supply, and the following advanced technologies are considered to be applied.

- Solution on suppression of short circuit capacity of the power system
- Stability improvement countermeasures of the power system
- Solution voltage instability of power system

In the application of advanced technologies, plural numbers of technology which is achievable may be proposed. Combining these technologies, the concrete project plan is finally proposed comparing the technical features and advantages.

(4) Assess the sustainability of the Project in detail, and propose the Project effectively utilized for ODA scheme such as Yen Credit, Technical Assistance and Dispatch of Expert

Improvement of quality of electricity is closely related to the cooperation of policy assistance, development of facility, technical assistance, training and education, etc., and the effect of the Project will be demonstrated, continued and developed to the fullest extent.

Studying in detail of the applicability to the objective area, advantages, finance, maintenance, update and renovation of facilities, technical transfer, etc., necessary assistance to secure the sustainability of the backbone project will be discussed. In this Study, utilizing the ODA scheme of the Japanese government, the appropriate assistance is proposed as the result of the Study. Envisaged assistance at present are technical cooperation, soft component assistance such as operational assistance, training and capacity building by dispatching expert, assistance to the self-effort by Indian side.

1.4 Methodology of Implementation of the Study

Flow chart of the whole Study and the detailed flow chart of the Study are presented in Fig. 1.4-1 and Fig. 1.4-2, respectively.

This study had started from the beginning of July 2011 and completed in the middle of November 2011.

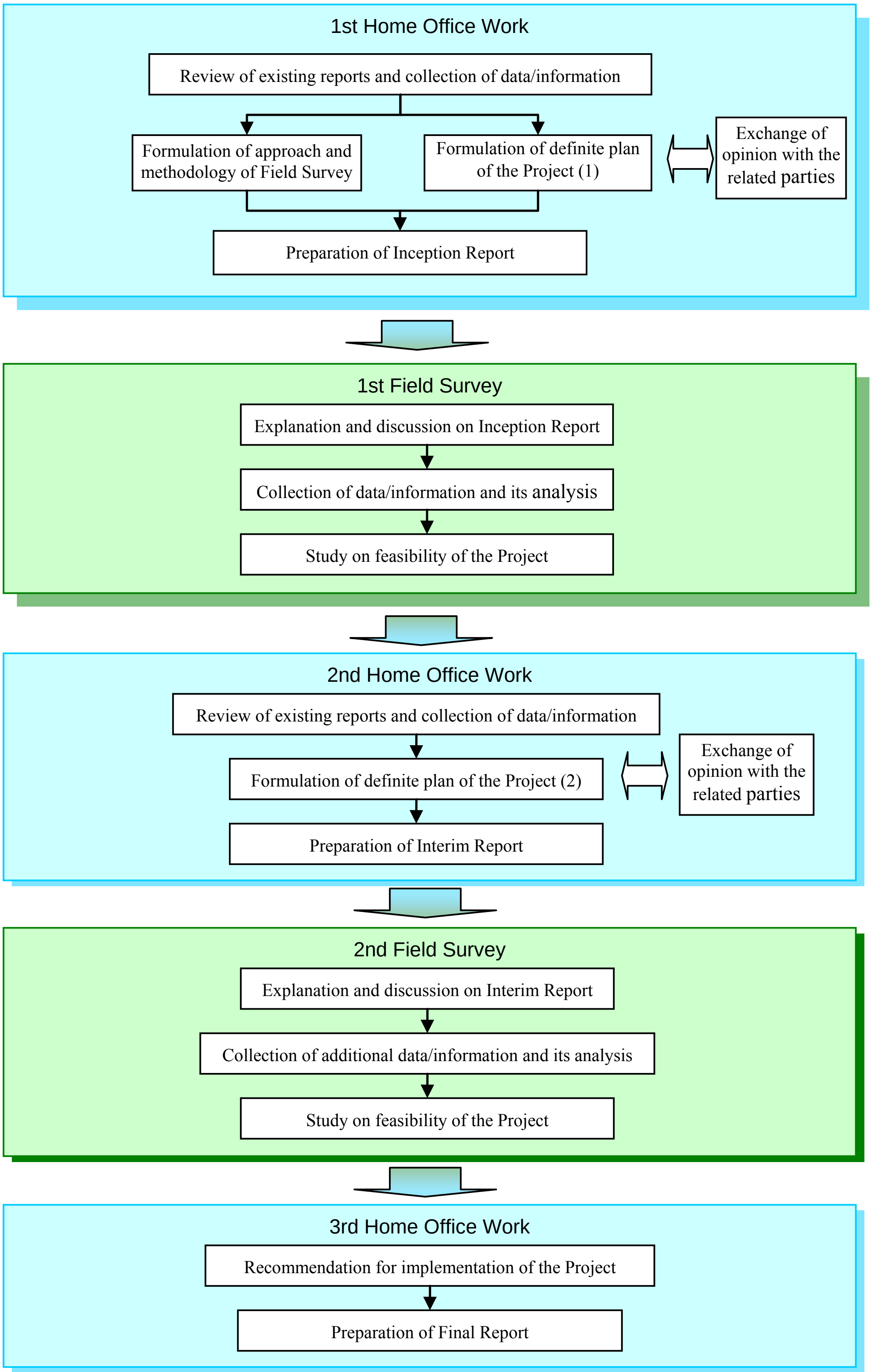


Fig. 1.4-1 Flow Chart of Whole Study

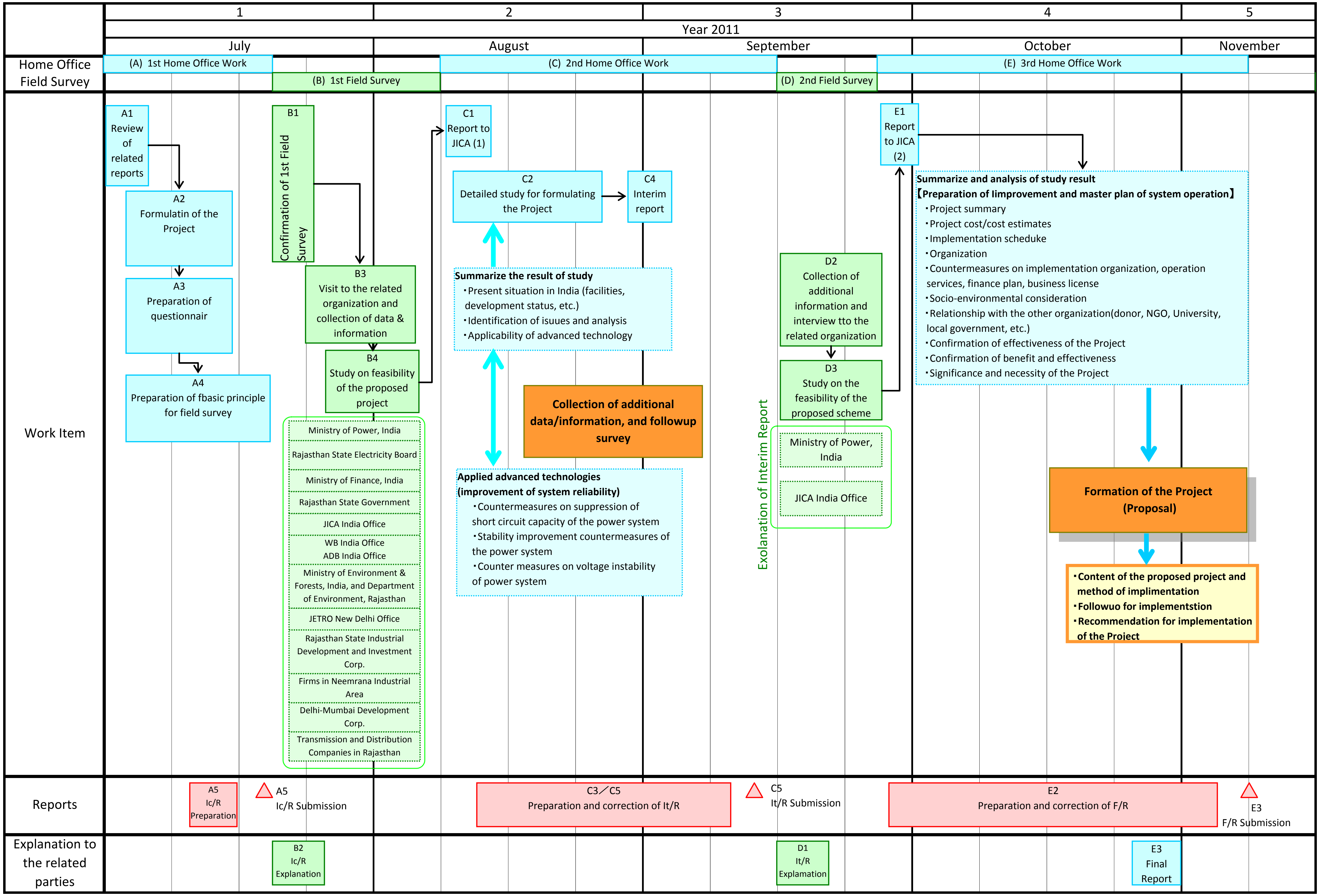


Fig. 1.4-2 Detailed Flow Chart of the Study

1.5 Site Survey

The site surveys were carried out twice from 17th July to 13th August and from 9th October, 2011 to 19th October, 2011. Members and schedule of the surveys are as shown below.

Table 1.5-1 Study Team and Schedule of 1st Site Survey

Position	Name	Schedule		
		Start	End	Days
Team Leader / Project Planning	Satoshi YAMAOKA	17th July	5th August	20
Advanced Technology in Power Sector	Yukao TANAKA	17th July	3rd August	17
Formation of Power Project	Takao SHIRAISHI	25th July	13th August	20
Socio Environmental Expert	Sho SHIBATA	17th July	5th August	20
Financial Analysis	Takumi MARUOKA	25th July	13th August	20

Table 1.5-2 Study Team and Schedule of 2nd Site Survey

Position	Name	Schedule		
		Start	End	Days
Team Leader / Project Planning	Satoshi YAMAOKA	9th Oct.	19th Oct.	11
Advanced Technology in Power Sector	Yukao TANAKA	9th Oct.	19th Oct.	11
Formation of Power Project	Takao SHIRAISHI	9th Oct.	19th Oct.	11
Socio Environmental Expert	Sho SHIBATA	9th Oct.	19th Oct.	11
Financial Analysis	Takumi MARUOKA	9th Oct.	19th Oct.	11

CHAPTER 2

CURRENT SITUATIONS AND TRENDS OF POWER SECTOR IN INDIA

CHAPTER 2 CURRENT SITUATIONS AND TRENDS OF POWER SECTOR IN INDIA

2.1 Basic Information of Power Sector in India

2.1.1 Outlook of Primary Energy Supply and Power Generation

(1) Outlook of Primary Energy Supply

The outlook of primary energy supply up to 2035 in India is shown in the following figure.

While the supply was 620 million tons of oil equivalent (Mtoe) in 2008, it will increase by an average of 3.1% per year and reach 1,405 Mtoe in 2035. By each energy source, the average annual supply growth rates from 2008 to 2035 will be: coal 2.8%, oil 3.4%, natural gas 5.4%, nuclear power 9.8%, hydropower 4.7% and combustible biomass including wood and cow manure 1.2%. This shows that the growth rates of natural gas and nuclear power are relatively high.

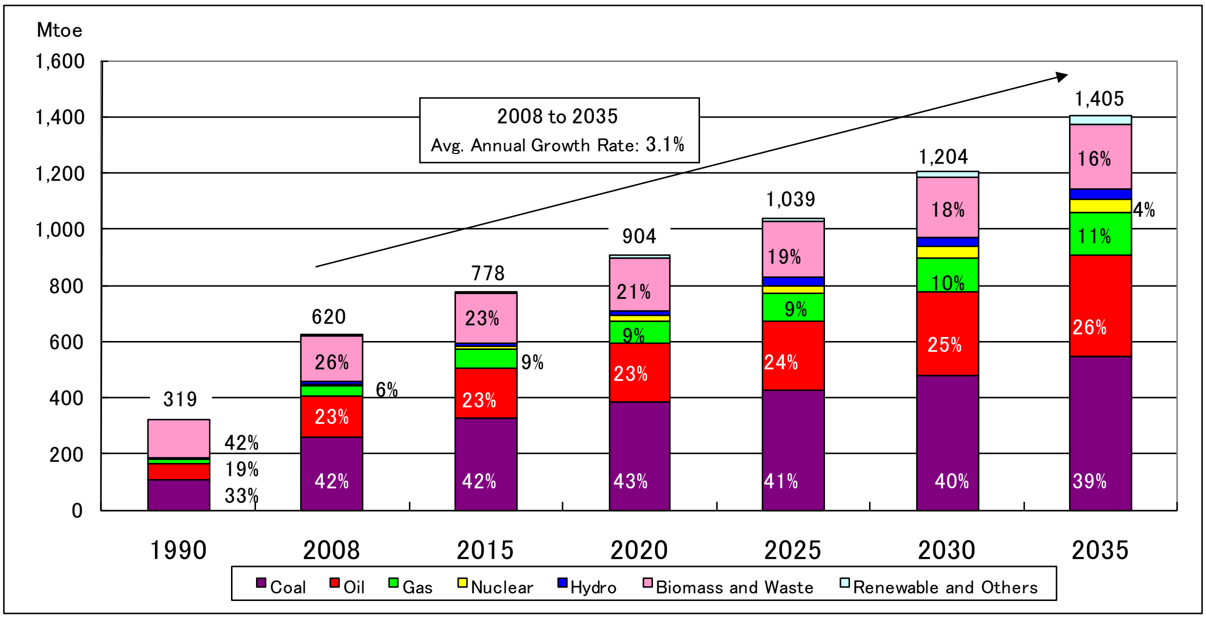


Fig. 2.1-1 Outlook of Primary Energy Supply in India

Source: IEA (International Energy Agency), World Energy Outlook 2010

The breakdown of energy sources in 2008 was coal 42%, oil 23%, natural gas 6%, nuclear 1%, hydro 2% and combustible biomass 26%. The high share of combustible biomass is notable in India.

The breakdown of energy sources in 2035 will be coal 39%, oil 26%, natural gas 11%, nuclear 4%, hydro 2% and combustible biomass 16%. It is estimated that coal will keep a high share even in 2035 due to the abundant coal resources in India.

(2) Outlook of Power Generation

The outlook of the power generation in India up to 2035 is described in Fig.2.1-2.

While the amount of power generation in India was 830 TWh in 2008, it is expected to increase by an average of 5.0% annually and to reach 3,106 TWh in 2035. According to types of energy sources, the average annual growth rates from 2008 to 2035 will be: coal 3.9%, natural gas 6.5%, nuclear 9.9%, hydro 4.8%, biomass and waste 16.3%, and wind and others 12.0%. The growth rates of natural gas, nuclear, and renewable energy are higher than those of other sources.

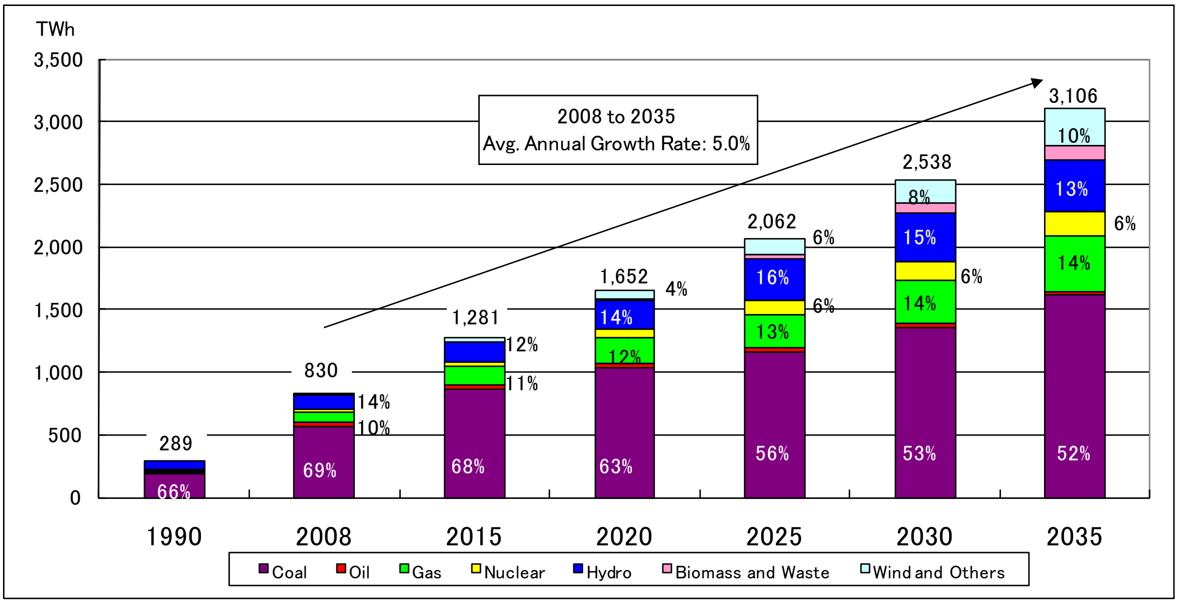


Fig. 2.1-2 Outlook of Power Generation in India

Source: IEA, World Energy Outlook 2010

As shown above, the share of coal in 2008 was 69%, which is dominantly high. The breakdown of other sources was: oil 4%, natural gas 10%, nuclear 2%, hydro 13% and wind, solar and others 2%.

According to the outlook of power generation in 2035, the share of coal will be still the highest, 52%, but that of other sources is expected to increase: natural gas 14%, nuclear 6%, biomass 4% and wind, solar and others 10%. On the other hand, the share of hydro power will be almost unchanged (13%) and that of oil will decrease to 1%.

In summary, it is estimated that while coal will be still the main source of power generation, the variation of energy sources including natural gas, nuclear, and renewable energy will be promoted. However, the domestic production of coal has not been catching up with the increasing demand for power generation, and the dependence on imported coal tends to grow. In fact, coal has been imported for coal-fired thermal power plants in the coastal areas. As natural gas produced in India also cannot meet the domestic demand, the amount of imported LNG has been increasing. Since natural gas tends to be in short supply, it is preferentially supplied for power generation and fertilizer production.

2.1.2 Power Industry System in India

(1) General

India has five (5) jurisdictional ministries of energy. The power sector is under the jurisdiction of the Ministry of Power (MOP). While the federal government and state governments used to be in charge of electric power business, the participation by private sectors has been allowed since 1991. Private companies are classified according to type of license they possess: 1) companies that generate and distribute electric power, 2) companies that generate and purchase power, and distribute it and 3) companies that purchase and distribute power.

The roles of the federal government, state governments, and private companies are as follows:

Sector	Federal government	State governments	Private companies
Generation	Large-scale thermal power Large-scale hydropower Nuclear power	Medium-scale thermal power Medium-scale hydropower	○
Transmission	○	○	–
Distribution	–	○	○

The characteristics of the power sector in India are listed below.

1) India is a federal state and both of the federal government and state governments are running their own electric power business.
2) The state power industry system is complicated because some states are vertically integrated from power generation to distribution while other states adopt unbundling.
3) The distribution sector is mainly controlled by the state governments.
4) The major fuel for power generation is coal. The domestic coal is transported by long-distance railways.

(2) System of Electric Power Business

Power business is conducted by the central sector, state sector, and private sector in India. Both of the central and the state governments have the jurisdiction of power business, and private sector joins the business.
Roles of each player in power business are: The central government and the state government establish policies, control and supervise the business, and electric power companies of central, state and private sectors operate the business.

Outline of the power sector organization and the power supply structure are shown in Fig.2.1-3 and Fig.2.1-4.

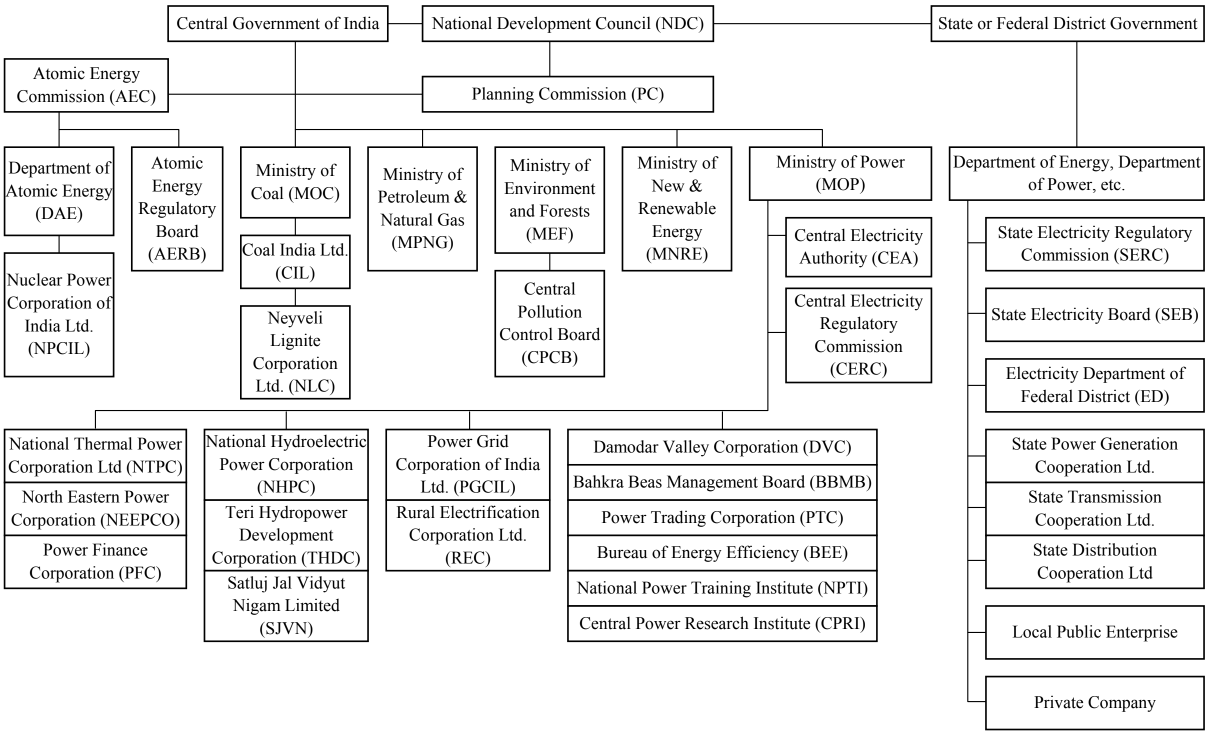


Fig.2.1-3 Outline of Power Sector Organization

Source: Japan Electric Power Information Center 2008

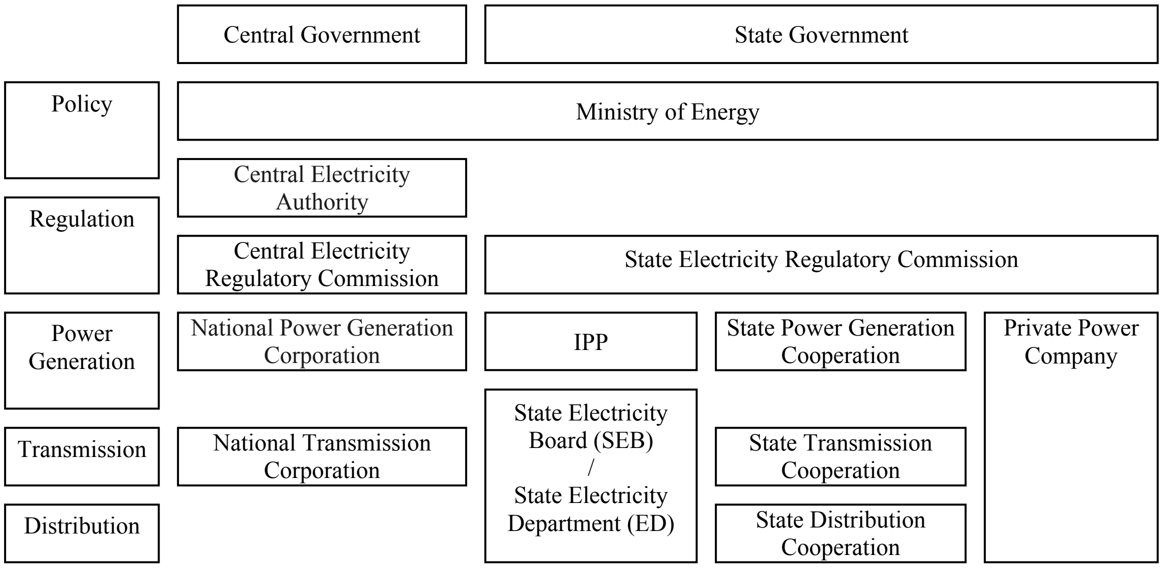


Fig.2.1-4 Outline of Power Supply Structure

Source: Japan Electric Power Information Center 2008

1) Central power sector

The central government involves electric power related organizations as follows: “Planning Commission” who establishes long-term plans, “Central Electricity Regulatory Commission” who regulates the electric power, and “MOP” who controls power sectors as well as “Atomic Energy Committee”, “Ministry of New and Renewable Energy” and etc.

2) State sector

Electric power related organizations at the state level exist as follows: “State Electricity Regulatory Commission”, “State Electricity Board”, “State Power Generation Cooperation”, “State Power Transmission Cooperation”, and “Local Public Enterprise”.

3) Private sector

Representative private companies related to electric power are as follows: “Tata Power Co., Ltd.”, “Reliance Energy Ltd.”, “Torrent Power Ltd.”, “Calcutta Electricity Supply Corporation”, etc. Additionally, foreign-owned companies exist such as “China Light & Power Co., Ltd.” and “Marubeni Corporation”.

2.1.3 Transmission Grid

The transmission grid is divided into five (5) power grids respectively in the north, west, south, east and northeast of India. All these girds are connected to each other and the four grids except the southern grid are synchronized. A federal government-owned company, POWERGRID, handles almost half the amount of power transmission in India.

Fig.2.1-5 Transmission Line Grid in India

Source: Central Electricity Authority, MOP, Major Transmission Network of India 2006

2.1.4 Trends in Power Generation and Sales

(1) Trends in Power Generation by States

The trends in the power generation by states from FY 2004[1] to FY 2010 are shown in Table 2.1-1 (note that the source of the data from 2004 to 2007 is different from that from 2008 to 2010).

Table 2.1-1 Trends in Power Generation by State

(Unit: TWh)

State	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Haryana	9.8	13.2	14.1	14.6	13.8	14.6	15.6
Himachal Pradesh	2.8	2.8	3.1	3.7	3.7	3.1	3.7
Jammu and Kashmir	0.7	0.8	1.3	1.5	1.6	3.3	3.6
Punjab	21.7	25.2	24.1	26.3	22.3	23.5	22.5
Rajasthan	21.0	23.2	22.7	25.7	22.2	22.9	24.8
Uttar Pradesh	20.9	20.7	23.0	22.7	23.5	23.9	25.1
Uttarakhand	3.1	3.5	4.3	5.5	6.6	5.9	6.8
National Capital Territory of Delhi	5.5	5.3	5.0	5.3	5.5	4.6	4.6
Federal Government	84.7	86.4	94.2	98.9	98.5	101.9	112.7
(Total of North Area)	*(170.1)*	*(181.0)*	*(191.8)*	*(204.3)*	*(197.7)*	*(203.7)*	*(219.3)*
Chhattisgarh	8.3	9.3	9.6	11.6	19.9	23.2	26.3
Gujarat	44.2	44.3	44.4	48.3	46.5	55.3	61.8
Madhya Pradesh	16.0	16.5	19.0	19.3	18.4	17.7	17.4
Maharashtra	67.1	67.2	69.0	72.8	66.0	66.8	65.8
Federal Government	48.2	50.3	58.0	68.9	71.8	85.4	90.4
(Total of West Area)	*(184.4)*	*(188.2)*	*(200.6)*	*(221.9)*	*(223.3)*	*(248.4)*	*(261.8)*
Andhra Pradesh	37.3	36.4	38.3	43.4	40.6	49.5	57.1
Karnataka	23.5	24.9	31.1	32.7	27.9	31.5	32.0
Kerala	6.5	7.6	8.0	9.2	7.5	7.6	7.4
Tamil Nadu	32.2	34.2	40.7	43.2	36.7	34.9	32.6
Federal Government	46.6	48.7	50.4	51.6	52.0	55.5	54.6
(Total of South Area)	*(146.8)*	*(152.4)*	*(169.1)*	*(180.8)*	*(165.4)*	*(179.3)*	*(184.0)*
Jharkhand	4.2	4.8	6.3	5.1	5.7	5.7	5.7
Orissa	10.3	8.4	10.8	11.1	9.4	7.3	9.3
West Bengal	24.9	25.7	25.8	27.6	30.4	33.1	34.0
Federal Government	46.0	55.7	59.5	62.5	64.7	67.2	71.4
(Total of East Area)	*(86.2)*	*(95.2)*	*(103.0)*	*(107.7)*	*(110.9)*	*(113.9)*	*(121.0)*
7 States in the Northeast Area	2.1	2.0	2.1	3.3	3.1	2.7	2.8
Federal Government	5.8	5.8	5.0	6.1	5.9	5.2	5.5
(Total of Northeast Area)	*(7.9)*	*(7.9)*	*(7.1)*	*(9.4)*	*(9.0)*	*(7.9)*	*(8.3)*
(Total of Federal Government)	*(220.5)*	*(234.3)*	*(253.0)*	*(272.8)*	*(277.2)*	*(300.3)*	*(318.0)*
Total	**594.5**	**623.8**	**670.7**	**722.6**	**705.2**	**752.7**	**794.0**

(Note) The states listed above have more than 1-TWh power generation.
The power generation of a state consists of that of the state government and private companies.
The power generation by the federal government is divided according to grid.

Source: All India Electricity Statistics 2007, 2008, 2009 Central Electricity Authority, MOP, Monthly Report

[1] Fiscal Year (FY) in India runs from April to March as same as that in Japan

(2) Trends in Power Sales by State

The trends in the electric power sales of the main states in India from FY 2005 to FY 2007 are shown in Table 2.1-2. As the data has not been published by MOP in recent years, the latest data available here is FY 2007's.

Table 2.1-2 Trends in Electric Power Sales of Main States in India

(Unit: TWh)

State	FY 2005	FY 2006	FY 2007
Haryana	16.4	17.7	19.4
Himachal Pradesh	3.6	4.4	5.1
Jammu and Kashmir	4.2	4.0	4.0
Punjab	25.4	27.2	30.7
Rajasthan	20.7	23.2	28.4
Uttar Pradesh	38.1	41.2	45.4
Uttarakhand	3.9	4.3	5.2
National Capital Territory of Delhi	13.4	14.7	16.3
(Total of North Area)	*(126.6)*	*(137.8)*	*(155.7)*
Chhattisgarh	11.0	16.6	14.3
Gujarat	50.1	55.5	62.8
Madhya Pradesh	22.8	23.6	26.9
Maharashtra	63.0	66.7	72.8
(Total of West Area)	*(152.5)*	*(168.7)*	*(183.7)*
Andhra Pradesh	44.3	49.9	53.3
Karnataka	28.9	33.8	37.8
Kerala	10.6	11.7	12.1
Tamil Nadu	49.4	54.6	59.0
(Total of South Area)	*(135.2)*	*(152.2)*	*(164.5)*
Bihar	4.0	3.8	4.6
Jharkhand	11.5	14.7	15.0
Orissa	16.7	18.2	20.5
West Bengal	22.7	24.4	27.8
(Total of East Area)	55.3	61.5	68.3
Total of Northeast Area	4.8	5.4	5.7
Total	**474.5**	**525.7**	**578.0**

(Note) "Total" includes the states listed above and also states whose sales are very small.

Source: All India Electricity Statistics 2007, 2008, 2009

2.2 Development Policy of Power Sector

This section shows the issues surrounding the power sector and then arranges the basic policy of MOP.

2.2.1 Issues of Power Sector

(1) Severe Shortage of Power Supply

In India, both peak power and amount of power generation are in an approximately 10% shortage of those demands. Due to the economical growth, the power demand for all the sectors such as industry, commerce, and households has been increasing. Therefore, the power supply cannot catch up with the demand all the time in spite of the efforts to secure additional power supply.

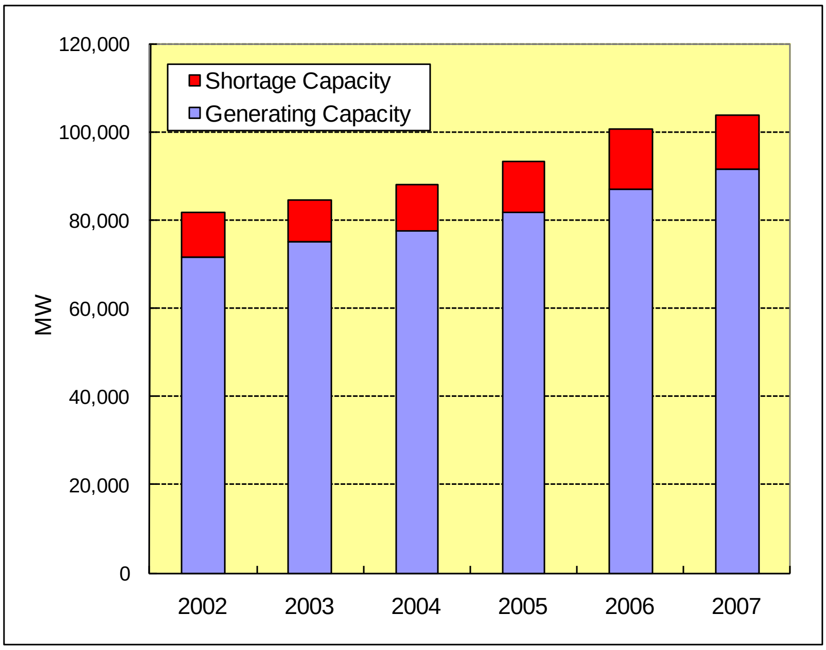


Fig.2.2-1 Peak Power

Source: Central Electricity Authority, MOP in India

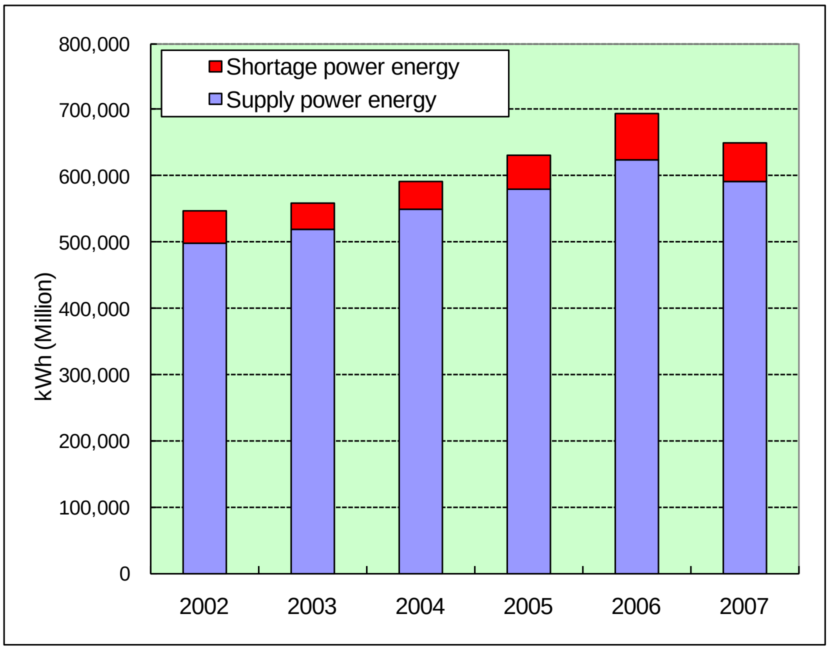


Fig.2.2-2 Amount of Power Generation

Source: Central Electricity Authority, MOP in India

(2) Power Generation Efficiency and Internal Consumption

The coal thermal power plant is a major power generation in India. The power generation efficiency of Indian coal thermal plants is about 15 % lower than that of Japanese ones while it is difficult to simply compare them due to the different qualities of coal in both countries. By contrast, the power generation efficiency in China, a same developing country, has been improving.

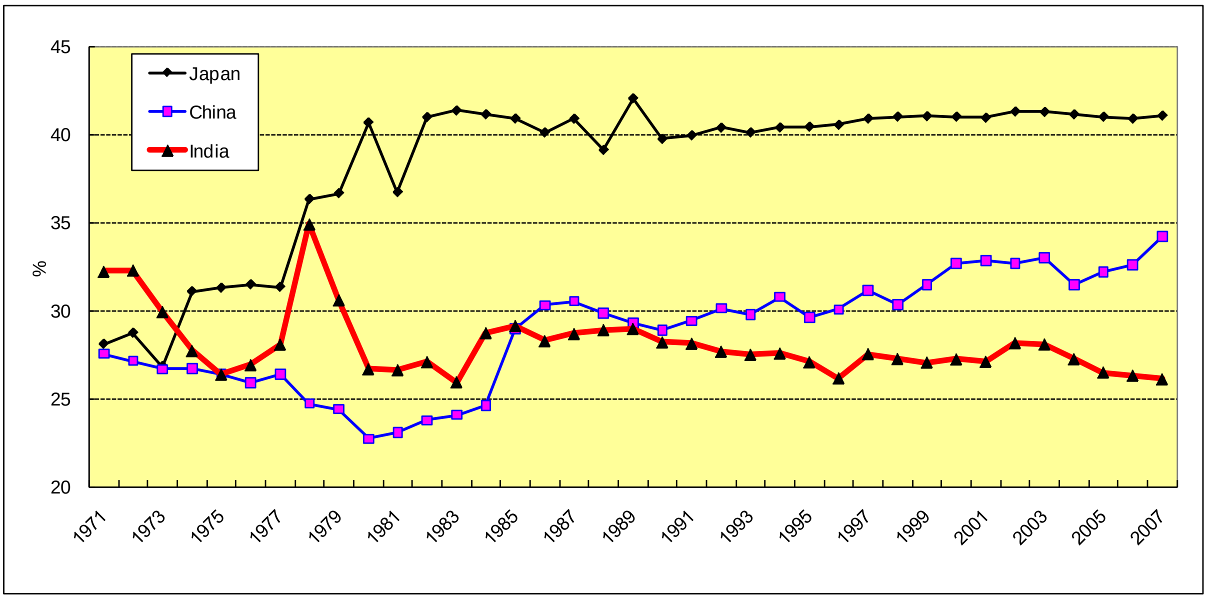


Fig.2.2-3 Efficiency of Coal Thermal Power Generation

Source: List of IEA Energy Balance

In addition, the Indian internal power consumption ratio at coal thermal plants is lower than the Japanese one.

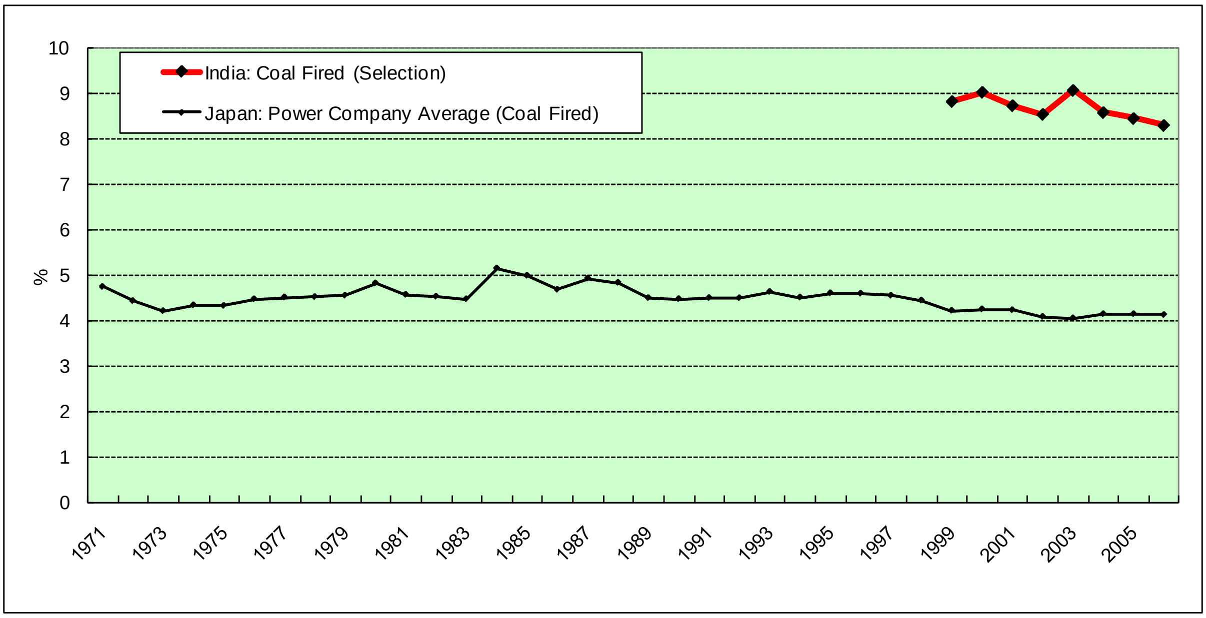


Fig.2.2-4 Internal Power Consumption Ratio in Japan and India

Source: MOP

The possible reasons for low power generation efficiency and high internal power consumption rate in India are: the thermal efficiency and plants are not well-managed; many of the plants are over 20-year-old outdated ones; these plants have only small capacities; and the coal in India has low heating value and high ash content.

(3) Transmission and Distribution Losses

According to the energy balance table of the IEA, the transmission and distribution losses in India are as high as 20 to 30%. As described later, due to the electricity theft and power supply without installation of electricity meters, it is difficult to measure the technical losses of transmission and distribution only. As transmission and distribution losses in the figure below include the all the types of losses, the actual technical loss is lower than losses shown the figure. According to the National Action Plan on Climate Change (June 2008), the transmission and distribution losses in India are reported to be 16 to 19%.

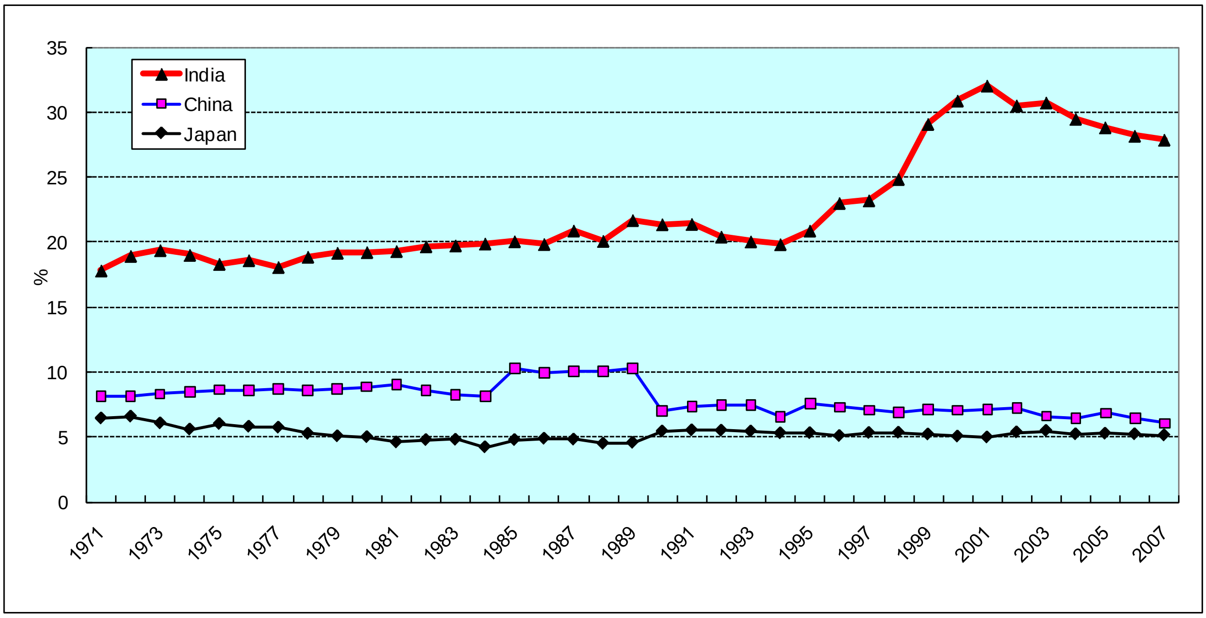


Fig. 2.2-5 Transmission and Distribution Loss

Source: IEA Energy Balance Table

In addition to the technical transmission and distribution losses, there are other problems such as electricity theft, measurement error, manipulation of meter value, uninstallation of electricity meters, clerical mistake by electricity meter readers, bribe to electricity meter readers, and unpaid charge. Those kinds of losses mainly caused by the human factors are called commercial loss and the index of technical and commercial losses is established, namely AT&C losses (aggregate technical and commercial losses).

The latest figure of AT&C losses has not been published, but it is assumed that the losses are not drastically improved. According to the Central Electricity Authority, MOP, the losses in 2009 of three distribution companies in Rajasthan are as follows:

Table 2.2-1 Transition of AT&C Losses in India

FY 2002	36.64%
FY 2003	34.90%
FY 2004	34.33%
FY 2005	34.34%

Source: TERI investigation

JVVN (Jaipur Vidyut Vitran Nigam Ltd.) : 28.06%
JoVVN (Jodhpur Vidyut Vitran Nigam Ltd.) : 29.21%
AVVN (Ajmer Vidyut Vitran Nigam Ltd.) : 30.68%

(4) Power Tariff

Power tariff is set by each state. While the power tariff system greatly varies from sector to sector because of the state industrial structures, in general the tariff is set low for households and agriculture, and high for industry. As a result, while large factories which pay higher tariff are positive for energy conservation, small factories do not have incentive for energy conservation, which has led to the low energy efficiency in the whole country.

Table 2.2-2 Sectoral Comparison of Power Tariff in India

(INR/kWh)

	Maximum		Minimum	
Household	5.8870	Gujarat State	0.3180	Bihar State
Commercial	9.6998	Kerala State	0.3286	Bihar State
Agriculture	3.2754	Gujarat State	0.0000	Punjab State
Industry (Small)	5.6000	Delhi	1.5700	Jammu Kashmir State
Industry (Medium)	6.9241	Maharashtra State	1.5700	Jammu Kashmir State
Industry (11 kV)	5.9305	Gujarat State	0.7135	Mizoram State
Industry (33 kV)	5.9240	Gujarat State	0.7135	Mizoram State
Industry (Large)	4.5013	Himachal Pradesh State	1.3554	Daman Diu
Railway	5.7600	Delhi	2.8050	Bihar State

Source: Central Electricity Authority, MOP

(5) Conclusion

Many of the problems for the power sector in India are due to the state power business systems. Low efficiency of power generation, high power loss and inexpensive tariff system which lowers the motive for energy conservation have been causing a decline in profits of the electric power industry managed by the state governments and preventing them from investing.

Since MOP has recognized these serious situations, it has been implementing the following programs to improve the state power business. Although these programs have achieved a certain success, the progress seems slow yet.

1) Thermal power generation

- ♦ Renovation & Modernization Programme (R&M)
- ♦ Life Extension Programme (LE)
- ♦ Efficiency improvement through energy analysis
- ♦ Education for staff in low-efficient power plants by those in high-efficient power plants
- ♦ Accelerated Generation and Supply Programme (AG&SP)
- ♦ Introduction of the latest technology of power generation

2) Distribution

- ♦ Accelerated Power Development and Reforms Programme (APDRP) to reduce technical and commercial losses in power distribution has been implemented by initiative of central government since 2000.
  The purpose of APDRP is to improve financial situations of state electric companies, AT&C loss, consumer's satisfaction and reliability, and quality of power supply. The schemes of APDRP are divided into investment factors and incentive factors. For example, the state government of Rajasthan has received INR 13,771,000 from Ministry of Finance (MOF) as incentive funds from FY 2001 to FY 2002.

2.2.2 Basic Policy of MOP

MOP established "Mission 2012: Power for All" as a basic comprehensive development policy of the power sector. The following are the aims of this plan:

- Sufficient power supply in order to achieve a GDP growth rate of 8%
- Improvement of power reliability
- Improvement of power quality

- Proper power generation cost
- Commercial growth of power industry
- Power for all

Followings are the basic strategies to achieve these aims.

Table 2.2-3 Basic Strategies of MOP

Generation sector	Low-cost generation, optimal operating rate, management of input costs, best mix of fuels, technology upgrade and practical use of unconventional energy source
Transmission sector	Development of national transmission grid including interstate transmission, technology upgrade and transmission cost optimization
Distribution sector	System improvement, loss reduction, electricity theft protection, consumer-oriented service, improvement of power quality and power supply to rural areas through isolated power generation
Regulation	Protection of consumer interests and commercial development of power sector
Financial resource	Creation of resources necessary for power sector growth
Energy conservation	Optimization of operation rate focusing on demand and electric power load management, and technology upgrade to produce high efficient equipments
Public relations	Consensus building for improvement in public awareness with the help of media

2.3 Japanese Aid Policy and Achievement toward Indian Power Sector

2.3.1 Japan-India Energy Dialogue

The Government of Japan and the Government of India inaugurated a new bilateral 'Japan-India Energy Dialogue', the regular ministerial-level policy dialogue, and held the first meeting in Tokyo in April, 2007. Recognizing the critical importance of securing the energy needs of both countries, they decided that the establishment of the 'Japan–India Energy Dialogue' will focus on promoting comprehensive cooperation in the energy sector, as endorsed in the Joint Statement 'Towards Japan-India Strategic and Global Partnership' issued by the Prime Minister of Japan, H.E. Shinzo Abe and the Prime Minister of India, H.E. Dr. Manmohan Singh, during Prime Minister Singh's visit to Japan in December 2006.

The Japan-India Energy Dialogue has been held four times since 2007. Recently, the ministerial-level energy policy dialogue was held in New Delhi on the 30th of April, 2010. In the meeting, the both Ministers reached a conclusion on the following cooperation, outlined below from 1) to 4), in order to concretize common recognition and build a cooperative relationship between the two countries in the energy and environment sector through.

1) Energy conservation sector
2) Electricity and coal sectors
3) Renewable energy sector
4) Oil and natural gas sectors

2.3.2 Ministry of Foreign Affairs of Japan (MOFA)

MOFA has set the following objectives in the mid-term policy for the economic cooperation with India:

- Promotion of economic growth along with strengthening bilateral economic interactions
- Poverty reduction and social sector development
- Cooperation with regards to environment, climate change and energy

The Japanese policies toward the Indian power sector are as follows:

➢ In order to strengthen power supply and transmission/distribution capacities, higher priorities will be given to the following areas of cooperation: construction of high efficient power supply facilities (power plant, transmission & distribution networks); energy efficiency improvement of the existing facilities; and reduction of transmission/ distribution losses. Additionally, from the standpoint of climate change adaptation, the demand side energy conservation as well as new & renewable energy development will also be facilitated further.

- The cooperation in power sector would encourage economic activities of Japanese private sectors in India through ensuring of stable power supply, and thereby, lead to promotion of economic growth of India through enhancement of Indo-Japan economic relationship. Therefore, considerations may be given in choosing target regions of cooperation where many Japanese companies are moving into the business.

2.3.3 JICA

The following table is a rolling plan on strengthening of capacities of power supply and energy conservation and efficiency improvement:

Table 2.3-1 JICA's Rolling Plan for India

Project	Scheme	Period	Assistance Amount (100 Million Yen)
Study on Improving Operations in Thermal Power Plants	TCDP	Up to 2010	2.50
Counterpart Training for Study on Improving Operations in Thermal Power Plants	CTR	Up to 2010	
Thermal Power Engineering for Gas Turbine and Coal Fired Steam Turbine	CTR	Up to 2010	
North Karanpura Super Thermal Power Project	LA	Up to 2012	159.16
Bakreswar Thermal Power Station Units Extension Project	LA	Up to 2010	367.71
Umiam Stage II Hydro Power Station R&M Project	LA	Up to 2012	19.64
Purulia Pumped Storage Project	LA	Up to 2014	415.41
Transmission System Modernization Project in Hyderabad	LA	Up to 2010	236.97
Bangalore Distribution Upgradation Project	LA	Up to 2011	106.43
Maharashtra Transmission System Project	LA	Up to 2010	167.49
Haryana Transmission System Project	LA	Up to 2010	209.02
Energy Conservation Techniques	CTR	Up to 2010	
Micro, Small and Medium Enterprises Energy Saving Project	LA	Up to 2011	300.00
Study on Promotion of Low-Carbon Technology in India	STC	2010 to 2014	2.70

(Note) TCDP = Technical Cooperation for Development Planning, CTR = Country-focused Training, LA = Loan Aid, STC = Science and Technology Cooperation on Global Issues

Source: MOFA, Japan's ODA: Rolling Plan for India

On June 6, 2011, Japan approved for India the following ODA loan projects regarding the power sector.

Project	Assistance Amount (100 Million Yen)
Madhya Pradesh Transmission System Modernization Project	184.75
Andhra Pradesh Rural High Voltage Distribution System Project	185.90
Micro, Small and Medium Enterprises Energy Saving Project (Phase 2)	300.00
New & Renewable Energy Development Project	300.00

Source: Website of MOFA

2.3.4 Japan Bank for International Cooperation (JBIC)

In December, 2007, JBIC has signed an agreement in contract of guarantee for amount of up to 380 million US$ with four Japanese private financial institutions - Sumitomo Mitsui Banking Corporation (the agent bank), Mizuho Corporate Bank, the Bank of Tokyo-Mitsubishi UFJ, and the Tokyo branch of Société Générale for the syndicated loan to the National Thermal Power Corporation (NTPC).

This syndicated loan is to be used for the capital investment of Barh Super Thermal Power Project (1,980 MW) by NTPC. The electricity to be generated by this project will be supplied to the north-western part of India including Delhi and Mumbai, where many Japanese companies are operating and further investments by Japanese companies are promised.

In July, 2009, JBIC signed two loan agreements for an aggregate amount of up to 153.7 million US$ with L&T-MHI Boilers Private Ltd. and L&T-MHI Turbine Generators Private Ltd. (LTMT), the two joint venture companies established primarily by Mitsubishi Heavy Industries Ltd. (MHI) and Larsen & Toubro Ltd. (L&T), one of the largest heavy machinery manufacturers in India.

In this business project, L&T-MHI Boilers Private Ltd. and LTMT will manufacture high-efficiency, high-performance boilers and steam turbines for power generation by using advanced supercritical pressure technology provided by MHI. The boilers will be manufactured in the city of Hazira in the Gujarat State and sold in the Indian market.

In October, 2009, JBIC signed a loan agreement for an aggregate amount of up to 90 million US$ with Toshiba JSW Turbine and Generator Private Ltd. (TJTG), the joint venture company established by Toshiba Corporation and two Indian firms - JSW Energy Limited and JSW Steel Limited.

In this business project, TJTG, in which Toshiba has a majority equity share, will manufacture high-efficiency, high-performance steam turbines and power generators by using advanced supercritical pressure technology provided by Toshiba to sell them in the Indian market. The proceeds of the loan will primarily be used for the construction of a manufacturing facility in

Chennai, Tamil Nadu. It will become Toshiba's first overseas production factory of steam turbines and power generators.

In April, 2011, JBIC signed with ICICI Bank Limited (ICICI)[2] in India, 1) bank-to-bank loan to finance the export of thermal power generation boiler/steam turbine sets to India and 2) loan to finance renewable energy and energy conservation projects in India.

1) Bank-to-bank loan to finance the export of thermal power generation boiler/ steam turbine sets to India

In this project, the joint venture company established by L&T, one of the largest construction and heavy machinery manufacturing companies in India, and MHI, fabricate supercritical pressure boiler/turbine sets (manufactured by MHI and exported by Marubeni Corporation) and sell them to Jaiprakash Power Ventures Limited (JPVL), -an Indian corporation constructing and operating a supercritical pressure coal-fired thermal power plant in Nigrie in the Madhya Pradesh State. JBIC's export financing, which reached the aggregate amount of 15.3 billion yen, was co-financed with the Bank of Tokyo-Mitsubishi UFJ, Ltd (lead arranger). This will finance, by way of ICICI, JPVL's purchase of boilers and steam turbine/generators.

2) Loan to finance renewable energy, energy efficiency and other environment- related projects in India

This loan was made to ICICI Bank to finance renewable energy, energy efficiency and other environment-related projects in India. This is the first loan provided in the Asian region for GREEN operations. The loan, totaling 200 million US$, was co-financed with Sumitomo Mitsui Banking Corporation (lead arranger).

2.3.5 Energy Conservation Center, Japan

By undertaking programs from Ministry of Economy, Trade and Industry (METI), JICA and JETRO, Energy Conservation Center, Japan dispatches experts and instructors to India and accepts trainees.

[2] ICICI Bank Limited: Private bank in the second place in India

2.4 Assistance from Other Aid Organizations

2.4.1 Multilateral Cooperation

(1) World Bank (WB)

The WB's Country Strategy for India for 2009-2012 focuses on helping development of much-needed infrastructure and supporting the seven (7) poorest states to achieve higher standards of living for their people. The assistance is provided through the International Development Association (IDA).

As for the Indian power sector, WB is assisting the construction of the following hydropower plants:

Rampur Hydropower Generation Project

The Rampur hydropower plant is currently under construction, locating in the downstream of Nathpa Jhakri Hydropower Plant completed in 2002 on the Satluj River in Himachal Pradesh.

Vishnugad Pipalkoti Hydropower Generation Project

The Vishnugad Pipalkoti Hydropower Plant will be built on the Alaknanda River in Uttarakhand State and this project is currently under appraisal.

Luhri Hydropower Generation Project

The Luhri Hydropower Plant will be built on the Sutlej River in Himachal Pradesh State and this project is currently under appraisal.

WB has been providing assistance to the state governments of Uttarakhand and Himachal Pradesh engaging in the construction of the cascade hydropower plants.

(2) Asia Development Bank (ADB)

In accordance with the India's 11th five-year plan, the ADB's India Country Partnership Strategy covers a broad range of areas.

ADB has been providing assistance to the following projects dealing with power infrastructure.

- 620 million US$ loan to the investment of the Madhya Pradesh's power sector (Apr., 2007)

- 3.52 billion INR loan to the 100 MW wind power generation project in Maharashtra by Tata Power Company Ltd which is the country's largest private power company (May, 2007)
- 600 million US$ loan to the state power transmission company, POWERGRID (Apr., 2008)
  Power transmission project generated by hydropower plants from north and northeast to central region in India
- 113 million US$ loan to two wind power generation projects by private companies in Gujaratand and Karnatak (Apr., 2008)
- 800 million US$ loan to the hydropower plants with the total capacity of 808MW in Himachal Pradesh (Oct. 2008)
- 225 million US$ loan to the rural electrification (Nov., 2008）
  Construction of transmission and distribution network including high-voltage transmission
- 450 million US$ loan to the 4,000 MW Mundra Ultra Mega Power Project by Tata Power (Mar., 2009）
- 200 million US$ loan to the power sector improvement project in Assam (Nov., 2009)
  Improvement in transmission and distribution lines including system loss reduction
- 132 million US$ loan to the power system improvement project in Bihar (Oct., 2010)
  Elimination of system bottleneck and technical and commercial loss reduction
- Establishment of a joint venture with NTPC and Kyushu Electric Power Cooperation to develop and operate 500 MW renewable energy plants in India in the next three years (Nov., 2010）
- 150 million US$ loan security to promote solar power generation (Apr., 2011)
  75 million US$ out of 150 million US$ is funded by the Asian Clean Energy Fund (controlled by ADB) contributed by the Government of Japan
- 100 million US$ loan to solar power generation and transmission project in Gujarat (Sep., 2011)
  This loan will be used for the substation, transmission lines, etc. to supply the power generated in Charanka Solar Park of Patan district in Gujarat. The Charanka Solar Park is one of the projects of which the state of Gujarat is planning the construction of mega solar power plants (large-scale Photovoltaic (PV) power plants) with the power capacity of exceeding 500 MW. This project will assist the Government of India to achieve the goal that introduces PV power generation of 20 GW by 2022. The total cost is about 137 million US$ and about 37 million US$ out of this amount is contributed by the State Government of Gujarat. This project is carried out by Gujarat Energy Transmission

Corporation Ltd., a local electric power company, in cooperation with the State Government of Gujarat.

(3) Europe Union (EU)

EU has continued the development cooperation to India since 1976. In July, 2007, it announced the new Country Strategy Paper for India 2007 - 2013 mainly focusing on the fields of health and education while it does not cover any specific electric power projects.

2.4.2 Bilateral Cooperation

(1) France

In 2006, France proposed the assistance to India through the French Agency for Development (AfD). Both governments signed the Inter-Government Agreement in January, 2008 and the Department of Economic Affairs of India and the AfD also signed the MoU in September, 2009.

Based on the agreement, the AfD put emphasis on the following areas:
- Energy conservation, renewable energy and public transportation
- Biodiversity conservation
- Prevention of widespread epidemic

The AfD's project does not include the area of power infrastructure.

(2) Germany

Germany has provided India with funds and expertise since 1958. Under the agreement between both governments, the Indo-German Development Cooperation focuses on the following areas:

Energy	:	Energy conservation, renewable energy and institutional reform
Environment	:	Environmental conservation in urban and industrial areas and natural resource management
Sustainable economic development	:	Local financing, social security guarantee and development of and loan to small and medium-size enterprises

Financial assistance is provided through Kreditanslat fur Wiederufbau (KfW) while technical assistance is provided through a government-owned company, Deutsche Gesellschaft fuer

Technische Zusammenarbeit (GTZ). The GTZ is stationed regularly at Bureau of Energy Efficiency, MOP in charge of the energy conservation policy in India. The GTZ has been implementing the following programs:

- Indo-German Energy Programme	:	Energy conservation
- Renewable Energy Supply for Rural Areas	:	Dispersed renewable energy in local areas
- Indo-German Energy Forum	:	Energy conservation and Clean Development Mechanism (CDM)
- Trigeneration Tamil Nadu House, Delhi	:	Cogeneration and Energy Service Cooperation (ESCO)

The German assistance programs do not include power infrastructure-related programs.

(3) Italy

Italy has provided financial assistance for India since 1981. At present, Italy is undertaking only the management of tap water and solid waste, not related to power infrastructure.

(4) Russia

With technical assistance provided by the Russian government, an Indian government-owned company, Nuclear Power Corporation Ltd. is constructing the 2,000 MW Kudankulam nuclear power plant with two VVER-type pressurized-water reactors.

(5) United States of America (USA)

The USA has provided aid to India through the United States Agency for International Development (USAID) since 1951. The USAID mainly focus on distribution loss reduction, power supply increase, development of energy conservation and clean coal technology, and commercialization of renewable energy.

The USAID and MOP of India started the Distribution Reform, Upgrades and Management (DRUM) in 2004. Its aim is to develop applicable, sustainable and expandable practices in distribution businesses by using experiences accumulated from other programs of MOP. Currently, the following three pilot projects are in place:

- Aurangabad Division-1 by the power company in Maharashtra
- Doddaballapur by the power company in Bangalore
- Umreth by MGVCL established by the Gujarat Electricity Board

(6) Britain

Britain has provided the assistance to India through the Department for International Development (DFID) since 1958. The DFID emphasizes poverty reduction in India and has deployed the projects on education, health, urban and local development, and governance reform where power infrastructure is not included.

2.5 Japanese Firms' Activities in Power Sector

(1) MHI

- Incorporated resident office in India (Nov., 2004)

- Joint venture agreement with L&T, one of the biggest construction firms, for establishment of the manufacturing and sales firm 'L&T-MHI Boiler' in connection with supercritical boiler for thermal power plant (Apr., 2007)

- License agreement with Bharat Heavy Electricals Ltd. (BHEL) on pump technology for thermal power plants, i.e.
  Water supply pump for critical and supercritical boiler installed in 500 - 1,000 MW thermal power plants, water supply booster pump, water circulation pump, condensate pump.
  The first license agreement by Japanese firm in this field (May, 2007)

- Agreed with VTTL, tractor manufacturer, to establish 'MHI-VST DIESEL ENGINES PRIVATE LIMITED' manufacturing and sales firm of low capacity diesel engine (Jul., 2007)

- Joint venture agreement with L&T for establishment of manufacturing and sales firm 'L&T-MHI Turbine Generator' in connection with steam turbine and generator for thermal power plant (Nov., 2007)

- Expansion of organization of Mitsubishi Heavy Industries India Private Ltd
  Established 2 branches in Mumbai and Bengaluru (Jan., 2008) in addition to the current office in New Delhi

- Order receipt from Andhra Pradesh Power Development Co., Ltd. (APPDCL) invested by Andhra Pradesh Power Generation Corporation Ltd. (APGENCO), in connection with supercritical steam turbine × 2 units for 800 MW output to be supplied to the coal thermal power project developed by APPDCL. Delivery time: End of 2010 (Feb., 2009)

- Order receipt from Jaiprakash Power Ventures Ltd. in connection with supercritical coal boiler (pressure proof part) and steam turbine generator, 2 systems each.
  To be installed in No.1 and No.2 units in the thermal power plant with 660 MW output at Nigrie, Madhya Pradesh. Delivery time: 2011 (Jan., 2010)

- Order receipt from Mahagenco in connection with supercritical coal boiler and steam turbine generator 3 systems each.

To be installed in the thermal power plant with 660 MW output at Koradi, Maharashtra. Operation starts at end of 2013. (May, 2010)

- Order receipt from NTPC, in cooperation with BHEL who is licensed technology from MHI, in connection with 18 sets of pump for No.1 and 2 units of the thermal power plant in the Bath II project, in the north-east region of India. Delivery time: 2011 (May, 2010)

- Order receipt from 2 IPP, Nabha Power Limited and Sangam Power Generation Company Ltd. in connection with 660 - 700 MW supercritical coal boiler and steam turbine, 5 systems each, for high efficiency coal thermal power plants.
  Delivery time: Starting delivery in the middle of 2011 for 2 systems for the power plants being constructed in the state of Punjab by Nabha Power Limited, affiliate company of L&T, and in the end of 2011 for 3 systems for the power plants being planned in the state of Uttar Pradesh by Sangam Power Generation Company Ltd. (Feb,. 2011)

- Agreed with the State of Gujarat, DMIDC on collaboration for smart community development
  Consortium was inaugurated by Mitsubishi Electric, Mitsubishi Corporation, Mitsubishi Research Institute, J-Power and MHI to join the project which is a part of "Industrial Corridor" with the aim of encouraging large-scale development to establish the industrial park, power plant, airport, port, railways, roads, commercial facilities, etc. between Delhi and Mumbai. Smart Community, placed one of DMIDC, is to be developed in Sanand and Changodal, Gujarat.
  MHI aims to introduce the power generation system by renewable energy (solar power generation) and to promote electrification in the traffic network in cooperation with four companies composing the consortium. (Jan., 2011)

- 2 JV firms for supercritical coal boilers and supercritical pressure steam turbines and generators, established in cooperation with L&T, started the operation at the location next to the factory of L&T in the Hazira industrial area, Gujarat (Jan., 2011)

(2) Kawasaki Heavy Industries, Ltd.

Order receipt from Raymond Ltd., a large-scale textile firm in the Gujarat state, in connection with 7,200 kW gas turbine cogeneration system in cooperation with Quippo Energy Private Ltd., an engineering company in India (Sep., 2010).

(3) Hitachi, Ltd.

- Agreed with BGR Energy Systems Limited, an engineering and industrial electric firm, for establishing JV firm of design, manufacturing, sales, and maintenance of steam turbine, generator, and boiler for 660 MW - 1,000 MW supercritical thermal plant

- ♦ Order receipt from BBMB, Himachal Pradesh, in connection with staple spare parts supply, maintenance work and modification of the Bhakra Beas Left Shore Hydropower Station (Total output 540 MW Turbine and Generator: 108 MW × 5 units) Contract amount : 9 Billion Yen, in cooperation with Sumitomo Corporation (Mar., 2008)

- ♦ Established India Business Support Center in New Delhi on December 1, 2007 to aim helping Hitachi Group companies to move into the Indian market and already operating business in air conditioning systems, construction machinery and others, taking into account of India business practices, tax system and regulatory environment (Dec., 2007).

- ♦ Order by an EPC contract basis receipt from L&T in connection with 5 units of H-25 gas turbine installed for the cogeneration plant to supply power and steam to Panipat oil refinery plant of Indian Oil Corporation Limited (IOCL) (Dec., 2006)

(4) J-Power Systems (JV between Hitachi Cable Ltd. and Sumitomo Electric Industries Ltd.)

- ♦ Order receipt from Power Grid, a power transmission firm, in connection with Gap Type Conductor for the expansion of the existing 400 kV overhead transmission line.
  Contract amount: 2.5 Billion Yen. Delivery time: Feb 2012. This project financed by World Bank to expand the capacity for the power transmission to Purulia, West Bengal from Assam (Oct., 2010).

- ♦ JV Contract with Finolex Cables Limited for the establishment of high voltage conductor manufacturing plant (Dec., 2007)

(5) Toshiba Corporation

- ♦ Order receipt from the Essar Group, in connection with the supercritical steam turbines and generators for the Salaya II Supercritical Coal Thermal Power Plant of Essar Power Gujarat Limited, one of independent power producers.
  This order is for 2 units of thermal power generation facility with 660 MW output, generating higher efficiency and delivering clean energy. Delivery starting in 2012 and expecting operation time in 2013 (Jan., 2011).

- ♦ Signed on Memorandum of Understanding with BHEL to enter into discussing the establishment of JV company of transmission and distribution equipment business (Feb., 2010)

- ♦ Agreed with Jindal South West (JSW) Group to establish JV company for manufacturing and sales of thermal power generating equipment (May, 2008)
- ♦ Order receipt from TATA Power Company Limited, the largest private power company, in connection with thermal power generating system for the Mundra Power Plant (Gujarat) with 4,000 MW output. (Aug., 2007)

(6) Toshiba Plant Systems and Services Corporation

New Delhi Office of TPSC (INDIA) Private Limited opened.
In New Delhi, National Thermal Power Cooperation, National Hydroelectric Power Cooperation, the power related manufacturers as well as Toshiba and Japanese trading firms have offices. (Oct., 2006)

(7) NGK Insulators Ltd.

JV company of insulator production established in February, 2003 in cooperation with ABN and Mitsubishi Corporation, has dissolved due to continuous deficit and malfunction in quality, yield rate, and cost effect in 2006.

(8) Power Company

1) J-Power, the Kyushu Electric Power Company, the Chugoku Electric Power Company

Consulting contract for the study with JICA under JV formation for Thermal Power Generation Operation Improvement Planning Study in India.

At the request of the Government of India, this study provided with recommendations on the most optimal improvement as well as technical transfer to Indian engineers, taking into consideration improvement technology in thermal efficiency and operation of Japan after investigation and diagnosis of existing thermal plants of NTPC in terms of the facilities and thermal efficiency (Dec., 2008).

2) The Kyushu Electric Power Company

Contract with NPTC and ADB for the establishment of JV company of a renewable energy power generation business in India aiming at the development of renewable energy plants with total output of 500 MW in three years, following feasible project finding. (Nov., 2010)

CHAPTER 3

POWER SECTOR SITUATION IN RAJASTHAN AND ACTIVITIES OF JAPANESE FIRMS

CHAPTER 3 POWER SECTOR SITUATION IN RAJASTHAN AND ACTIVITIES OF JAPANESE FIRMS

3.1 DMIC Concept in Rajasthan

3.1.1 DMIC Concept

(1) Outline of the DMIC Concept

The concept of DMIC has been agreed between the governmental officials of Japan and India. Beginning with the Yen Credit project for the Mass Rapid Transport System between Delhi and Mumbai, development of infrastructure surrounding the DMIC areas is promoted intensively by private sector's participation and investment under facilitation of both governments.

One of the major projects in the DMIC Concept is the Mass Rapid Transport System Project which is funded by Yen Credit and will connect Delhi and Mumbai for approximately 1,500 km, and this project will be the backbone for industrial logistics. Furthermore, by using private investments, industrial complexes and logistics bases will be developed along the corridor.

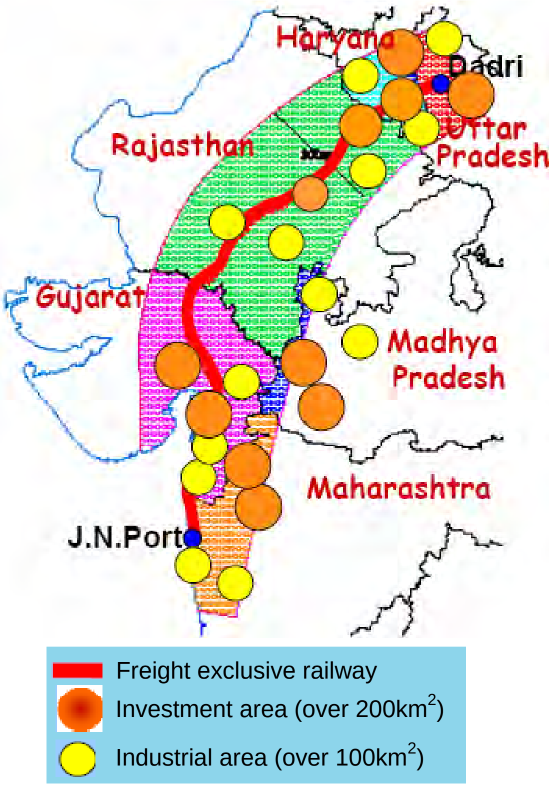


Fig. 3.1-1 DMIC's Target Areas

Source: METI

The MoU among DMIDC, JETRO and Japanese companies concerned on the four (4) F/S projects of "Smart Communities and Eco-friendly Townships" has been agreed in December, 2009. The F/S on the multi-sectional improvement of urban infrastructure development such as electric power, water and sewerage, and urban transport has been implemented.

There are projects called "Early Bird Project (EB)" within the framework of DMIC. Each of Indian and Japanese government chooses its own projects among EB and implements them. At present, Japan has chosen 6 projects and while India has picked 21 projects. Among the power sectors, the Energy Center Project at the NIC in Rajasthan State is now at the stage of

F/S implemented by a group of private firms.

Early Bird Projects from Japan side (6 projects)

○**Rajasthan**
1. Concept of Neemrana Industrial Area corporative energy center:
   Hitachi, Neemrana Japanese Participating Companies
2. Neemrana Logistics Hub Construction Project: NYK

○**Uttar Pradesh**
1. Free Trade Warehousing Zone Project: Mitsui & Co., Ltd.

○**Haryana**
1. Free Trade Warehousing Zone Project: Mitsui & Co., Ltd.

○**Maharashtra**
1. Human Resources Training Project (Maharashtra (Base), Whole India)
   Planning and Proposal: Techno Brain Company
   Technical Support: Sony Corporation
   Implementation Organization: Science and Technology Park (Public Corporation of the state)

○**Gujarat**
1. Textile & Mobile Phone Recycling Infrastructure Project: Japan Environment Planning

Early Bird Projects from India side (21 projects)

○**Haryana**
1. Multimodal Logistics Hub (Rewari)
2. Convention Center

○**Madhya Pradesh**
1. Knowledge City (Ujjain District)
2. Water Supply and Waste Water Management for Pithampur Industrial Area
3. Integrated Multimodal Logistic Hub (Pithampur)
4. Development of Economic Corridor (Indore Airport - Pithampur SEZ)

○**Gujarat**
1. Mega Industrial Park (Dholera)
2. Development of International Airport (Ahmedabad)
3. Six Laning of Highway (Ahmedabad-Vataman-Pipli-Bhavnagar)
4. Mass Rapid Transit System (Gandhinagar -Ahmedabad -Dholera)

○**Maharashtra**
1. Mega Industrial Park (Shendra- Bidkin District)
2. Mega Industrial Park (Supa- Newasa-Dhavlapuri District)
3. Multimodal Logistics Park (Talegaon)
4. Transportation and Tele-communication Network (Pune - Nashik and Pune- Aurangabad highways)
5. Convention Center (Navi - Mumbai)

○**Rajasthan**
1. Road link connecting Bhiwadi and Neemrana
2. Airport City near Jaipur
3. Knowledge City

○**Uttar Pradesh**
1. Development of Boraqui Railway Station
2. Integrated Multimodal Logistics Hub (Greater NOIDA)
3. Development International Airport (Greater NOIDA)

Fig.3.1-2 Early Bird Project (EB)

Source: METI

(2) Industrial Areas and Infrastructure Development in Rajasthan

In DMIC, there are industrial areas of Delhi, Gurgaon, Manesar, Bawar and Neemrana along Route No.8, in that order. Gurgaon, Manesar and Bawar are located in Haryana and Neemrana is located in Rajasthan. Bawar is located at the boundary area between the states of Haryana and Rajasthan. Japanese manufacturers have offices and factories in these areas.

Because Route No.8 is a highway between Delhi and Mumbai with heavy traffic, the renovations of the road are on the way everywhere. Many big trucks and trailers are also seen due to heavy freight transportations. Therefore, it is believed that the construction of railway for freight transportation will contribute to the social and economic development in the DMIC region.

The DMIC concept has a plan to construct the railway for freight transportation which is to build new railway lines between Delhi and Mumbai, approximately 1,500 km and to transport double stack cargo containers massively and rapidly by electric train. This project is implemented by the support of Japanese technology through tied Yen Credit. It is expected to be the backbone of industrial logistics for DMIC.

Announcement of Ministry of Economy, Trade and Industry (METI)

Governmental officials held the Annual Bilateral Summit in New Delhi on 29 December, 2009 and issued the following statements.

- Both sides welcomes the commencement of the preparatory survey of the second phase, and will make utmost efforts for early and simultaneous completion of both phases.
- The two leaders will also work together for conclusion of the agreement for the Main Loan for the first phase by March 2010 and for commencement of the assistance for the second phase at the earliest in 2010.
- Both sides will strive for early finalization of a funding and implementation schedule for the whole Western Corridor.

Amounts of Yen Loan concerning to DMIC are as shown below.

- Engineering service of Phase-I on October 2009 (2,606 million yen)
- A part of Phase-I on March 2010 (90,262 million yen)

Transportation and infrastructure in the DMIC area is more developed than those in other areas in India and expected to develop much further by increasing of Japanese companies in the future.

(3) NIC

The NIC has been developed as a part of the DMIC concept. Neemrana is a name of town and located in Behror city of the Alwar district. Neemrana is 123 km away from Delhi and 139 km away from Jaipur. The Rajasthan State Industrial Development and Investment Corporation Limited (RIICO) facilitates Japanese companies' participations in investment and establishment in the NIC in cooperation with JETRO. RIICO has its head office at Jaipur and branch office in the NIC. It is developing other industrial areas in Rajasthan State and attracting the investment to these areas.

The NIC Phase-III has been developed for Japanese companies. This area is located at east side of Route 8. The eleven (11) Japanese manufacturers such as DAIKIN and TOYODA GOSEI have already been operating. In addition, seventeen (17) companies are planning to establish their offices or factories.

Regarding the infrastructure around the NIC, the railway runs along the neighborhood. There are two railway stations around the NIC. Bawar station is 26 km away and Ajaruka station is 29 km away from the NIC. Other routes of railway are Khatuwas station (15 km) and Rewari station (39 km). The freight railway project of the DMIC concept is expected to leverage them.

Elevation of Neemrana is at EL. 309 m. The temperature is 25 - 45 degrees in Celsius in summer and 5 - 25 degrees in Celsius in winter. The average humidity is 53.8%. The average rainfall is 620 mm/year. There are no river around Neemrana. Accordingly, the manufacturers in the NIC are pumping groundwater for water use.

Land and labor costs are low in Neemrana compared with Haryana. However, due to the shortage in human resource in Rajasthan, manufacturers in the NIC intend to procure skilled workers and officers from Haryana. Therefore, labor costs tend to rise and number of labors is increasing around the NIC area. Their accommodation is under construction and lodging expense is rising, too.

Development of infrastructures such as telecommunication, internet, banking, ATM, postal, police, hospitals, schools, hotels and markets is proceeding.[1]

The electric power is supplied for the NIC by 11 kV or 33 kV distribution lines from 220 kV substation of Neemrana or 132 kV substations of Behror and Shahjahanpur.

The mega solar project of 5 MW is under way on the scheme of research cooperation at the

1 There are Rath international school and technical colleges.

NIC by New Energy and Industrial Technology Development Organization (NEDO). This project has started since 2008 in cooperation with MOP as the counterpart.[2] 1 MW out of the 5 MW is planned to operate as a micro grid which composed of 1 MW PV and diesel power generators. The rest of 5 MW, corresponding to 4MW, is planned to be introduced to the Japanese latest PV module as demonstration.

On the other hand, the project is proceeding to transmit stable power to Japanese companies in the NIC by gas turbines from Independent Power Producer (IPP). The F/S for this project by the METI has been already completed, and the proponents are proceeding the coordination with related organizations such as JETRO and RIICO and consumers. At present, Japanese companies generate power by their own diesel generators at the time of the power failure, but the cost for power generation by diesel generators is high at 15 INR/kWh. Therefore, the selling price of electricity by IPP becomes an important issue for the viability of the Project.

The Study aims to improve the power distribution facilities of JVVN supplied from outside to inside of the industrial area, while other projects aims to develop or provide the power supply within the industrial area. It could decrease dependence on the power by captive power supply owned by factories, but it must be insufficient to greatly improve the power supply to Japanese companies as power generation by diesel generators is not required. Therefore, comprehensive measures are desired for consumers. Also, arrangement of power distribution system enables to supply the surplus power generated in the industrial area to outside.

As described above, it can be expected that the Project will work efficiently for consumers in the industrial area who are the target of other ongoing projects. Therefore, the Project can establish the Win-win relationship with other ongoing projects.

3.1.2 Issues on the DMIC Concept

Before analyzing issues on the DMIC concept including the NIC in Rajasthan State, the issues in the whole of India and Neemrana need to be clarified respectively. First of all, issues in India are noted as follows.

- In India, it becomes difficult to develop infrastructures and establish manufacturing factories because of increase of public awareness for the social, environmental and local residential requirements for their rights. It is difficult for the project developer to implement land acquisition and to bear compensation. Even the India's largest conglomerate Tata Group’s construction works of new manufacturing factories have been

2 New Energy and Industrial Technology Development Organization (NEDO) has conducted six projects in India.

interrupted by the opposition to the development plan from local residents in spite of the environmental impact assessment and land acquisition processes in accordance with Indian laws.

- The information related to social environment and land acquisition has spread to other regions all over the country through telecommunications such as internet and mobile phones. This is becoming a serious problem for investors and developers.

- It has been very difficult for Japanese companies to be awarded a contract even in Yen Credit projects. In the power sector of India, since local Indian companies have more advantages in cost and Chinese companies have broad experience of projects on power sector, price competition is getting severer.

- The Mass Rapid Transport System Project is partially implemented by tied Yen Credit. However, Japanese companies do not necessarily make positive efforts to participate in the tender because it includes various risks such as delay of the construction schedule due to land acquisition of railway lines, environmental countermeasures during the construction and compensation after the commissioning.

- In addition to social environmental issues mentioned above, there are problems for approvals and licenses on power sector. It is difficult for developers to obtain the approval and permission of gas supply for power plants. The stakeholders who have established the interests make resistance against new gas supply for power generation. Moreover, the tariff of selling is low. The production of gas has drastically decreased at KG mine site in Orissa State operated by Reliance Energy Ltd. It is assumed that Reliance Energy Ltd. has controlled its production because the purchase rate of gas for power generation is low.

- Private Public Partnership (PPP) on power generation projects is more popular than IPP. However, the government is only in charge of land acquisition and application for approvals and licenses. The private sector is generally in charge of fund procurement and construction works.

Secondly, issues on the NIC are noted as shown below. Issues on the electric power sector are described in the Section of 3.3.

- The manufacturers in the NIC are pumping the groundwater from a deep well with depth of approximately 100 m. The regulation of Rain Water Harvesting is in force so that companies can only use amount of water equivalent to less than annual rainfall in the area of their factories.[3] Thus, they must fill in the gaps of required water by purchasing it from outside. In addition, diesel power generators require cooling water. The burden for the cost of water has been a serious problem for manufacturers in the NIC.

- As the electric power quality is not high in the NIC, the project on improvement of electric power supply is proceeding. On the other hand, the improvement of electric power supply from existing facilities is also expected. Nevertheless, there are various kinds of voltage in the grid system, and this makes the power grid including the future plan so complicated.

- Since the power supply from the grid is unstable, manufacturers own their diesel power generators. The critical load that is power supply of equipments for production is a maximum of 2 MW. If manufacturers introduce the system for synchronized operation between diesel generation and PV power generation for the stable power supply, manufacturers must bear the expense for improvement of their substation facilities.

Accordingly, it seems to be valuable to formulate projects on development of power grid to satisfy the electric power quality required by consumers by means of introduction of Japanese advanced technology for grid stability.

3 Yoichi IMAI, Power Supply Business in the Neemrana Industrial Area in India, Technical Paper of HITACHI, 2009.6. The Rajasthan state government has made rainwater harvesting mandatory for all public and establishments and all properties in plots covering more than 500 sq m in urban areas (http://www.rainwaterharvesting.org/policy/Legislation.htm#raj).

3.2 Current Situations and Issues of Power Infrastructure

3.2.1 Power Sector of Rajasthan

The power sector of Rajasthan is under the jurisdiction of the Department of Energy (DOE). As the regulating body, the Rajasthan Electricity Regulatory Commission is authorized as the body to provide permission and license.

While the Rajasthan State Electricity Board used to control power generation, transmission and distribution in Rajasthan, the Board was divided into the following companies owned by the state governments. The state guarantees open access on transmission, distribution, or related facilities.

Sector	Company Name	Representative	Location
Generation	Rajasthan Rajya Vidyut Utpadan Nigam Ltd. (RVUN)	Shri N.S.Chaudhary	Jaipur
Transmission	Rajasthan Rajya Vidyut Prasaran Nigam Ltd. (RVPN)	Shri Shrimat Pandey	Jaipur
Distribution	JVVN	Shri R. G.Gupta	Jaipur
	AjVVN	Shri S.C.Dutta	Ajmer
	JoVVN	Shri S.R.Bansal	Jodhpur

3.2.2 Electric Power Policy in Rajasthan

(1) Reform of the Power Sector

The power supply cost in Rajasthan is higher than those in other states for the following reasons. First of all, due to the lack of energy resources, especially coal, Rajasthan receives the resource by rail from other states. The state also purchases electricity not only from companies owned by the state governments, but also the federal government's thermal and nuclear power companies. Second, since two-thirds of the area of Rajasthan is covered by deserts, and its population density is low.

In addition, despite high power generation cost, the power tariff for domestic and agricultural use is set as low as those in many of other states, and the state government covers the difference between the generation cost and the power tariff, which has led to the chronic deficits. Moreover, like other states, Rajasthan has many problems such as high system loss of power, sudden fluctuation of voltage and frequency, power demand restriction and high commercial loss.

Given this situation, Rajasthan enacted "Rajasthan Power Sector Reforms Act" in December 1999 to embark on the reform of the power sector. This act is a basic electric power policy in Rajasthan and its outlines are shown below.

(2) Objectives and Issues

The objectives of the power sector reform are to;

- supply electricity to customers in the most effective way in terms of quality and cost in order to support the state's economic development,
- ensure mobility in the power sector and achieve funding for grid expansion, and
- improve the regulatory environment to attract investment and encourage competition by participation of new entities from private sectors in power generation, transmission and distribution business.

The issues of the power sector reform are to;

- make financial soundness of the power sector by establishing a independence regulatory body, protect consumer interests in terms of quality, price and reliability, and improve the electric tariff structure step by step, and reduce the governmental subsidies,
- establish independent organizations in each power generation, transmission and distribution business,
- reorganize segments of the distribution areas from economic standpoints,
- attract investment in the power sector by increasing its profits,
- promote competition in the power sector, and
- enhance demand management and efficient use of electricity for environmental protection.

(3) Generation Sector

While the power generation company is initially to be a wholly-owned government one, the private sector's participation will be encouraged. The future vision of the power supply in Rajasthan will be as follows:

- IPPs selected through international biddings
- Federal government's power generation business
- Power generation company owned by the state or by a joint venture among private sectors, other states and federal government

(4) Transmission Sector

The transmission company is basically a wholly-owned government one. The roles of the transmission company is to purchase electricity from the power generation company and IPPs in the state, and purchase from and exchange electricity with the federal government-owned companies, or state or private companies in other states. The transmission company plays a role of a central command center of power feeding, and also provides the distribution company with electricity at a low price.

(5) Distribution Sector

While the distribution company is initially to be wholly owned by the government, it will be a joint venture whose capital of more than 50% is owned by private sectors in stages. The private sectors will be selected through international biddings from technical and financial standpoints. Based on costs, performances and discussions with the regulatory body, each distribution company will set the power tariff.

(6) Funding

In order to secure stable power supply, the government of Rajasthan will sell shares holding of the existing companies for development of infrastructure.

(7) Demand Management

The demand management is emphasized to maintain stable power supply and reduce the power demand as follows:

- Introduce demand management through the power tariff reform
- Improve efficiency of agricultural pumps and industrial machinery
- Disseminate energy conservation to consumers

(8) Summary of the Power Sector Reform in Rajasthan

Rajasthan government embarked on the power sector reform including unbundling, introducing private capital and revising (raising) the power tariff. Although 10 years have already passed since the reform was enacted, it seems that it has been still under proceeding except the establishment of the regulatory body and unbundling.

3.2.3 Outlook of Power Supply and Demand in Rajasthan

Power consumption by sector in 2005 - 2007 and proportion of power consumption by sector in 2007 in Rajasthan are shown below.

Table 3.2-1 Power Consumption by Sector in Rajasthan (2005-2007)

Sector	Consumption (Million kWh)		
	2005	2006	2007
Domestic	35,256.83	37,597.91	44,623.79
(Non-Domestic) Commercial	11,309.56	12,573.94	15,297.96
Small Industries	5,564.95	5,726.52	6,297.55
Medium Industries	10,246.34	11,092.65	12,676.97
Large Industries	41,591.06	46,574.89	53,769.37
Public Lighting	1,252.24	1,317.23	1,528.53
Public Water Works	10,275.51	10,493.27	11,624.91
Agriculture	56,238.13	66,581.98	81,455.92
Others	7,586.41	8,400.82	9,302.93
Total	**179,321.03**	**200,359.21**	**236,577.93**

(Source STATISTICAL ABSTRACT, RAJASTHAN, 2010)

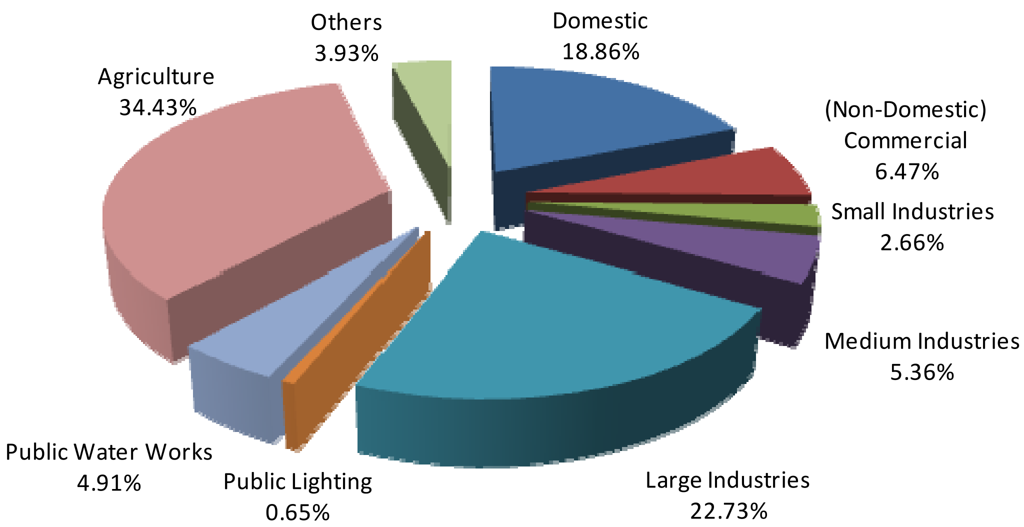


Fig.3.2-1 Proportion of Power Consumption by Sector in 2007

(Source: STATISTICAL ABSTRACT, RAJASTHAN, 2010)

Increase in power demand is outstanding as power consumption shows 17% increase in 2006 and 18.1% increase in 2007 compared with the previous year.

Power production by type of energy source in Rajasthan (including power production by the Federal Government) in FY 2008 - FY 2010 is shown in Table 3.2-2.

Table 3.2-2 Power Production by Type of Power Source in Rajasthan (including Power Production by the Federal Government)

(TWh)

Sector	Type	FY2008	FY2009	FY2010
State	Coal	18.9	19.5	21.1
	Natural Gas	2.6	2.8	2.3
	Hydro	0.7	0.3	0.4
Private	Coal	-	0.2	1.0
Federal	Coal	-	0.0	0.3
	Natural Gas	2.5	3.0	2.5
	Nuclear	2.3	3.5	7.7
Total		27.0	29.4	35.3

(Source: Central Electricity Authority, MOP, Monthly Report)

Power production by nuclear power plants by the Federal Government increased more than three times for three years.

DOE in Rajasthan estimates the future power supply-demand balance as follows. According to this estimation, power shortage of 1,381 MW (14.36%) is expected until 2012, but surplus power of 3,172 MW (30.36%) is expected to be available from 2013 because of increasing capability of power supply by the Central Government and Rajasthan State.

Table 3.2-3 Outlook of Power Supply Demand Balance in Rajasthan

(Unit : MW)

	XI-Plan					XII-Plan					
	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2021-22
	(Actual)	(Actual)	(Actual)	Projections							
1. State sector	4,000.31	4,375.31	4,820.31	5,070.31	6,943.96	6,943.96	10,573.96	10,573.96	13,373.96	14,693.96	14,693.96
A. Total-Shared Projects	*972.96*	*972.96*	*972.96*	*972.96*	*986.61*	*986.61*	*986.61*	*986.61*	*986.61*	*986.61*	*986.61*
B. Total-RVUN Projects	*3,027.35*	*3,402.35*	*3,847.35*	*4,097.35*	*5,957.35*	*5,957.35*	*9,587.35*	*9,587.35*	*12,387.35*	*13,707.35*	*13,707.35*
2. Total Central Sector Allocation	1,853.98	1,878.17	1,977.21	2,273.65	2,446.65	2,508.65	2,968.65	3,376.65	3,621.65	3,951.65	3,951.65
3. Total Provice Sector Projects / Building Process	0.00	0.00	135.00	540.00	1,080.00	1,080.00	3,135.00	4,920.00	4,920.00	4,920.00	4,920.00
4. Total Ultra Mega Power Project (Considering 60% Success rate of UMPPS)	0.00	0.00	0.00	0.00	0.00	0.00	480.00	480.00	480.00	1,533.00	1,533.00
5. NES Projects	566.40	766.00	1,144.00	1,512.75	2,097.75	2,762.75	3,737.75	4,212.75	4,702.75	5,252.75	5,252.75
a. Wind Power	*535.10*	*734.70*	*1,084.70*	*1,436.70*	*1,886.70*	*2,311.70*	*2,736.70*	*3,161.70*	*3,601.70*	*4,101.70*	*4,101.70*
b. Biomass Power	*31.30*	*31.30*	*59.30*	*71.30*	*106.30*	*146.30*	*196.30*	*246.30*	*296.30*	*346.30*	*346.30*
c. Solar Power	*0.00*	*0.00*	*0.00*	*4.75*	*104.75*	*304.75*	*804.75*	*804.75*	*804.75*	*804.75*	*804.75*
6. Grand Total of Installed Capacity (1 to 5)	6,420.69	7,019.48	8,076.52	9,396.71	12,568.36	13,295.36	20,895.36	23,563.36	27,098.36	30,351.36	30,351.36
7. Grand Total of Installed Capacity (1 to 5) (Excluding Wind Power)	5,885.59	6,284.78	6,991.82	7,960.01	10,681.66	10,983.66	18,158.66	20,401.66	23,496.66	26,249.66	26,249.66
8. Total Peaking Capacity (75% of 7)	4,414.19	4,713.59	5,243.87	5,970.01	8,011.25	8,237.75	13,619.00	15,301.25	17,622.50	19,687.25	19,687.25
9. Peak Demand as per New Forecast (From 2010-11 to 106-17)	5,564.00 (Actual)	6,101.00 (Actual)	6,859.00 (Actual)	8,287.00	8,927.00	9,619.00	10,447.00	11,604.00	12,894.00	14,396.00	22,000.00
				(As per New Forecast)							
10. Deficit / Surplus (-/+) (8-9)	-1,149.81	-1,387.42	-1,615.14	-2,316.99	-915.76	-1,381.26	3,172.00	3,697.25	4,728.50	5,291.25	-2,312.76
11. Deficit / Surplus (%) (8-9)	-20.67%	-22.74%	-23.55%	-27.96%	-10.26%	-14.36%	30.36%	31.86%	36.67%	36.75%	-10.51%

(Source : RRVUN)

3.2.4 Situation and Issues of Power Supply-Demand in Rajasthan

(1) Current Situation of Power Supply in Rajasthan

1) Current situation of power supply

Present status of power generation plants is shown in the following table. The table shows the installed or allotted capacity of the state owned or the shared plants.

Table 3.2-4 (1/3) Capacities of Power Generation Facilities in Rajasthan (RVPN Grid as of June 2011)

		Installed Capacity (MW)	Raj. Share (%)	Firm capacity available to Raj. (MW)
1. State Sector		**5,812.645**		**5,812.645**
(a) Hydro		**163.85**		**163.85**
1) Mahi	(2 × 25 + 2 × 45)	140.00	100.00	140.00
2) Anopogarh	(3 × 1.5 + 3 × 1.5)	9.00	100.00	9.00
3) Mahi-RMC	(2 × 0.4 + 1 × 0.165)	0.97	100.00	0.97
4) Suratgarh MH	(2 × 2)	4.00	100.00	4.00
5) Mangrol MH	(3 × 2)	6.00	100.00	6.00
6) Pugal MH	(1 × 1.5 + 1 × 0.65)	2.15	100.00	2.15
7) Charanwala	(1 × 1.2)	1.20	100.00	1.20
8) Birsulpur MH	(1 × 0.535)	0.54	100.00	0.54
(b) Thermal / Gas		**3,933.50**		**3,933.50**
1) KTPS Stage I, II, III	(2 × 110 + 2 × 210 + 1 × 210)	850.00	100.00	850.00
2) KTPS Stage IV	(1 × 195)	195.00	100.00	195.00
3) Ramgarh Gas	(1 × 3)	3.00	100.00	3.00
4) Ramgarh Gas	(1 × 35.5)	35.50	100.00	35.50
5) Ramgarh Gas Extension	(2 × 37.5)	75.00	100.00	75.00
6) STPS Stage I, II, III	(2 × 250 + 2 × 250 + 1 × 250)	1,250.00	100.00	1,250.00
7) Dholpur GTPP Unit 1 to 3	(3 × 110)	330.00	100.00	330.00
8) Giral TPS Stage I Unit 1&2	(2 × 125)	250.00	100.00	250.00
9) STPS Stage IV, Unit-1	(1 × 250)	250.00	100.00	250.00
10) KTPS Stage V, Unit-7	(1 × 195)	195.00	100.00	195.00
11) Chhabra TPS Stage I, Unit-1	(1 × 250)	250.00	100.00	250.00
12) Chhabra TPS Stage I, Unit-2	(1 × 250)	250.00	100.00	250.00
(c) Non-Conventional (Wind, Biomass)		**1,715.295**		**1,715.295**
1) Wind Power		1,616.495	100.00	1,616.495
2) M/s Kalpataru Power Ltd.	(Biomass)	15.800	100.00	15.800
3) M/s Chambal Power Ltd.	(Biomass)	7.500	100.00	7.500
4) M/s Amrit Environmental Power Ltd.	(Biomass)	8.000	100.00	8.000
5) M/s Sanbhav Energy Ltd.	(Biomass)	20.000	100.00	20.000
6) M/s S.M. Environmental Tech. Ltd.	(Biomass)	8.000	100.00	8.000
7) M/s Trans Tech Green Power Pvt. Ltd.	(Biomass)	12.000	100.00	12.000
8) M/s Satyam Power Pvt. Ltd.	(Biomass)	10.000	100.00	10.000
9) M/s Sanjog Sugar Pvt. Ltd.	(Biomass)	10.000	100.00	10.000
10) M/s Realiance Industries Ltd.	(Solar)	5.000	100.00	5.000
11) M/s Acme Telepower Ltd.	(Solar)	2.500	100.00	2.500

Table 3.2-4 (2/3) Capacities of Power Generation Facilities in Rajasthan (RVPN Grid as of June 2011)

		Installed Capacity (MW)	Raj. Share (%)	Firm capacity available to Raj. (MW)
2. Shared Projects		**3,564.80**		**972.95**
(a) Hydro		**3,252.30**		**847.95**
1) B.B.M.B. Complex				
i) Bhakra Left Bank	(5 × 108)	540.00	15.22	82.18
ii) Bhakra Right Bank	(5 × 157)	785.00	15.22	119.48
iii) Kotla	(1 × 29.25 + 1 × 24.2 + 1 × 24.2)	77.65	15.22	11.82
iv) Ganguwal	(1 × 29.25 + 1 × 24.2 + 1 × 24.2)	77.65	15.22	11.82
v) Dehar	(6 × 165)	990.00	20.00	198.00
vi) Pong	(6 × 66)	396.00	58.50	231.66
2) Chambal Complex				
i) Gandhi Sagar	(5 × 23)	115.00	50.00	57.50
ii) Rana Pratap Sagar	(4 × 43)	172.00	50.00	86.00
iii) Jawahar Sagar	(3 × 33)	99.00	50.00	49.50
(b) Thermal		**312.50**		**125.00**
1) Satpura	(5 × 62.5)	312.50	40.00	125.00
3. Central Sector Projects Allocation		**20,016.65**		**2,248.58**
(a) Hydro (NHPC/SJVNL/THDC)		**5,494.20**		**486.86**
1) Tanakpur	(3 × 31.4)	94.20	11.53	10.861
2) Salal Stage I & II	(690)	690.00	2.95	20.355
3) Chamera-I	(3 × 180)	540.00	19.60	105.840
4) Uri	(4 × 120)	480.00	8.96	43.008
5) Chamera-II	(3 × 100)	300.00	9.67	29.010
6) NJPS	(6 × 250) (SJVNL)	1,500.00	7.47	112.000
7) Dhauli Ganga	(4 × 70)	280.00	9.64	27.000
8) Tehri Stage 1 (Unit I to IV)	(4 × 250) (THDC)	1,000.00	7.50	75.000
9) Dulhasti HEP (Unit I to III)	(3 × 130)	390.00	10.88	42.420
10) Sewa HEP Stage II (Unit 1 to 3)	(3 × 40)	120.00	10.84	13.008
11) Koteshwar HEP (Unit 1)	(4 × 100)	100.00	8.36	8.360
(b) Thermal / Gas (NTPC)		**12,902.45**		**1,204.98**
1) Singrauli	(2 × 110 + 2 × 210 + 1 × 210)	2,000.00	15.00	300.00
2) Rihand TPS Stage I	(1 × 195)	1,000.00	9.50	95.00
3) Rihand TPS Stage II	(1 × 3)	1,000.00	10.00	100.00
4) Anta Gas	(1 × 35.5)	419.33	19.81	83.07
5) Anta Gas	(2 × 37.5)	663.36	9.20	61.03
6) Dadri Gas	(2 × 250 + 2 × 250 + 1 × 250)	829.76	9.28	77.00
7) Unchahar TPS	(3 × 110)	420.00	4.76	20.00
8) Unchahar TPS Stage II	(2 × 125)	420.00	9.05	38.00
9) Unchahar TPS Stage III	(1 × 250)	210.00	10.95	23.00
10) Kahalgaon Stage II	(1 × 195)	1,500.00	4.87	73.00
11) Barsingsar TPS Stage I, Unit 1	(1 × 250)	125.00	100.00	125.00
12) Barsingsar TPS Stage I, Unit 2	(1 × 250)	125.00	10.00	125.00
13) E.R. (in lieu of Tala-6 × 170 = 1,020 MW)				
i) Farakka	(0.69%)	1,600.00	0.69	11.04
ii) Kahalgaon-I	(3.04%)	840.00	3.04	25.54
iii) Kahalgaon-II	(2.24%)	1,500.00	2.24	33.60
iv) Majia	(5.88%)	250.00	5.88	14.70

Table 3.2-4 (1/3) Capacities of Power Generation Facilities in Rajasthan (RVPN Grid as of June 2011)

		Installed Capacity (MW)	Raj. Share (%)	Firm capacity available to Raj. (MW)
(c) Nulear (NPC)		**1,620.00**		**556.74**
1) RAPP	(1 × 100 + 1 × 200)	300.00	100.00	300.00
2) NAPS	(2 × 220)	440.00	10.00	44.00
3) RAPP Extension Unit 3	(1 × 220)	220.00	28.41	62.50
4) RAPP Extension Unit 4	(1 × 220)	220.00	28.41	62.50
5) RAPP Unit 5	(1 × 220)	220.00	19.94	43.87
6) RAPP Unit 5	(1 × 220)	220.00	19.94	43.87
4. Private Sector Projects		**270.00**		**270.00**
1) M/S Raj West Power (Unit 1&2)	(3 × 31.4)	270.00	100.00	270.00
Grand Total (1 to 4)		**29,664.10**		**9,304.18**
Capacity added during April 11 to June 11 (Prov.)		Increase in installed capacity (MW) / Comm./Sync./Date	Raj. Share (%)	Available capacity to Raj. (MW)
1. Koteshwar HEP Unit 1	(4 × 100)	100 MW/1-4-11	8.36	8.360
2. Wind Power		44.8 MW/May-11	44.80	44.800
3. Wind Power		50.3 MW/June-11	50.30	50.300
4. M/S Sanjog Sugar Pvt. Ltd.	(Biomass)	10 MW/June-11	10.00	10.000
5. M/S Acme Telepower Ltd.	(Solar)	2.5 MW/June-11	2.50	2.500
Total Increase				**115.96**

Total capacity of power generation facilities in Rajasthan is 9,304.18 MW as of July 2011, which breakdown is 5,812.65 MW by the state plants, 972.95 MW by the shared plants with other states, 2,248.58 MW by the central government plants, and 270.00 MW by private plants.

Breakdown of installed capacity of power stations owned by the state is 163.85 MW (2.8%) of Hydro, 3,933.50 MW (67.7%) of Thermal/Gas, 1,616.50 MW(27.8%)of Wind, 98.8 MW (1.7%) of Biomass, and 7.5 MW (0.1%) of Solar. Installed capacity of wind power is outstanding in Jaisalmer District in Rajasthan. Moreover, development of wind power generation by IPPs is promoted in Jaisalmer.

Development plan of new power stations by RVUN is shown as follows.

① State projects under implementation in 11th Five-year Plan

Name of Unit	Capacity (MW)	Date of Commissioning
KALISINDH TPS UNIT-1	600	31/12/2012
KALISINDH TPS UNIT-2	600	31/03/2012
CHHABRA TPS PHASE 2 (UNIT-3)	250	31/10/2011
CHHABRA TPS PHASE 2 (UNIT-4)	250	31/10/2011
RAMGARH EXTN. PROJECT GT	110	31/03/2012
RAMGARH EXTN. PROJECT ST	50	31/03/2012
Total	1,860	

Source: DOE

② Projects to be approved in 12th Five-year Plan

Name of Unit	Generation Type	Capacity (MW)	Likely Year of Commissioning
Suratgarh TPS Units 7, 8 (Stage V)	Coal	1,320	Early 12th Plan
Chhabra TPS Units 5, 6 (Stage II)	Coal	1,320	Early 12th Plan
Kota Gas Power Project	Gas	330	2013-2014
Chhabra Gas Power Project	Gas	330	2013-2014
Ramgarh Gas Power Station (Stage -IV)	Gas	160	2015-2016
Dholpur Gas Power Station (Stage -II)	Gas	330	2013-2014
Suratgarh TPS Units 9-10 (Super Critical)	Coal	1,320	2015-2016
Kalisindh TPS Units 3-4 (Super Critical)	Coal	1,320	2015-2016
Banswara TPS Units 1-2 (Super Critical)	Coal	1,320	2016-2017
Total		**7,750**	

Source: DOE of Rajasthan

In Rajasthan, the power supply is in severe shortage. The shortage of the supply is covered by power exchange from other states.

For such current situation, RVUN is planning to construct new thermal power plants of Coal/ Natural gas of 1,860 MW in 2012 and 7,750 MW in the 12th Five-year Plan. Installed capacity of thermal power plants to be implemented by RVUN to start commercial operation by the end of 2013 is 4,500 MW in total, and it almost correspond to the capacity for RVUN projects shown in Table 3.2-3. Thus, Rajasthan State is engaging for satisfying the supply-demand balance in the future.

2) Issues

Power supply-demand in Rajasthan shows shortage of power supply in 2009, but it is expected that the supply will exceed the demand after 2012 by development of new power plants. On discussion with the government of Rajasthan, rapidly increasing power demand is recognized, however it can be managed by development of new power plants in Rajasthan.

On the other hand, it is afraid that construction of a new power station is interrupted by issues of environmental and social consideration and land acquisition. According to the 12th Five-year plan, the development of power sources of 76,000 MW will be achieved, but many projects are behind the schedule due to the environmental and social consideration. For instance, even Tata Motors, one of the largest companies in India, had to move the construction site of its factory in Kolkata to Gujarat due to the residential issues. Also in the case of the Sumitomo Corporation’s project, the award for contract was expired because the environmental regulation issues were not settled.

Moreover, there is the possibility that fuel procurement becomes a large issue. It was reported in October 2011 about the difficulty of coal supply in India due to increasing demand for coal/gas in late years.

(2) Situation and Issues of Power Infrastructure in Rajasthan

1) Current situation of power infrastructure

Rajasthan is connecting to interstate transmission lines of other states. Table 3.2-2 shows that the transmission network in Rajasthan consists of 400 kV, 220 kV, 132 kV and 69 kV of AC.

The 400 kV / 220 kV transmission grid in the state is operated by RVPN and POWER GRID Corporation which the central government is running. POWER GRID Corporation operates transmission lines interconnected to other states such as Haryana in the northeast, Madhya Pradesh, and Gujarat in the southwest.

The distribution lines are of mainly 33 kV or 11 kV of AC and consumers are supplied with 415 V / 240 V.

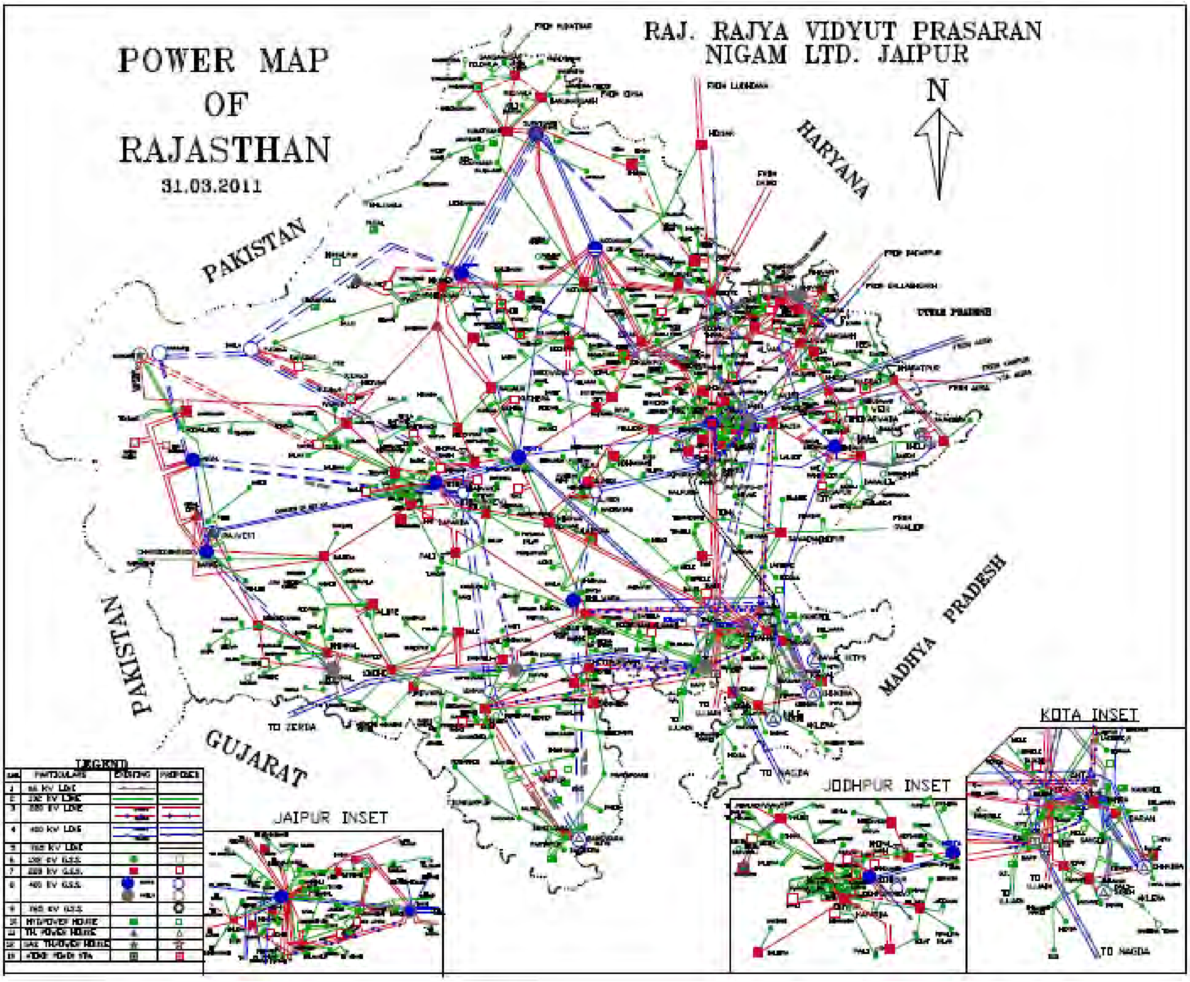


Fig. 3.2-2 Power Map of Rajasthan

(Source: DOE in Rajasthan)

2) Issues

Rajasthan depends on the power interchange from the grid transmission lines of other states. As this issue leads to a decline in reliability of the power supply, the grid transmission lines need to be reinforced.

(3) Situation and Issues of Grid Operation in Rajasthan

Period and number of power failure, power quality such as frequency and voltage deviation rate, and grid loss can be used as the indicators to show the situation of the grid operation in Rajasthan. The targets and performance levels of these indicators are shown in Table 3.2-5.

Table 3.2-5 Power Quality Indicators in Rajasthan (Year 2010 - 2011)

No.	Particulars	Voltage	Level of Performance specified by the Commission		Actual Performed Level		Inference Interior/Superior	
1	System Availability	Level 3						
		132 kV	98%		99.91%		Superior	
		33 kV	98%		99.78%		Superior	
		11 kV	98%		99.84%		Superior	
2	Voltage Profile		Max.	Min.	Max.	Min.	Max.	Min.
		400 kV	420	360	438	368	Inferior	Superior
		220 kV	245	200	250	161	Inferior	Inferior
		132 kV	145	120	152	92	Inferior	Inferior
		33 kV	34.98	30.03	38	22	Inferior	Inferior
		11 kV	11.66	10.01	12.3	9.0	Inferior	Inferior
3	Voltage Unbalance	Level 3						
		400 kV	2.00%		4.33%		Inferior	
		220 kV	2.00%		6.87%		Inferior	
		132 kV	3.00%		7.54%		Inferior	
		33 kV	3.00%		5.41%		Inferior	
		11 kV	3.00%		5.80%		Inferior	
4	Voltage Variation	Level 3			For Higher Voltage	For Lower Voltage		
		400 kV	±1.125%		2.36	1.74	Inferior	Inferior
		220 kV	±1%		3.55	2.79	Inferior	Inferior
		132 kV	±1%		1.91	2.51	Inferior	Inferior
		33 kV	±1%		1.93	2.09	Inferior	Inferior
		11 kV			1.91	1.56	Inferior	Inferior
5	Frequency Variation Index	As per IEGC			---		---	
6	Loss of Load Expectation (LOLE)	Level 3	2.00%		---		---	
7	System Average Interruption Frequency Index (SAIFI)	Level 3						
		132 kV	18 Nos/year		3.39 Nos.		Superior	
		33 kV	18 Nos/year		4.79 Nos.		Superior	
		11 kV	18 Nos/year		4.79 Nos.		Superior	
8	System Average Interruption Duration Index (SAIDI)	Level 3						
		132 kV	8 Hrs/year		1.47 Hrs		Superior	
		33 kV	8 Hrs/year		2.36 Hrs		Superior	
		11 kV	8 Hrs/year		2.98 Hrs		Superior	

Note: The authenticity of figures in respect of voltage profile, voltage unbalance and voltage variation index are based on manual readings of Analogue meters.

(Ashwini Bhagat Secretary)

1) Performance (including grid accidents and power outage) and issues of power grid

According to Table 3.2-5, it seems that in general, the performance of the grid operation in Rajasthan accomplishes the target, and it is endorsed by the person of power supply side.

However, performance of distributing and receiving electricity for a consumer in the NIC described below is out of this target level from the view point of voltage range and number and period of power failure. In addition, according to interview survey in the NIC, the consumer is annoyed by additional cost due to increasing private power generation and concerns about impact on products produced by sensitive machine to power quality.

Therefore, it is expected to improve electric power quality. It can be considered that the causes of inferior quality of power are inefficiency of operation and maintenance, shortage of power supply, delay of development of power supply facilities, etc. According to the interview survey, some consumers desire to replace 11 kV distribution lines with 33 kV distribution lines, because the underground 33 kV lines are more reliable than the overhead 11 kV lines. However, actually, they have been stood up, because development of 33 kV distribution network is delayed. It is required that the development will be implemented as soon as possible.

2) Actual performance and issues of transmission and distribution grid loss

As for the performance of the transmission and distribution grid loss, the loss reaches to nearly 30 %. According to the performance across the country as shown above and the data on energy balance provided by IEA, the transmission and distribution loss is as high as 20 to 30 %. While the grid loss is affected by grid composition and reinforcement, the estimation indicates that the transmission loss will exceed 20% in the future. Given the fact that power loss should be 10% in general, it is assumed that the 20% to 30% loss might be caused not only by transmission, but also by other factors.

The actual technical loss might be smaller because total loss includes losses from other than technical factors. The authority concerned in India also recognizes that power loss by other than technical factors is included in the total loss. According to the National Action Plan on Climate Change of June 2008, the transmission and distribution grid losses in India is planned to be within 16% to 19%.

Other factors of the losses resulting in the overall grid loss could be power theft, power supply without installation of power meters and nonpayment. These illegal acts are conducted due to the following reasons, which contribute to the difficulty in understanding the actual situation of the grid loss:

- length of low-voltage distribution lines whose power can be stolen easily
- large number of low income persons
- low-quality meters which can be manipulated
- low rate of collecting electric bills

The reduction in the overall grid loss, which gives adverse impact on income of the power companies, by improving collecting system of electricity charge and introducing automatic metering system must be a high priority task to enhance the economic health of the power sector.

3.2.5 Potential of Building New Power Plants in Rajasthan

In order to explore the potential of new power plants, the availability of primary energy is investigated.

(1) Reserves and Issues of Primary Energy in Rajasthan

Reserves of primary energy available for power generation including natural energy in Rajasthan are shown below. Basically, few reserves are available or it takes time and cost to utilize them. Thus, development of coal-fired thermal or hydropower plants seems to include difficulty.

1) Lignite

Rajasthan has approximately 2,000 million tons of lignite close to ground surface, which is equivalent to 3,000 MW. Economic efficiency should be elaborately studied for the development in the future.

2) Methane gas

According to the assessment performed by the President’s Office, Barmer reserves methane gas reserves being equivalent to nearly 3,500 MW. . Economic efficiency should be elaborately studied for the development in the future.

3) Heavy oil

Rajasthan has about 15 billion tons of heavy oil and bitumen reserves, which can generate 8,000 to 10,000 MW.

However, the development rights of Oil India Ltd. belong to the companies from the Republic of Colombia, Europe and the U.S. Thus, Indian companies need to gain those rights.

4) Gas

While rights of gas in Jaisalmer is mostly owned by Oil and Natural Gas Corporation (ONGC), the survey on it has not started yet. On the other hand, OILf providing better terms of contract is negotiating the rights with the Rajasthan government

5) Hydropower

Development of hydropower plants is difficult since Rajasthan has few rivers.

6) Nuclear power

It is believed that nuclear power generation will decline in the next few decades due to the high cost and strict regulation on the global basis. Nevertheless, India and China are planning to expand their nuclear power generation, considering CO_2 reduction. Rajasthan receives 342 MW from the Rajasthan Atomic Power Project (RAPP) and Narora Atomic Power Station. The Nuclear Power Corporation has a plan to construct additional two units of 220 MW in RAPP Power Plant.

7) Wind power

Development of wind power generation by IPP is promoted in Rajasthan, and the installed capacity of the project will be of 1,616.50 MW. Potential of wind power generation is very high in Jaisalmer which has desert areas in the northwest of the state has good potential of wind power. Installed capacity of wind power plants in this district reaches 75% of a total installed capacity of wind power plants in Rajasthan.

8) Solar power

Rajasthan has a potential suitable for solar power generation, because it has small rainfall and large dry land in desert climate. According to Rajasthan Solar Energy Policy 2011 issued by DOE, it is planned to develop photovoltaic and power plants with the installed capacity of 200 MW of by 2013.

9) Natural gas

Rajasthan began to develop the Suratgarh Power Plant, Kota Power Plant and Ramgarh Power Plant. As the Ramgarh Power Plant has an issue of lack of gas supply, it plans to be supplemented by high-speed diesel.

10) Captive power generation

It is estimated that Rajasthan has 500 MW of captive power generation. While this type of generation has both advantages and disadvantages, it has contributed to the improvement in the reliability of the power supply.

In conclusion, not only the issues of development rights and costs, but also technical problems shall be solved while Rajasthan has the potential of primary energy resources used for power generation. Many procedures and clearances are required to utilize these energies. In addition, some types of power generation require a large volume of water, therefore F/S on each type of power generation and also the government’s clear policy are essential.

On the other hand, according to the recent studies conducted by Gas Authority of India Ltd. (GAIL), ONGC, Shell and other agencies, there are huge reserves of lignite and gas (coal bed methane gas and natural gas) in Rajasthan, which might be able to contribute to solving the supply shortage of electricity and meeting the demand.

(2) Feasibility of use of Fuel Transported from Other Areas

It can be considered that coal and natural gas transported from other areas are used for power generation. Coal has many issues relating to transportation costs, long-distance transport and transport of low-quality coal. On the other hand, natural gas can be used for power generation by transportation through the gas pipeline.

Natural gas is a promising efficient and environmentally-friendly fuel. The demand for natural gas is growing in India. Most of natural gas in India can be found in the offshore seabed of the western Indian Ocean. Most of natural gas is transported to Maharashtra. Gas pipelines is widely laid in India and extend to Delhi and Haryana by way of Rajasthan. Gas power generation projects by receiving natural gas from the pipeline is considered feasible and the gas power generation project in the NIC is also under way. In the case of gas power generation, the issues to secure cooling water in the state would be mitigated.

Meanwhile, the Ministry of Petroleum and Natural Gas controls the allocation and price of natural gas, and provides the agriculture sector favor prices, etc.

3.2.6 Electricity Tariff in Rajasthan State

(1) Electricity Tariff Policy in India

The electricity tariff in India is estimated by distribution companies based on the Tariff Policy enforced in 2006, and approved by the State Electricity Regulation Commission. The policy, supplementing provisions in Electricity Act of 2003, states details to determine the electricity tariff.

The objectives of the tariff are to:

(i) ensure availability of electricity to consumers at reasonable and competitive rates,
(ii) ensure financial viability of the sector and attract investments,
(iii) promote transparency, consistency and predictability in regulatory approaches across jurisdictions, and minimize perceptions of regulatory risk, and
(iv) promote competition, efficiency in operations and improvement in quality of supply.

In addition, the Tariff Policy lays down following frameworks for performance based cost.

(i)	Return on Investment	:	Balance needs to be maintained between the interests of consumers and the need for investment
(ii)	Equity Norms	:	For financing of future capital cost of projects, a Debt: Equity ratio of 70:30 should be adopted.
(iii)	Depreciation	:	The Central Commission may notify the rates of depreciation in respect of generation and transmission assets. Benefits of reduced tariff after the assets have been fully depreciated should remain available to the consumers.
(iv)	Cont of Debt	:	Structuring of debt with a view to reducing the tariff should be encouraged.
(v)	Cost of Management of Foreign Exchange Risk	:	Foreign exchange variation risk shall be a pass through.
(vi)	Operating Norms	:	Suitable performance norms of operations would need to be evolved.
(vii)	Renovation and Modernisation	:	Renovation and modernization for higher efficiency levels needs to be encouraged.
(viii)	Multi Year Tariff	:	Multi Year Tariff to minimize public and consumers, to promote the higher efficiency and deduction of system loss, and to encourage attract investment circumstances is introduced.
(ix)	Benefits under CDM	:	Tariff should take into account the benefits obtained from the CDM.

(2) Electricity Tariff and Generation and Transmission Costs in Rajasthan

1) Electricity tariff

The electricity tariff of JVVN, who is a distribution company in the Rajasthan state, is shown below. It has been revised on September 8, 2011 to be increased by 20 ~ 30%.

The present electricity tariff includes the subsidies from the Government of Rajasthan. These subsidies are provided to the consumers whose incomes are below the poverty line and agricultural sector, according to National Electricity Policy in 2005. Amount of such subsidies has been increasing because the electricity tariff for these consumers is unchanged in spite of the revision of electricity tariff.

According to Table 3.2-6, normal domestics shall pay the variable energy charge of 2.5

INR/kWh (first 50 kWh/month) and 4.0 - 4.35 INR/kWh (above 50 kWh/month), Industrial users shall pay the charge of 4.0 - 5.0 INR/kWh.

Table 3.2-6 Electricity Tariff of JVVN

No.	Term / Category	From September 8, 2011: Monthly Fixed Charge in INR		Energy Charge (10^{-2}INR/kWh)			From 2007 to Until September 7, 2011: Monthly Fixed Charge in INR		Energy Charge (10^{-2}INR/kWh)			Historical Energy Charge (10^{-2}INR/kWh)		
		Rate	Unit	Net	Government Subsidy	After Subsidy	Rate	Unit	Net	Government Subsidy	After Subsidy	July, 97	Nov, 99	May, 01
1	Domestic Service													
(a)	Below Poverty Line and Kutir Jyoti Progman (Upto 50kWh/month)	50	/Connection*4	225	140	85	N.A.		195	110	85	112	155	170
(b)	Small Domestic (Less than 50 kWh/month)	80	/Connection	250	80	170	N.A.		195	25	170	112	155	170
(c)	Normal Domestic													
(i)	First 50 kWh/month	140	/Connection	250	0	250	80	/Connection	195	0	195	112	155	170
(ii)	Above 50kWh upto 150kWh/month	140	/Connection	400	0	400	105	/Connection	350	0	350	149	220	275
(iii)	Above 150kWh upto 300kWh/month	150	/Connection	415	0	415	These categories are available from September 8, 2011. Before September 8, 2011, the Category (ii) is applied for these (iii) and (iv) category.							
(iv)	Above 300kWh/month	180	/Connection	435	0	435								
2	Non Domestic Service													
(a)	Upto 5 KW of SCL						These categories are available from September 8, 2011.							
(i)	Upto first 100 kWh/month	150	/Connection	510	0	510								
(ii)	Above 100 and upto 200 kWh/month	150	/Connection	550	0	550								
(iii)	Above 200 kWh/month	180	/Connection	590	0	590								
(b)	Above 5KW of SCL													
(i)	Upto first 100 kWh/month	60	/kW	510	0	510								
(ii)	Above 100 and upto 200 kWh/month	60	/kW	550	0	550								
(iii)	Above 200 kWh/month	60	/kW	590	0	590								
(i)	First 100 kWh/month	These categories was available until September 8, 2011.					80	/Connection	450	0	450	185	264	450
(ii)	Above 100kWh/month						120	/Connection	490	0	490	231	304	490
3	Public Street													
(i)	Areas having population below 100,000	50	/lamp point*5	410	0	410	30	/lamp point*2	350	0	350	100	154	300
(ii)	Areas having population 100,000 above	60	/lamp point*6	450	0	450	45	/lamp point*3	375	0	375	130	184	330
4	Agriculture													
(a)	Metered Supply													
(i)	General (not getting round the clock supply)	50	/Connection*7	136	46	90	50	/Connection	110	20 *1	90	50	70	90
(ii)	Others	50	/Connection*7	260	50	210	50	/Connection	210	45 *1	165	120	140	165
(iii)	Farm Houses	50	/Connection*7	420	80	340	50	/Connection	340	65 *1	275	138.5	220	275
(b)	Flat Rate Supply (In INR/HP/Month)													
(i)	General (not getting round the clock supply)	20	/Connection*8	175	90	85	20	/Connection	140	55 *1	85	37.5	60	85
(ii)	Special Fodder/24 hrs Supply	20	/Connection*8	250	50	200	20	/Connection	200	55 *1	145	-	120	145
(iii)	Farm Houses	20	/Connection*8	290	60	230	20	/Connection	230	55 *1	175	-	220	175
5	Small Industry													
(i)	Upto 5kW	45	/HP/unit of SCL	400	0	400	35	/HP/unit of SCL	350	0	350	-	203	344
(ii)	Above 5kW but not exceeding 18.65kW(25HP)	45	/HP/unit of SCL	435	0	435	This category is available from September 8, 2011.							
6	Medium Industry													
(i)	Low Voltage	50	/HP/unit of SCL	475	0	475	50	/HP/unit of SCL	375	0	375	204	236	372
(ii)	High Voltage (> 11kV)	112	/kVA of Billing demand	475	0	475	80	/kVA of Billing demand	375	0	375	204	236	372
7	Bulk Supply for Mixed Load													
(i)	Low Voltage	50	/HP/unit of SCL	475	0	475	50	/HP/unit of SCL	375	0	375	204	236	372
(ii)	High Voltage (> 11kV)	112	/kVA of Billing demand	475	0	475	80	/kVA of Billing demand	375	0	375	204	236	372
8	Large Industry													
(i)	High Voltage (> 11kV)	125	/kVA of Billing demand	500	0	500	90	/kVA of Billing demand	401	0	401	225	259	401

*1: If the supply is for 24 hrs., the rates without subsidy are applicable.
*2: Maximum INR 300/service connection
*3: Maximum INR 900/service connection
*4: The fixed charge rate is INR80, INR50 is the rate after government subsidy of INR30.
*5: Maximum INR 500/service connection
*6: Maximum INR 1200/service connection
*7: The fixed charge rate of INR 50 is the rate after government subsidy of INR 10.
*8: The fixed charge rate of INR 20 is the rate after government subsidy of INR 5.

Source: Website of JVVN Tariff Scenario, Tariff hike from time to time, JVVN、Tariff for supply of Electricity- 2004, JVVN)

Note : SLC; Sanctioned Connected Load

2) Financial conditions and electric power sales of JVVN

Financial conditions and breakdown of sales amount of electric power of JVVN are shown in Table 3.2-7 and Table 3.2-8. Table 3.2-7 shows that subsidies and grant account for approximately 50% of income of JVVN in 2009/10. Breakdown of sales amount shown in Table 3.2-8 is arranged as Fig.3.2-3. It shows that sales amount of Industry, which is charged with the higher electricity tariff without governmental subsidies, accounts for approximately 43% of total sales and it is the largest rate.

Table 3.2-7 Financial Conditions of JVVN

Particulars	For the year ended 31-Mar-09		For the year ended 31-Mar-10		Increase Rate
	(INR)	(%)	(INR)	(%)	(%)
Income					
Revenue from Sales of Power	35,401,595,423	53.0	39,804,263,624	46.5	12.4
Revenue subsidies and Grant	26,476,893,002	39.6	43,568,560,974	50.9	64.6
Other Income	1,428,548,270	2.1	1,532,026,345	1.8	7.2
Receipt from Sale of Power through Trading	1,540,847,850	2.3	75,391,479	0.1	-95.1
Deferred income relating to cost of Capital Assets/CC&SL	2,008,433,755	3.0	666,421,786	0.8	-66.8
Sub Total	**66,856,318,300**	**100**	**85,646,664,208**	**100**	**28.1**
Expenditure					
Purchase of Power	52,260,317,989	83.2	63,577,237,212	80.7	21.7
Repairs & Maintenance	482,695,772	0.8	541,352,068	0.7	12.2
Employees Costs	7,614,598,055	12.1	11,712,521,891	14.9	53.8
Administration & Other Expenses	533,250,843	0.8	627,451,182	0.8	17.7
Other Debits	114,487,500	0.2	65,786,178	0.1	-42.5
Rebates allowed to Consumers	169,355,152	0.3	197,184,307	0.3	16.4
Depreciation	1,656,899,269	2.6	2,030,379,105	2.6	22.5
Sub Total	**62,831,604,580**	**100**	**78,751,911,943**	**100**	**25.3**
Less: Incidental expenses during construction transferred to capital work in progress	1,326,588,433		1,643,139,166		
Sub Total	**61,505,016,147**		**77,108,772,777**		
Profit before Interest & Taxes	5,351,302,153		8,537,891,431		
Net Interest, Finance Charges & lease rental	5,172,765,348		8,480,935,991		
Profit/ (Loss) for the year before taxes	178,536,805		56,955,440		
Add: Prior period Income/Expenses	(98,568,172)		(55,080,440)		
Add: Net amount of extra ordinary items	(578,012)		0		
Less: Fringe Benefit Tax					
Current Year	10,992,211		0		
Previous Year	68,398,410		1,875,000		
Net Profit after tax available for appropriation	0		0		

(Source : 10th Annual Accounts 2009-10, JVVN)

Table 3.2-8 Breakdown of Sales Amount of Electric Power of JVVN

Particulars	For the year ended 31-Mar-09		For the year ended 31-Mar-10		Increase Rate
	(INR)	(%)	(INR)	(%)	(%)
1 Domestic	6,094,684,207	19.6	7,076,056,135	20.3	16.1
2 Non Domestic	3,976,062,856	12.8	4,213,068,053	12.1	6.0
3 Public Street Lighting	251,135,539	0.8	269,714,345	0.8	7.4
4 Agriculture-Metered	2,875,699,220	9.3	3,541,980,142	10.2	23.2
5 Agriculture-Flat rate	1,040,014,826	3.3	898,461,108	2.6	-13.6
6 Agriculture-Nursery	3,389,187	0.0	3,359,022	0.0	-0.9
7 Agriculture-Poultry Farm	15,300,095	0.0	2,603,685	0.0	-83
8 Small Industrial Power	778,365,324	2.5	730,756,978	2.1	-6.1
9 Medium Industrial Power	1,944,284,928	6.3	2,098,412,607	6.0	7.9
10 Large Industrial Power	10,791,529,210	34.8	12,125,076,059	34.8	12.4
11 PWW & Pumping-Small	671,655,506	2.2	681,995,809	2.0	1.5
12 PWW & Pumping-Medium	107,871,970	0.3	107,544,614	0.3	-0.3
13 PWW & Pumping-Large	399,355,553	1.3	449,967,759	1.3	12.7
14 Bulk supply to other Consumers (Mixed Load)	901,914,895	2.9	1,257,231,454	3.6	39.4
15 Traction Railways	1,198,640,894	3.9	1,405,287,380	4.0	17.2
16 Bulk supply to controlled station	(397,824)	0.0	14,255	0.0	-
Sub Total (1 to 16)	**31,049,506,386**	**100**	**34,861,529,405**	**100**	**12.3**
17 Electricity Duty Recoverable	2,673,635,015		2,982,160,810		
18 Meter Rent / Service line rental	53,107,968		67,738,295		
19 Recovery for Theft of Power / Malpractice	263,681,591		281,622,224		
Sub Total (17 to 19)	**2,990,424,574**		**3,331,521,329**		**11.4**
Sub Total (1 to 19)	**34,039,930,960**		**38,193,050,734**		**12.2**
20 Miscellaneous Charge from Consumers	4,035,252,941		4,593,472,821		
21 National Revenue due to reduction in T&D losses	608,082,477		546,366,820		
22 Difference due to Round off	46,537		(99,121)		
Sub Total (1 to 22)	**38,683,312,915**		**43,332,791,254**		**12.0**
Less					
23 Electricity Duty Recoverable	2,673,635,015		2,982,160,810		
24 National Revenue due to reduction in T&D losses	608,082,477		546,366,820		
Net Revenue from Sales of Power	35,401,595,423		39,804,263,624		12.4

(Source : 10th Annual Accounts 2009-10, JVVN)

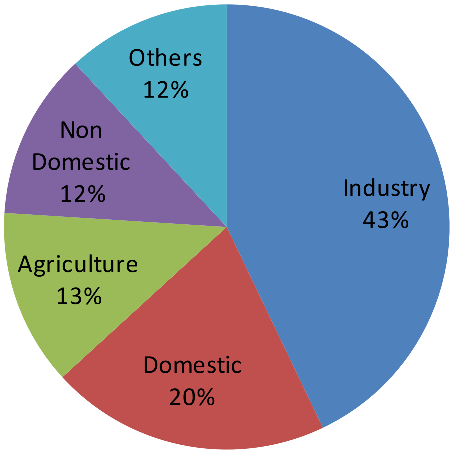


Fig.3.2-3 Breakdown of Sales Amount of Electric Power of JVVN (2009/10)

4) Cost of purchase of energy of JVVN

Cost for purchase of electricity of JVVN including transmission charge is shown in Table 3.2-9. It can be seen that averaged unit purchase rate of 3.66 INR/kWh is higher than averaged unit sales rate 3.19 INR/kWh. Moreover, approximately 30% (4,870 × 10^6 kWh) out of purchased energy of 17,366 × 10^6 kWh is losses, and this is considered one of reasons to make financial conditions of JVVN worse.

Table 3.2-9 Cost of Purchase of Energy of JVVN

Particulars	For the year ended 31-Mar-09			For the year ended 31-Mar-10			Increase Rate
	Electricity (10^6 x kWh)	Amount (10^6 x INR)	Rate (INR/kWh)	Electricity (10^6 x kWh)	Amount (10^5 x INR)	Rate (INR/kWh)	(%)
Purchase of Energy	15,410.58	52,260.3	3.39	17,366.13	63,577.2	3.66	12.7
Less: Sales of energy through Power exchange	197.92	1,540.8	7.78	9.21	75.4	8.19	-
Net availability before Transmission Loss	15,212.66			17,356.92			14.1
Transmission Loss	1,034.62			1,070.51			3.5
Rate of Transmission Loss in %	6.80%			6.17%			-9.3
Net availability after Transmission Loss	14,178.04			16,286.41			14.9
Energy Sales	10,676.06	35,401.6	3.32	12,486.28	39,804.3	3.19	17.0
Distribution Loss	3,501.98			3,800.13			8.5
Rate of Distribution Loss in %	24.70%			23.33%			-5.5
Transmission & Distribution Loss	4,536.60			4,870.64			7.4
Rate of Transmission & Distribution Loss in %	29.82%			28.06%			-5.9

(Source: 10th Annual Accounts 2009-10, JVVN)

5) Power selling charge of RVUN

The power selling charge of RVUN depends on power stations as mentioned below and varies from 2.4 to 3.2 INR/kWh.

Table 3.2-10 Power Selling Charge of RVUN

No.	Name of Plant		Installed Capacity	Main Fuel	Fixed Cost	Variable Cost	Total Cost
			(MW)	-	(INR/kWh)	(INR/kWh)	(INR/kWh)
1	Kota Super Thermal Power Station	KTPS	1,240.0	Coal	0.5155	1.8861	2.4016
2	Suratgarh Super Thermal Power Station	STPS	1,500.0	Coal	0.8036	2.3018	3.1054
3	Dholpur Combined Cycle Power Station	DCCP	330.0	Gas	0.8400	2.3425	3.1825
4	Ramgarph Gas Thermal Power Station	RGTPP	113.5	Gas	0.5115	1.8224	2.3339
5	Chhabra Themal Power Station (Unit-1)	CTPP	250.0	Coal	1.3319	1.4481	2.7800

Note: 1) Tariff for Mini-Micro Hydropower is fixed 3.78 INR/kWh.
2) Incentive @0.25 INR/kWh recovered on more than target Planned Load Factor.
3) Fuel Price Adjustment as per RERC Tariff regulation 2009.

(Source: RVUN Recovered/Claim Tariff Charge from DISCOM for FY 2011-12, RVUN)

6) Comparison of Electricity Tariff

Electricity tariffs by state in India are compared in Table 3.2-11. Electricity tariff of 3 electric power corporations including JVVN in Rajasthan is established at a little higher rate than the average rate of all states.

Table 3.2-11 Electricity Tariff by State in India

(Unit : 10^{-2} INR)

SI. No.	Name of Utility	Domestic 4 kW (400 kWh/month)	Large Industry 1,000 kW 60% L.F., (438,000 kWh/Month)
1	Andhra Pradesh	396.63	365.03
2	Assam	441.50	399.21
3	Bihar	321.98	501.18
4	Chhattishgarh	230.63	405.87
5	Gujarat	554.83 U 463.83 R	592.76
6	Haryana	422.10	470.00
7	Himachal Pradesh	282.61	365.55
8	Jammu & Kashmir	203.09	285.58
9	Jharkhand	163.50	408.60
10	Karnataka	449.79 D 436.67 E 418.29 F	527.80 D 521.09 O
11	Kerala	398.89	378.49
12	Madhya Pradesh	562.19 U 526.56 R	470.86
13	Maharashtra	445.40	521.66 B 484.93 C
14	Meghalaya	352.50	484.38
15	Orissa	247.00	295.31
16	Punjab	447.25	486.30
17	Rajasthan	396.88 U 363.81 R	463.83
18	Tamil Nadu	216.25	452.11
19	Uttar Pradesh	384.00 U 124.00 R	503.37 U 429.21 T
20	Uttarakhand	218.75	390.48
21	West Bengal	434.66 U 422.36 R	493.94
22	Arunachal Pradesh	345.00	295.00
23	Goa	186.75	398.29
24	Manipur	299.70	336.09
25	Mizoram	360.00	595.00
26	Nagaland	319.25	314.68
27	Sikkim	266.06	441.78
28	Tripura	365.00	-
29	A & N Islands	342.50	-
30	Chandigarh	304.00	360.70
31	Dadra & Nagar Haveli	172.50	319.08
32	Daman & Diu	172.50	279.97
33	Delhi BYPL/BRPL/NDPL	351.75	561.13
34	Delhi NDMC	254.10	524.07
35	Lakshadweep	221.88	-
36	Puducherry	113.75	307.84
37	Torrent Power Ltd. (Ahmedabad)	493.04	503.40
38	Kolkata (CESC)	496.98	491.48
39	D.V.C. (A) BiharArea (B) West Bengal Area	- -	428.99 453.65
40	Durgapur Projects Ltd.	299.61	354.31
41	Mumbai (B.E.S.T) Mumbai (RelianceEnergy) Mumbai (TATA'S)	523.59 558.34 370.01	753.78 795.80 537.18
	Average	349.84	448.86
	Median	360.00	452.88
	Maximum	113.75	279.97
	Minimum	562.19	795.80

Remarks: B : Continuous Supply Areas; C : Non-Continuous Supply Areas; D : Bangalore, Devangere & other City Municipal Corp.; E : Areas under other local bodies; F : Areas under Village Panchayats; U : Urban; R : Rural; O : Other

Note : The above rates of electricity are for certain assumed load and electricity consumption levels in a month.

(Source : Economic Survey 2010-11, Ministry of Finance)

Electricity tariffs of the countries participating IEA as well as India is shown below. It can be seen that electricity tariff of JVVN is established at lower rate for households and at slightly lower rate for industry compared with that of other IEA countries, although they cannot be simply compared because the tariff depends on conditions of each country. In Rajasthan, electricity tariff for industrial sector is established at higher rate because of political reason.

Table 3.2-12 Electricity Tariff of IEA Countries

Country	Unit	Electricity for Industry [kWh]	Electricity for Households [kWh]
Austria	US$	-	0.258
Belgium	US$	0.125	0.232
Canada	US$	0.070	0.095
Chinese Taipei	US$	0.078	0.093
Czech Republic	US$	0.144	0.186
Denmark	US$	0.114	0.356
Finland	US$	0.095	0.175
France	US$	0.106	0.157
Germany	US$	-	0.325
Greece	US$	0.114	0.158
Ireland	US$	0.137	0.233
Italy	US$	0.258	0.263
Japan	US$	0.154	0.232
Korea	US$	-	0.083
Luxembourg	US$	0.122	0.216
Mexico	US$	0.104	0.089
Netherlands	US$	0.123	0.221
New Zealand	US$	-	0.182
Norway	US$	0.074	0.176
Poland	US$	0.120	0.179
Portugal	US$	0.120	0.215
Slovak Republic	US$	0.169	0.213
Sweden	US$	0.096	0.218
Switzerland	US$	0.102	0.180
Turkey	US$	0.151	0.184
United Kingdom	US$	0.121	0.199
United States	US$	0.068	0.116
Average	US$	0.120	0.194
Median	US$	0.120	0.186
Max.	US$	0.258	0.356
Min.	US$	0.068	0.083
INDIA JVVN*	US$	0.111	0.097
	INR	5.00	4.35

(Source : 2011 Key World Energy Statistics, IEA, excluding countries of which data is Not Available (NA))
Note) India is the country of NA and not included in this list
*: Electricity tariff after September 8, 2011 converted with the exchange rate in Chapter 6 is adopted.

7) Issues of electricity tariff in JVVN

Findings in electricity tariff of JVVN are summarized below.

- JVVN is under bad financial conditions as subsidies and grant account for approximately 50% of his income.
- Averaged sales rate per kWh is lower than averaged unit purchase rate of electricity.
- Electricity loss is no less than 30% and it becomes contributory cause of bad financial conditions of JVVN.
- Electricity tariff of JVVN is established at lower rate compared with that of other IEA countries, although it depends on conditions of each country.
- Electricity tariff in Rajasthan is established at a little higher rate than the average rate of all states in India.

Electricity tariff of JVVN is not established to cover all expense of JVVN. Therefore, revenue of JVVN has to depend on subsidies from the government. However, the electricity tariff of JVVN is not lower than that of other states in India.

3.3 Electric Power Situation and Issues in the NIC in Rajasthan

3.3.1 Situation and Issues of Electricity Infrastructure in NIC

Fig 3.3-1 Neemrana Industrial Complex

(1) Situation of Power Consumption in Alwar District

Power consumption by sector in 2005 - 2007 and proportion of power consumption by sector in 2007 in Alwar are shown below.

Table 3.3-1 Power Consumption by Sector in Alwar District (2005-2007)

Section	Consumption (Million kWh)		
	2005	2006	2007
Domestic	1337.25	1,480.68	1,789.18
(Non-Domestic) Commercial	358.55	408.59	492.57
Small Industries	233.05	273.62	308.27
Medium Industries	755.81	825.05	963.61
Large Industries	8,352.00	9,118.62	11,879.75
Public Lighting	33.78	40.27	52.97
Public Water Works	239.31	250.07	253.82
Agriculture	3,443.03	3,883.45	4,915.79
Others	147.19	181.34	193.23
Total	**14,899.97**	**16,461.69**	**20,849.19**

(Source : STATISTICAL ABSTRACT, RAJASTHAN, 2010)

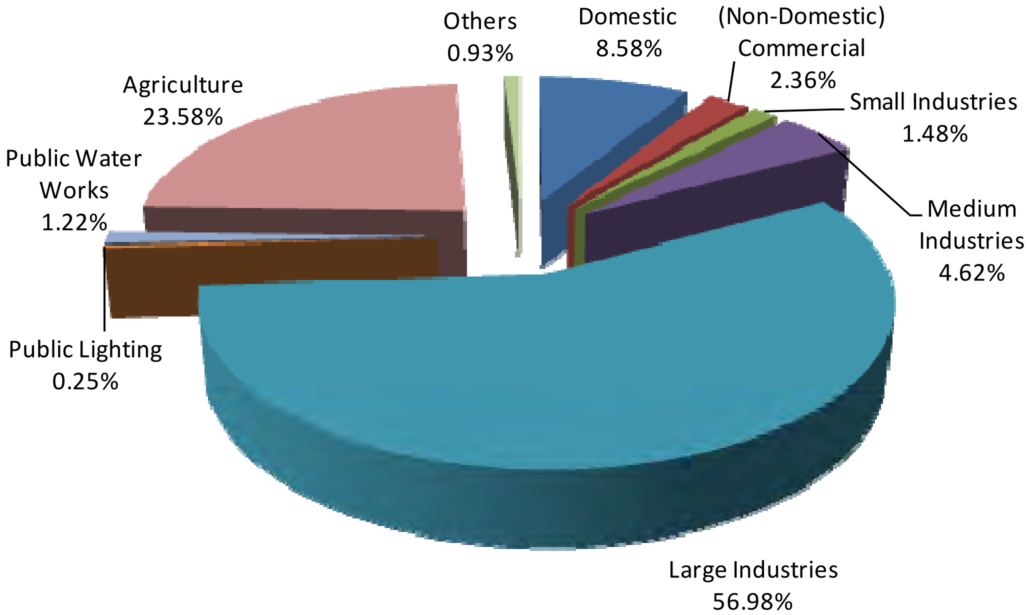


Fig.3.3-2 Proportion of Power Consumption by Sector

(Source : STATISTICAL ABSTRACT, RAJASTHAN, 2010)

Increase in power demand is also outstanding in Rajasthan as power consumption increased by 11% in 2006 and 27% in 2007 compared with the previous year. Large Industries account for 56.98%, more than half of total consumption in the district. Alwar is the district that power demand by industries is large, as power consumption by Large Industries in the district accounts for 22% of those in whole India.

(2) Power Facilities in NIC

Electric power is supplied to the NIC from the power grid in the state through the substations controlled by RVPN and distribution networks controlled by JVVN. Outline of power transmission and substation facilities is shown below.

Table 3.3-2 Outline of Power Transmission and Substation Facilities in NIC

Substation	Outline of Facility	Remarks
Neemrana 220kV Substation	Transformer: 220/132kV (100MVA) × 2 units and 132/33kV (50MVA) × 2 units	— Substation owned by RVPN that has operated from September 21, 2008 — Two 220kV transmission lines and two 132kV transmission lines are connecting. — Sufficient facilities are equipped — Distribution feeders for 33kV exclusive lines are installed in the substation. — Substation with 400/220kV transformers of 2 units is under construction.
Shahjahanpur 132kV Substation	Transformer 132/33kV (62.5MVA)	— Substation owned by RVPN
Behror 132kV Substation	Transformer: 132/33kV(75MVA) and 132/11kV (20.5MVA)	— Substation owned by RVPN — New transformers of 220/132kV (100MVA) and 132/33kV (25MVA) are under construction.

The electric power is supplied to the NIC through 11 kV distribution network and 33 kV exclusive distribution lines controlled by JVVN.

1) Power distribution by 11 kV distribution network

33 / 11 kV step-down transformers are installed at three substations in the NIC and electric power is supplied to the customers consuming less than 1,500 kVA through overhead lines by 11 kV distribution network. Therefore, an accident caused by a customer as well as aging facilities may cause power failure in wide area. Also, 11 kV network has less reliability than 33 kV underground exclusive lines because such overhead lines can be damaged by wind, vehicle accidents, fall of trees, etc.

As for power failures in the NIC (to be described in Section 4.1.2 in details), it is recorded that voltage fluctuation is 5 ~ 6%, and 109 times of power failures occurred in 89 days. It is considered that such situations of voltage fluctuation and power failures can be seen also in other regions as well as the NIC. Automatic recovering system of distribution network from power failure as applied in Japan is not introduced in the system of the NIC and that is one of the reasons why it takes a long time to recover the system when an accident occurs on distribution lines.

Automatic voltage regulation is implemented in a substation but not by transformers on 11 kV distribution lines as well as 33 kV distribution lines. Therefore, voltage drop becomes larger at the end of a distribution line according to its length. Also, voltage drop occurs by heavy electric load. Transformers with automatic voltage regulator for the distribution network are effective to improve this voltage drop.

It is expected to study in details to understand the current conditions of electric power quality.

2) Power distribution by 33 kV exclusive lines

JVVN supplies power to large customers consuming 1,500 kVA and above by 33 kV underground exclusive lines. Some Japanese companies are provided with electric power by these exclusive lines. The consumers have to bear the cost of leading the exclusive line, but the reliability is higher than that in 11 kV distribution lines because of few accidents due to causes mentioned above. Therefore, some consumers desire to replace 11 kV distribution lines with 33 kV distribution lines in spite of additional cost. However, all customers who like to connect to the 33 kV distribution lines cannot do that, because development of 33 kV distribution network is delayed.

It is expected to study in details of electric power quality of 33 kV distribution lines as well as 11 kV lines.

3.3.2 Interview Surveys at the NIC

The interview surveys regarding to electricity situation of the NIC were undertaken for companies and related parties of the NIC.

(1) Company T (Japanese Corporation)

Table 3.3-3 Results of Interview (Company T)

Item	Description
Corporate Profile	Manufacturing factory of automotive parts They came into the NIC in 2008 and started the operation in 2009.
Power Supply	Diesel generator (DEG) : 125 kVA, 400 kVA × 2, 1,000 kVA JVVN : Provided from 11 kV Power Distribution Line
Power Conditions	The electric power quality from the grid is low, the frequency is 49.1 to 52 Hz and voltage fluctuates up to 5 %. Although the power condition was relatively stable in March and April, the power outages have occurred 4 to 5 times during a day from June. The recent storm caused a fall of a steel tower, which stopped the power supply for a week. The power supply from the grid is unstable. The cost of power generated by the diesel generator is 14.1 INR/kWh and that of power from the grids is 4 - 5 INR/kWh. Currently, the proportion of power supply from the inexpensive grid is increased balancing the production efficiency of facilities in the factories. Annual electricity charge is about 8 INR/kWh on the average in consideration of charge from the power grid and additional cost including maintenance and fuel cost for DEG. The tariff of around 8 INR/kWh is expected to be accepted by consumers and will be a target of electricity purchase rate for factories in surrounding area.
Countermeasures for Power Supply	This company had submitted the application to connect 33 kV distribution line. According to the information from electrical technicians of other factories, the 33 kV distribution line comprises only 17 % of the grid and its power supply is shut off later than 11 kV line's. The 33 kV line can provide the more stable power supply. Since 33 kV underground distribution line has a high supply quality including infrequent power outage, the shift from the 11 kV to the 33 kV has been strongly requested. The procedure takes three (3) months and the charge of expansion of the line is borne by themselves. Some companies in the NIC suspend their production lines during a power outage when they can expect that it is recovered within about 20 minutes. The companies in the NIC including Japanese ones operates their factories with combination use of power from owned diesel generators and the grids. Most of companies have Uninterruptible Power Supply (UPS) in case of power outage.
Request	It is the most important that power outage is decreased and stable and high-quality electricity is supplied.

(2) Company H (Indian Corporation)

Table 3.3-4 Results of Interview (Company H)

Item	Description
Corporate Profile	The 7th largest company in India who manufactures glass containers such as beer bottles, cosmetic bottles, etc.
Power Supply	Gas engine generators: 2 MW, 2.4 MW DEG: 1 MW × 3 JVVN: Provided from 33 kV exclusive lines for several years.
Power Conditions	Power supply without a power outage is required, because the factory operates 24 hours a day. They were in trouble frequently due to power outages because of power supplied through 11 kV distribution line. They had been provided with electric power though underground 33 kV transmission line for several years from the Neemrana substation. Therefore, frequency of power outages have been decreased. They still experience the power outage for 10 ~ 12 hours/month and then they have to obtain electric power from owned power generator. Electricity tariff is 4-5 INR/kWh, the lowest among all sources, from JVVN, 5 INR/kWh from gas engine generators, and 9 INR/kWh, the highest, from diesel generators.
Countermeasures for Power Supply	33 kV distribution transformer is equipped with On-Load Tap Changer. Also, Automatic Voltage Switch is installed in the factory and protective relay deal with fluctuation of voltage and frequency. However, it is still not sufficient countermeasures against power outage. Stable power supply is strongly required.
Request	Electricity cost accounts for 40% of all costs and it is very high rate because they are glass products manufacturer. Therefore, electricity rate and reliability of power supply have large impact to running of the factory. Stable power supply without a power outage is required because the factory operates all the day.

(3) Others

Information obtained from the interview surveys to the companies and related agencies in the NIC is shown as follows.

- Because of the poor power condition in the NIC, many of the Japanese companies possess their own electrical power facilities or diesel generators despite the expensive costs.
- Owing to the poor grid power condition, non-critical loads such as air conditioners in the office are supplied from the grid and the electric power of factories are supplied from diesel generators.
- With an increase in power demand, declines in power quality including outages often occur during a busy faming season from June to October.
- A majority of the companies in the NIC is automobile-related company, and their factories

have machines with large fluctuation of power factor such as welding machines. At the start of operation of welding machines, voltage reduction occurs since power generators of 400 to 700 kVA cannot catch up with the power demand.

- The voltage reduction at the start of operation of welding machines has caused poor welds.
- As a pipeline for natural gas will be built in the area, new gas turbines are expected to be introduced. Nevertheless, a diesel generator is necessary as a back-up power supply.
- The Japanese companies in the area established a committee and sent requests for support to the embassy of Japan and JETRO.
- Most of the privately-owned power generators are made in the U.S. and installed dominantly by Indian companies.

Other valuable information on overall Indian power sector to formulate a project plan collected through the interview are described as follows:

- Since the electric tariff is low in India, the electric power corporation controlled by the government of Rajasthan is in a chronic deficit, which is compensated by the national government. This is because of the policy where the tariff for commerce and industry is set high and the tariff for agriculture and household are set low.
- Environmental and social consideration is an also obstacle.
- Due to its financial ability, India does not necessarily need to depend on yen loans. As it also have good manufactures and contractors, Japanese companies have difficulty in winning contracts on power sector.
- More than 1,000-kilometer transportation of coal is prohibited in India. Lying of pipe line for natural gas has not been developed and agriculture has a priority to use natural gas. For these reasons, procurement of fuel has been a concern.

3.3.3 Issues and Measures

(1) Issues

Due to the shortage of the power supply, receiving of power from other states through the long-distance transmission lines, and delayed infrastructure development, the low quality of power including power outage and the high transmission loss are the challenges in Rajasthan including the NIC.

6 to 8-hour power outage occurs a few times a month without notice in this industrial area.

Average cost of electricity of factories in the NIC is 8 - 12 INR/kWh, and it is fairly high because they have to bear not only electricity charge of 4 - 5 INR/kWh from JVVN but the additional cost of 14 - 17 INR/kWh for their private power generation by diesel generators or fuel oil in case of power outage or emergency.

(2) Measures

- The consortium of Sumitomo Corporation, Hitachi Corporation and Kansai Electric Co., Inc. has started the project to build a gas turbine as an IPP business. As problems of gas supply often arise in India, it is necessary for IPP to avoid such problems.

- 33 kV distribution line comprises only 17 % of the grid and its power supply is shut off later than 11 kV line's. Since 33 kV underground distribution line has a high supply quality including infrequent power outage, the shift from 11 kV to 33 kV has been strongly requested.

- Expansion of 33 kV behind the schedule doesn't meet the requirement of consumers. Negative factors are found about the expansion; the procedure takes long time and the expansion cost is owned by consumers.

- According to JVVN regulations, the consumers of 1,500 kVA or more can basically receive power through the 33 kV exclusive lines.

- The focus of companies in the NIC including Japanese ones seems to be shifting from introduction of new power sources to combination use of power from diesel generators and the grids. Most of companies have UPSs in case of power outage.

- Since the development of 500 MW solar power generation (with generation by fossil fuel) in the western part of Rajasthan is being planned, solar power is a promising power source in this area.

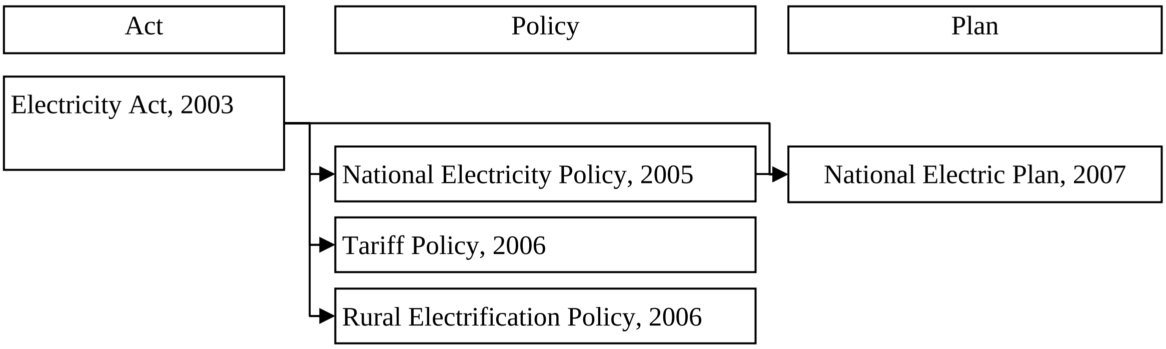
- The grid capacity in the Neemrana area is 200 MW and it seems difficult to plan a project on the installation of the solar power system with the capacity of more than 20 MW.

3.4 Power Sector Master Plan and Legal System relating to Implementation of Infrastructure Project

3.4.1 Legal System for Power Sector

The Government of India established "Electricity Act, 2003" as the current basic law for power sector, which is integrated and revised laws of "Electricity Act, 1910" established under the reign of the United Kingdom (U.K.), "Electricity Supply Act, 1948" and "Electricity Regulatory Commission Act, 1998".

Various policies have been established under this act. The outline of current legal system is as shown below.



Name		Year	Authority	Related Law	Remark
Act	Electricity Act	2003	MOP	-	-
Policy	National Electricity Policy	2005	MOP	Electricity Act 2005, Section 3	The goal of power sector as of 2012
	Tariff Policy	2006	MOP	Electricity Act 2005, Section 3	-
	Rural Electrification Policy	2006	MOP	Electricity Act 2005, Section 4 and 5	-
Plan	National Electric Plan	2007	CEA	Electricity Act 2005, Section 3 National Electricity Policy 2005, Section 3	Program of power sector every five years

Fig.3.4-1 Laws related to Electricity and Policy System of Central Government of India

Electricity Act 2003, the current basic law for power sector, describes the following items.

1) Promotion of private investment, 2) Liberalization of electric power trade, 3) Abolishment of license system excluding hydropower, 4) Permission for mutual participation of power generation and distribution projects, 5) Liberalization of installation of private power generation, 6) Unbundling of the State Electricity Board, 7) Implementation of open access to power transmission and distribution grid, 8) Rationalization of electricity tariff (Gradual reduction and abolition of internal subsidy), 9) Obligating installation of electricity meter, penalty enhancement against electricity

theft and unauthorized use of electricity meter, and 10) Issuing authority of environmental permission.

National electricity policy established in 2005 shows the following objectives.

1) Household electrification of 100%, 2) Supply-demand balance of electricity (Solution of power shortage, reserve margin, and improvement of load ratio), 3) Supply of reliable and stable electricity, 4) Realization of appropriate electricity tariff, 5) Promotion of hydropower development, 6) Realization of state-level Time-Of-Use rate, 7) Soundness of finance of power sector, and 8) Protection of consumer's benefit.

Electricity Tariff Policy established in 2006 indicates the following practical policies to reform the electricity rate system.

1) Establishment of State Electricity Regulatory Commission, 2) Competitive bidding of power generation and transmission projects, and 3) Application of Multi Year Tariff, etc.

Moreover, the guideline in relation to establishment and management of the Wholesale Electric Power Exchange was published in 2007 in conformity to the Electricity Act 2003, and Indian Energy Exchange thereof was established. Then, Indian Electricity Exchange was established for spot deals.

3.4.2 Legal System related to implement Infrastructure Project (Socio-economy)

(1) Land Acquisition

Land acquisition in India is implemented in accordance with "Land Acquisition Act" enacted in 1894 under the region of the U.K. This Land Acquisition Act was amended two times by "Land Acquisition (Companies) Rules" in 1963 and "Land Acquisition (Amendment) Bill" in 2009.

The Land Acquisition Act specifies that the State government can only acquire the land for the public use. However, as the term of "Public Use" is ambiguous, it sometimes occurs that the State government could not acquire the land for development of industrial areas by the opposition of the residents.

(Source: Website of Ministry of Rural Development, Department of Land Resources)

(2) Relocation of Residents

The Indian government formulated "Rehabilitation and Resettlement Policy, 2007", with regard to the land to be acquired by the State government, to minimize the impacts on relocation of the residents. This policy was the amendment to the same policy enacted in 2003 and enforced in 2004 as it had involved a lot of problems.

This policy aims at all the projects which involve involuntary relocation, and it provides to assess, using the participatory and transparent method, the economic, environmental, social and cultural impacts of the household to be relocated involuntarily.

Further, this policy also aims at 1) minimize the scale of relocation, 2) acquire only the minimum land required for the project, and 3) promotion of use of devastated, degraded and non-agricultural land.

(Source : Website of Ministry of Rural Development, Department of Land Resources)

(3) Preferential Tax Treatment

To promote the private investment, the policy on the preferential tax treatment is adopted for the implementation of infrastructure project of specific sectors.

1) Investment in infrastructure sector

For the infrastructure development such as power generation, highway, bridge, urban transport system, water treatment, irrigation, waste disposal, airport, and port and harbor, the corporate income tax is exempted (tax holiday) for 10 years. For those of telecommunication, the corporation tax is exempted for the initial 5 years and exempted 30 % of the corporate income tax for the next 5 years.

2) Investment in industrial zone development

For the investment in the development of Industrial Zone, the corporate income tax is exempted for 10 years of the initial 15 years after commencement of the project. However, the condition to enjoy the preferential tax treatment is that the project shall be commenced by March 31, 2011.

3) Investment in power source development and transmission/ distribution sector

For the investment in repair and upgrade sector of power source development, transmission line, and development of transmission/ distribution network, the corporate income tax is exempted for 10 years of the initial 15 years after commencement of the project. However, the condition to enjoy the preferential tax treatment is that the project shall be commenced by March 31, 2012.

4) Oil related firms

Firms involving in the commercial production and refinement of oil will be exempted from the profit tax for 7 years after its establishment with the condition to comply with the prescribed guideline. Besides, for the submarine oil pipeline and cross-border natural gas pipeline projects, the tax is exempted for 10 years within the condition required by the government. However, this tax treatment is only applied to the project commenced by March, 2011.

(Source: Website of JETRO)

3.4.3 Socio Environmental Consideration

(1) Legal System related to Environmental Aspects

1) Central government

Environmental Act, law, regulation and permit are enforced by Ministry of Environment and Forest (MOEF) in India. “The Environmental Protection Act” was enacted in 1986 and “The Environmental Protection Rules” was enacted in the same year. MOEF is authorized for necessary countermeasures against environmental protection and prevention of pollution as shown below.

1) Making of the medium and long term development plan for prevention of pollution and environmental protection.
2) Making of environmental standards and regulations
3) Making of emission standards for pollution
4) Establishment of related organizations

As the other Acts related to the socio-environmental consideration for the infrastructure project, there are “The Forest (Conservation) Act, 1980”, “The Wildlife (Protection) Act, 1972”, “The Air (The Air Prevention and Control of Pollution) Act, 1981” and “The Water (Water Prevention and Control of Pollution) Act, 1974”.

The Central Pollution Control Board (CPCB) established under The Water (Water Prevention and Control of Pollution) Act in 1974 is the authorized for environmental laws and regulations as one of the related organizations with MOEF. CPCB is in charge of the protection, improvement and monitoring of water resource and air pollution.

2) Rajasthan states

According to the Environmental Protection Rules enacted in 1986, the respective State governments are authorized to set their own standards which shall be applied to the whole India. From the result of interview with the officer in charge of socio-environmental consideration in JVVN, it understood that environmental standards for the whole India are applied in Rajasthan.

(2) Application of Environment Clearance (EC)

1) Outline of application of EC

Act on Environmental Impact Assessment (EIA) in India was enacted in 1991 and revised several times. At present, "Environmental Impact Assessment Notification-2006" which was notified in 2006 is applied. This notification specifies that all the projects classified in Categories A and B require EIA, and the prior EC which will be issued by MOEF, EIA Division of State government and Assessment Committee of Experts shall be applied. Application procedure is described in the following figure.

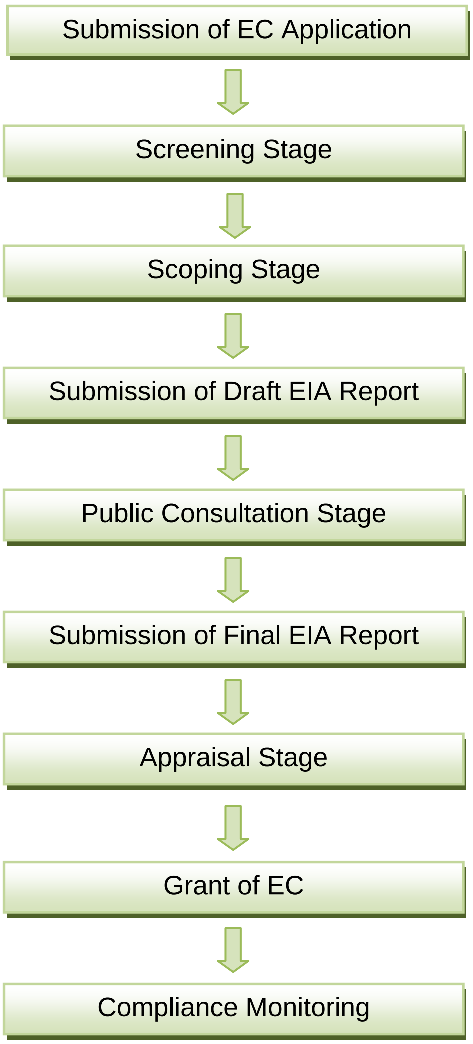


Fig. 3.4-2 Process for Application of EC

2) Requirements of prior EC

Thirty nine (39) projects and activities in eight (8) areas are listed to apply EC on EIA Notification-2006. All projects and activities are broadly categorized into two categories - Category A and Category B, based on the spatial extent of potential impacts on human health and natural and manmade resources.

a) Category A

All projects or activities included as Category 'A' in the Schedule, including expansion and modernization of existing projects or activities and change in product mix, shall require EC from the MOEF on the recommendations of an Expert Appraisal Committee (EAC).

b) Category B

All projects or activities included as Category 'B' in the Schedule, including expansion and modernization of existing projects or activities or change in product mix will require prior EC from the State/Union territory Environment Impact Assessment Authority (SEIAA). The SEIAA shall base its decision on the recommendations of a State or Union territory level Expert Appraisal Committee (SEAC). In the absence of a duly constituted SEIAA or SEAC, a Category 'B' project shall be treated as a Category 'A' project.

The classification of EC category for power industry and industrial estates are as shown below.

Table 3.4-1 Classification of EC Category for Power Industry

Project or Activity		Category with threshold limit A	Category with threshold limit B	Conditions if any
1		Mining, extraction of natural resources and power generation (for a specified production capacity)		
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
1(d)	Thermal Power Plants	(i) ≥ 500 MW (coal/lignite/naphtha & gas based); (ii) ≥ 50 MW (Pet coke diesel and all other fuels)	(i) < 500 MW (coal/ lignite/ naphtha & gas based); (ii) <50 MW, ≥ 5 MW (Pet coke, diesel and all other fuels)	General Condition shall apply
1(e)	Nuclear power projects and processing of nuclear fuel	All projects	-	

Table 3.4-2 Classification of EC Category for Industrial Estates

Project or Activity		Category with threshold limit A	Category with threshold limit B	Conditions if any
7		Physical Infrastructure including Environmental Services		
7(c)	Industrial estates/ parks/ complexes/ areas, export processing Zones (EPZs), Special Economic Zones (SEZs), Biotech Parks, Leather Complexes.	i) If at least one industry in the proposed industrial estate falls under the Category A, entire industrial area shall be treated as Category A, irrespective of the area. ii) Industrial estates with area greater than 500 ha. and housing at least one Category B industry.	i) Industrial estates housing at least one Category B industry and area <500 ha. ii) Industrial estates of area> 500 ha. and not housing any industry belonging to Category A or B.	Special condition shall apply Note: Industrial Estate of area below 500 ha. and not housing any industry of category A or B does not require clearance.

General Condition (GC): 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 Wild Life (Protection) Act, 1972,
(ii) Critically Polluted areas as notified by the CPCB from time to time,
(iii) Notified Eco-sensitive areas,
(iv) inter-State boundaries and international boundaries.

3) Organizations for Application of EC

MOEF

MOEF conducts the investigation of application for EC on Category A projects and provide the comprehensive supports for investigations to the state governments as control authorities.

SEIAA

SEIAA conducts the investigation for application of EC on Category B projects. SEIAA is composed of three persons, an officer of the concerned state government familiar with environmental laws and other two professional or experts.
Hereafter, MOEF and SEIAA are termed "the regulatory authority" as the implement agency of investigation for application of EC.

EAC and SEAC

EAC and SEAC conduct the screening, scoping and appraisal on the investigation for application of EC and make recommendation on grant or rejection of application. EAC and SEAC are composed of fifteen members who are environmental experts, sectoral experts in project management, EIA experts and so on.
EAC and SEAC may inspect any site(s) connected with the project or activity in respect of which the prior EC is sought, for the purposes of screening or scoping or appraisal, with prior notice of at least seven (7) days to the applicant, who shall provide necessary facilities for the inspection.

4) Application for prior EC

An application seeking prior EC in all cases shall be made in the prescribed form before commencing any construction activity, or preparation of land, at the site by the applicant. The applicant shall furnish, along with the application, a copy of the pre-feasibility project report except that, in case of construction projects or activities (item 8 of the Schedule) in addition to the form, a copy of the conceptual plan shall be provided, instead of the pre-feasibility report.

5) Stages in the prior EC

The EC process for new projects will comprise of a maximum of four stages, all of which may not apply to particular cases as set forth below.

Stage (1) Screening
Stage (2) Scoping

Stage (3) Public Consultation
Stage (4) Appraisal

Stage (1) - Screening

In case of Category B projects or activities, this stage will entail the scrutiny of an application seeking prior EC for determining whether or not the project or activity requires further environmental studies for preparation of an EIA for its appraisal prior to the grant of EC depending up on the nature and location specificity of the project. The projects requiring an EIA report are termed Category B1 and remaining projects are termed Category B2 and will not require an EIA report. For categorization of projects into B1 or B2, the MOEF issues appropriate guidelines from time to time.

Stage (2) - Scoping

Scoping refers to the process to determine detailed and comprehensive Terms of Reference (TOR) of all projects and activities listed as Category A and B1. EAC prepares TOR in the case of Category A projects or activities, and SEAC prepares TOR in the case of Category B1 projects or activities.

The TOR is conveyed to the applicant by EAC or SEAC within sixty days of the receipt of application. If the TOR are not finalized and conveyed to the applicant within sixty days, the TOR suggested by the applicant is deemed as the final TOR approved for the EIA studies. The approved TOR shall be displayed on the website of the regulatory authority.

Applications for prior EC may be rejected by the regulatory authority concerned on the recommendation of the EAC or SEAC concerned at this stage itself. In case of such rejection, the decision together with reasons is communicated to the applicant in writing within sixty (60) days of the receipt of the application.

Stage (3) - Public Consultation

Public consultation refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity are ascertained with a view to taking into account all the material concerns in the project or activity design as appropriate. All Category A and Category B1 projects or activities undertake Public Consultation, except the following:-

(a) Modernization of irrigation projects
(b) All projects or activities located within industrial estates or parks approved by the concerned authorities.

(c) Expansion of Roads and Highways which do not involve any further acquisition of land.
(d) All Buildings/Construction projects/Area Development projects and Townships.
(e) All Category B2 projects and activities.
(f) All projects or activities concerning national defense and security or involving other strategic considerations as determined by the Central Government.

The applicants of EC request The Statement Pollution Control Board (SPCB) to hold public hearing. SPCB conducts public hearing of local affected residents and stakeholders within forty five (45) days of a request from the applicant

Local Residents	A public hearing at the site or in its close proximity- district wise is held to be carried out for ascertaining concerns of local affected persons by SPCB. The proceedings of public hearing are forward to the regulatory authority. In case the SPCB does not undertake and complete the public hearing within the specified period, and/or does not convey the proceedings of the public hearing directly to the regulatory authority, the regulatory authority engages another public agency or authority which is not subordinate to the regulatory authority, to complete the process within a further period of forty five days.
Stakeholders	For obtaining responses in writing from other concerned persons having a plausible stake in the environmental aspects of the project or activity, the concerned regulatory authority and SPCB invite responses from such concerned persons by placing on their website the Summary EIA report along with a copy of the application, within seven days of the receipt of a written request for arranging the public hearing.

The regulatory authority concerned may also use other appropriate media for ensuring wide publicity about the project or activity. All the responses received as part of this public consultation process shall be forwarded to the applicant through the quickest available means.

After completion of the public consultation, the applicant addresses all the material environmental concerns expressed during this process, and makes appropriate changes in the draft EIA and Environmental Management Plan (EMP).

Stage (4) – Appraisal

EAC or SEAC scrutinizes the application and other documents like the final EIA report, outcome of the public consultations including public hearing proceedings and make the recommendation on grant or rejection of application for EC.

The appraisal of all projects or activities which are not required to undergo public consultation, or submit an EIA report is carried out on the basis of the prescribed application form as applicable, any other relevant validated information available and the site visit.

The appraisal of an application is completed by the EAC or SEAC within sixty days of the receipt of the final EIA report and other documents or the receipt of application form, where public consultation is not necessary.

6) EC process for expansion or modernization or change of product mix in existing projects

All applications as shown below are considered the necessity to conduct further studies beyond the prescribed form including preparation of EIA report and public consultations by the EAC or SEAC within sixty days from the receipt of application. The applicants of projects which are required further studies prepare the EIA report and public consultation.

- Expansion with increase in the production capacity of mining projects
- Increase in either lease area of mining projects
- Increase of production capacity in the case of mining projects
- The modernization of an existing unit with increase in the total production capacity

7) Grant or rejection of prior EC

The regulatory authority considers the recommendations of the EAC or SEAC and convey its decision to the applicant within forty five (45) days of the receipt of the recommendations in other words within one hundred and five (105) days of the receipt of the final EIA report.

The regulatory authority normally accepts the recommendations of the EAC or SEAC. In cases where it disagrees with the recommendations of the EAC or SEAC, the regulatory authority requests reconsideration within forty five (45) days of the receipt of the recommendations while stating the reasons for the disagreement. An intimation of this decision is simultaneously conveyed to the applicant. The EAC or SEAC considers the observations of the regulatory authority and furnish its views within a further period of sixty (60) days. The decision of the regulatory authority after considering the views is final and conveyed to the applicant by the regulatory authority concerned within the next thirty (30) days.

In the event that the decision of the regulatory authority is not communicated to the applicant within the period, the applicant may proceed as if the EC sought for has been granted or denied by the regulatory authority in terms of the final recommendations of the EAC or SEAC.

8) Validity of EC

The prior EC granted for a project or activity is normally valid for a period of five (5) years.

9) Post EC monitoring

It shall be mandatory for the project management to submit half-yearly compliance reports in respect of the stipulated EC terms and conditions in hard and soft copies to the regulatory authority concerned, on 1st June and 1st December of each calendar year.

3.5 Penetration Status of Japanese Firms and Perspective of Penetration and Investment to India and the DMIC Areas

3.5.1 Penetration Status of Japanese Affiliated Firms to India

Numbers of Japanese firms establishing factories or doing business in India are increasing every year. Those penetrated in India counted for 248 firms in April, 2005 and soared to 725 firms in October, 2010, increased about 2.9 times during 5 years.

Notes) Counts only the number of firms registered in India. Following figures are also the same.

Numbers of offices of the Japanese affiliated firms in India was only 290 in April, 2005, while those in October, 2010 reaches 1,236 offices, which corresponds to approximately 4.3 times in almost 5 years. Therefore, it is understood that those Japanese firms have been expanding its office network in India.

Rajasthan-based Japanese affiliated firm was only one in January, 2008, however, numbers of firms have rapidly increased to 21 firms in October, 2010 after development of exclusive industrial zone for Japanese firms in the NIC.

Numbers of Japanese affiliated firms operating in the NIC is 11 at the end of July, 2011, and 8 firms are constructing factories at present and 9 other firms are planning to construct the factories. After having start operation of all of these firms, no. of Japanese affiliated firms in the NIC will reach 28 firms. Further, there is an expansion plan of industrial zone to be developed exclusively for Japanese affiliated firms (300 to 400 acres), and Indian side is expecting more Japanese firms to come.

Japanese firms in the NIC commented, through the interview conducted by the Consultant, that the merits of the NIC are 1) low land price, 2) cheaper labor cost, and 3) no traffic jam in the industrial area and its surroundings, while the demerits are 1) supervisor’s salary would be relatively high as they have to be employed in Delhi or its nearby area, and 2) the quality of power is quite poor. To promote the investment by the Japanese firms, it is necessary to improve the business environment such as power.

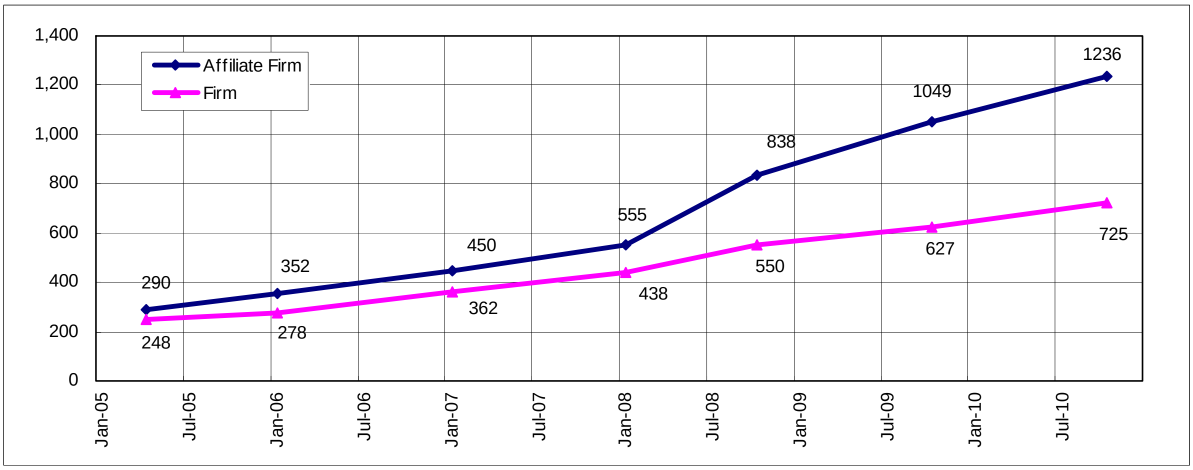


Fig. 3.5-1 Number of Offices and Number of Japanese Affiliated Firms invested in India

(Source: Data of Japanese Embassy in India

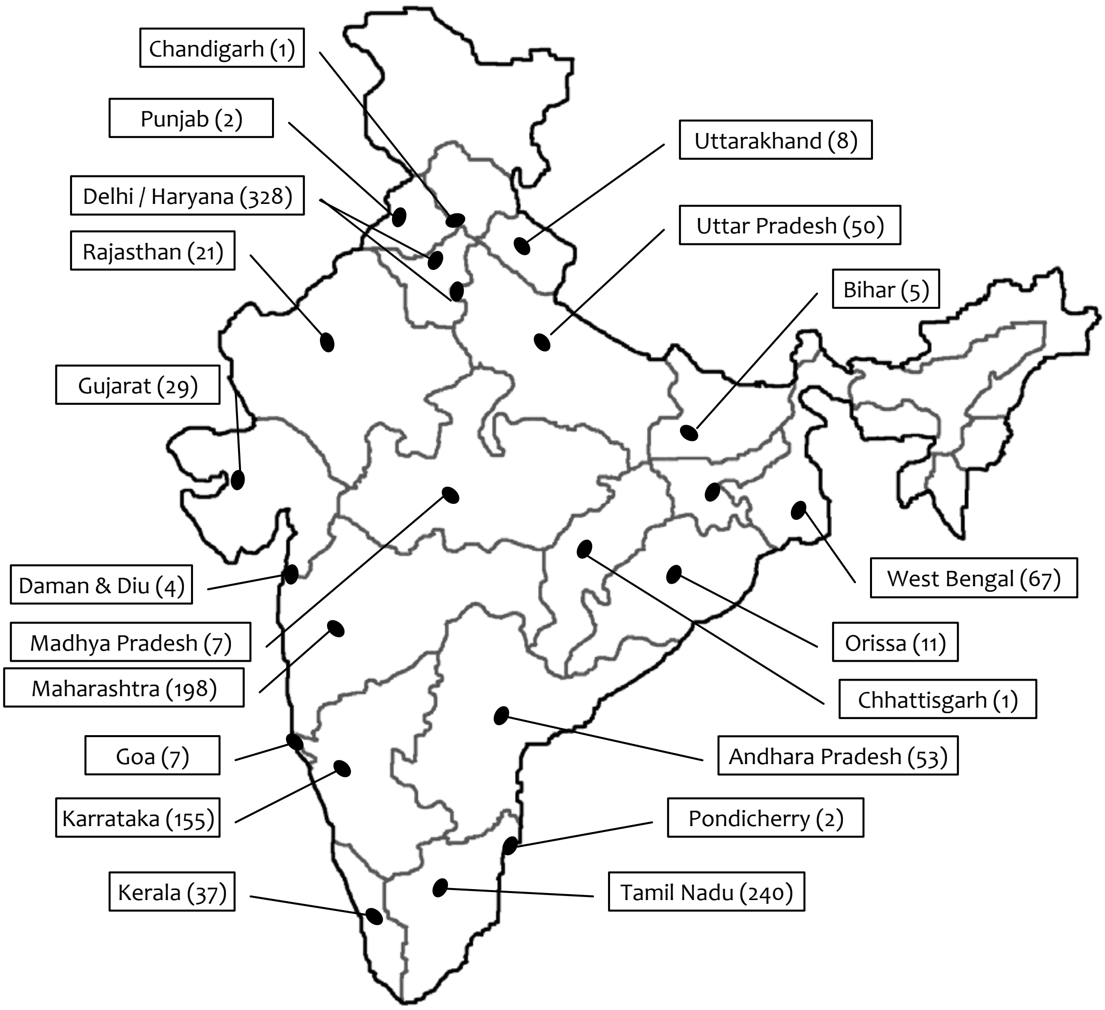


Fig.3.5-2 Number of Japanese Affiliated Firms in All Over India

(Source: List of Japanese Affiliated Firms in India (October, 2010), Japanese Embassy in India)

Table 3.5-1 Japanese Affiliated Firms by Each Base in India

Region / State	January, 2008	October, 2008	October, 2009	October, 2010
Delhi and its surrounding/North-east India				
Delhi / Haryana	203	255	295	328
Uttar Pradesh	29	34	42	50
Rajasthan	1	10	22	21
Chandigarh	1	1	2	1
Punjab	1	1	1	2
Uttarakhand	N.A.	4	6	8
Assam	N.A.	N.A.	1	N.A.
Sub-total	235	305	369	410
East India				
West Bengal	17	33	52	67
Jharkhand	1	3	5	10
Orissa	0	3	6	11
Bihar	N.A.	N.A.	2	5
Sub-total	18	39	65	93
South India				
Tamil Nadu	77	143	169	240
Pondicherry	0	1	1	2
Andhara Pradesh	12	25	32	53
Kerala	7	13	22	37
Sub-total	96	182	224	332
West India				
Maharashtra	103	174	219	198
Gujarat	4	22	31	29
Madhya Pradesh	3	6	8	7
Goa	4	5	6	7
Chhattisgarh	0	1	1	1
Daman & Diu	N.A.	N.A.	3	4
Sub-total	114	208	268	246
Bangalore and its surroundings				
Karrataka	92	104	123	155
Sub-total	92	104	123	155
Total	**555**	**838**	**1049**	**1236**

No. of Japanese Firms	**438**	**550**	**627**	**725**

(Source: List of Japanese Affiliated Firms in India (October, 2010), Japanese Embassy in India)

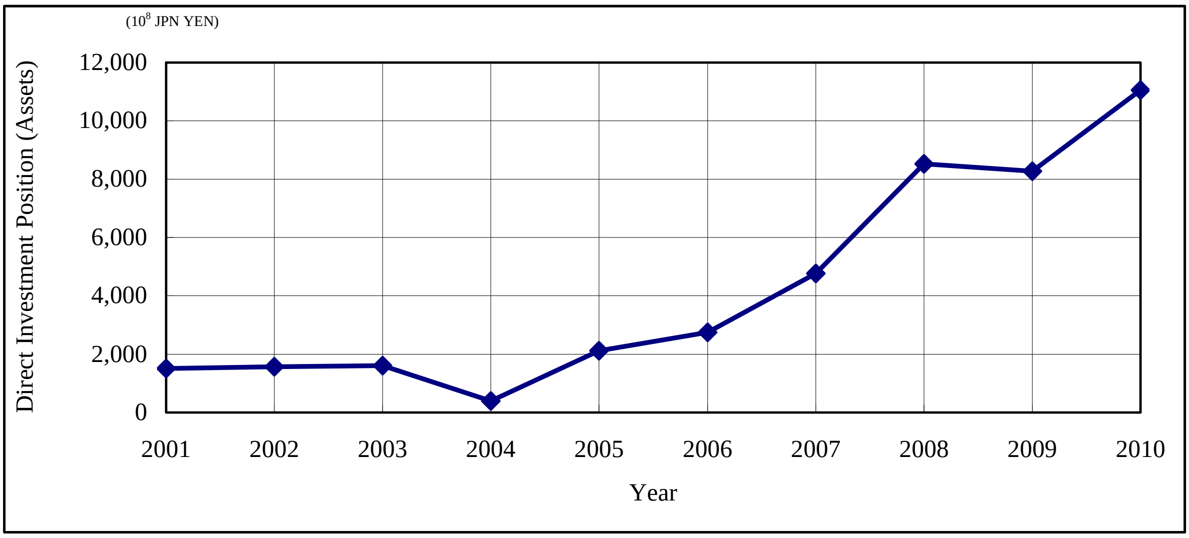
Table 3.5-2 Japanese Affiliated Firms invested in Rajasthan State

No.	Japanese Firm	Japanese Affiliated Local Firm	Sector	Location
1	Nishimatsu Construction Co., Ltd.	Nishimatsu Construction Co. Ltd. Liaison office	Construction	Bhiwadi
2	Sakata INX Corporation	Sakata Inx India Ltd. Factory	Manufacturing of printing ink	Bhiwadi
3	Bela Tsusho Co., Ltd.	Bela Tsusho India Pvt. Ltd.	Apparel inspection	Jaipur
4	Otsuka Chemical Co., Ltd.	Otsuka Chemical India Ltd. Factory	Medicine and chemistry	Keshwana
5	Kikuchi Co., Ltd., Takao Kinzoku Kogyo Co., Ltd., Honda Motor Co., Ltd.	Global Auto-Parts Alliance India Pvt. Ltd.	Automobile body accessory manufacturing	Keshkera
6	Honda Motor Co., Ltd.	Honda Siel Cars India Ltd. Tapukara Plant	4 wheel drive car manufacturing/ sale	Keshkera
7	Honda Siel Cars India Ltd., Steel Center Co., Ltd., Honda Trading Corporation	Rajasthan Prime Steel Processing Pvt. Ltd	Steel products processing	Keshkera
8	Yachiyo Industry Co., Ltd.	Yachiyo India Manufacturing Private Limited	Automobile accessory	Keshkera
9	Yutaka Giken Co., Ltd.	Yutaka Autoparts India Pvt. Ltd.	Automobile accessory manufacturing	Keshkera
10	Daikin Industries, Ltd.	Daikin Air Conditioning India Pvt. Ltd. Neemrana Plant	Air conditioner manufacturing	Neemrana
11	Dainichiseika Color & Chemicals Mfg. Co., Ltd., Marubeni Corporation	Dainichi Color India Private Ltd	Synthetic resin compound and manufacturing /sale of coloring agent	Neemrana
12	Imasen Electric Industrial Co., Ltd., Imasen Engineering Corporation	Imasen Manufacturing India Private Limited	Automobile accessory manufacturing	Neemrana
13	KDDI Corporation	KDDI India Pvt. Ltd. Neemrana Branch	IT services	Neemrana
14	Mikuni Corporation	Mikuni India Private Limited	Automobile accessory manufacturing	Neemrana
15	Mitsui Chemicals Inc., Prime Polychem Corporation	Mitsui Prime Advanced Composites India Pvt. Ltd., Factory	PP compound	Neemrana
16	Mitsubishi Chemical Corporation, Japan Polychem Corporation	Mytex Polymers India Private Limited, Factory	Plastic compound	Neemrana
17	Nissin Kogyo Co., Ltd.	Nissin Brake India Pvt. Ltd. Factory	Automobile accessory (break) Development/manufacturi ng/sale	Neemrana
18	NTT Communications Corporation	NTT Communications India Pvt. Ltd. Neemrana Branch	Electric/ telecommunication	Neemrana
19	Toyoda Gosei Co., Ltd.	Toyoda Gosei India Pvt. Ltd.	Safety system accessories such as handle, airbag, etc.	Neemrana
20	Teikoku Piston Ring Co., Ltd.	TPR Autoparts Mfg. India Pvt. Ltd.	Manufacturing/ sale of automobile accessory	Neemrana
21	Bestex Kyoei Co., Ltd., Marujun Co., Ltd., Masuda Manufacturing Co., Ltd.	Bestex MM India Pvt. Ltd.	Automobile accessory manufacturing	Tapukara

(Source: List of Japanese Affiliated Firms in India (October, 2010), Japanese Embassy in India)

3.5.2 Investment Status to India

Direct investment to India is rapidly increased in recent years. Balance of direct investment (asset) becomes approximately 7.3 times larger in the last 10 years. According to the "Study on Overseas Business Development of Japanese Manufacturers" conducted in 2008 by JBIC, India ranked second as the promising country for investment by the Japanese firms, therefore, the direct investment to India is expected to increase further in the future.



(10^8 JPN YEN)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Direct Investment Position (Assets)	1,510	1,565	1,612	398	2,117	2,753	4,771	8,523	8,275	11,051

Fig. 3.5-3 Balance of Direct Investment (asset) to India

(Source: Statistic Data of Bank of Japan)

3.5.3 Penetrated Status of Japanese Firms due to DMIC Concept

The DMIC Concept is an overall regional development plan implemented by the joint cooperation initiated by the private investment of Japanese and Indian firms. The project components include the construction of infrastructures such as 1) railway for freight transport (Yen Credit of 450 billion Japanese Yen), industrial zone, logistics base, power plant, road, port and harbor, housing and commercial facilities. To implement this DMIC Concept between Japan and India, JETRO and DMIDC concluded MoU in December, 2009 which provides 1) contribution of JBIC loan to Project Development Fund (75 million US Dollars) and 2) promotion of smart community.

Integrated Master Plan for the DMIC Regional Development has already been prepared. In Rajasthan, three (3) regions, namely Kushkera, Bhiwadi and Neemrana as development area, and two (2) districts of Jaipur and Dausa as industrial area are nominated for a target area for development. Besides, the EB which will be developed in advance (6 projects developed by Japanese side and 21 projects developed by Indian side) are selected, and the following projects are developed in Rajasthan.

Table 3.5-3 EB in Rajasthan

Japanese side	Joint Energy Center Project in the NIC: Hitachi, Ltd. and the firms in NIC
	Neemrana Integrated Logistic Hub Establishment Project: Nippon Yusen K.K.
India side	Construction of Neemrana – Bhiwadi Highway
	Airport City nearby Jaipur
	Knowledge City

The EB of Japanese side are planned, two in Rajasthan (Neemrana Area only), one each in Uttar Pradesh State, Haryana State, Maharashtra State and Gujarat State.

Significant increase of investment of Japanese firms in recent years becomes associated with the industrial development program in the DMIC regions, and it is forecasted that the investment of Japanese firms to India would continuously increase.

CHAPTER 4

PROJECT FORMATION AND APPLICATION OF JAPANESE TECHNOLOGY

CHAPTER 4 PROJECT FORMATION AND APPLICATION OF JAPANESE TECHNOLOGY

4.1 Possibility of Project Formation

4.1.1 Objective Area

Ever since the agreement of DMIC in 2006 between the governmental bodies of Japan and India, the industrial complex has been developed alongside the national road No.8 one after another. Among others, as the NIC which RIICO has developed in the Alwar district of Rajasthan State is located in the vicinity of New Delhi, this area has much potential for the future development. Actually, eleven (11) Japanese firms such as DAIKIN Industries Ltd. and TOYODA GOSEI Co., Ltd. have extended their business there, and other seventeen (17) firms are planning to be there.

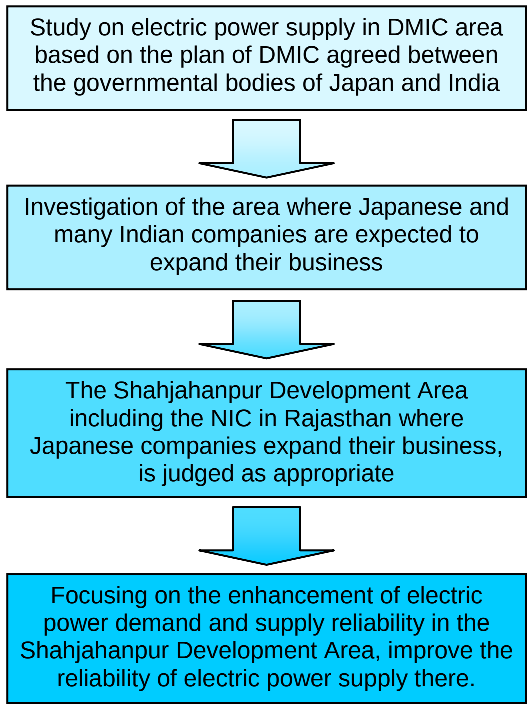


Fig.4.1-1 Selection of Objective Area for Project Formation

RIICO administrates six (6) industrial complexes (Keswana, Sotalana, Behror, Neemrana, Shahjahanpur and Ghilot), which locate along Route 8 surrounding Neemrana, as a unit of the Shahjahanpur Development Area. Some of the areas have expansion and new development plans under proceeding and these areas are expected to be further developed in the future. In this Study, it is considered that development of the power system is important for the areas developed by RIICO into which Japanese and local firms are expected to remarkably move in the future.

Therefore, the Shahjahanpur Development Area centered on the NIC, is selected as the object area for this Study.

Current situation of the Shahjahanpur Development Area is described as follows.

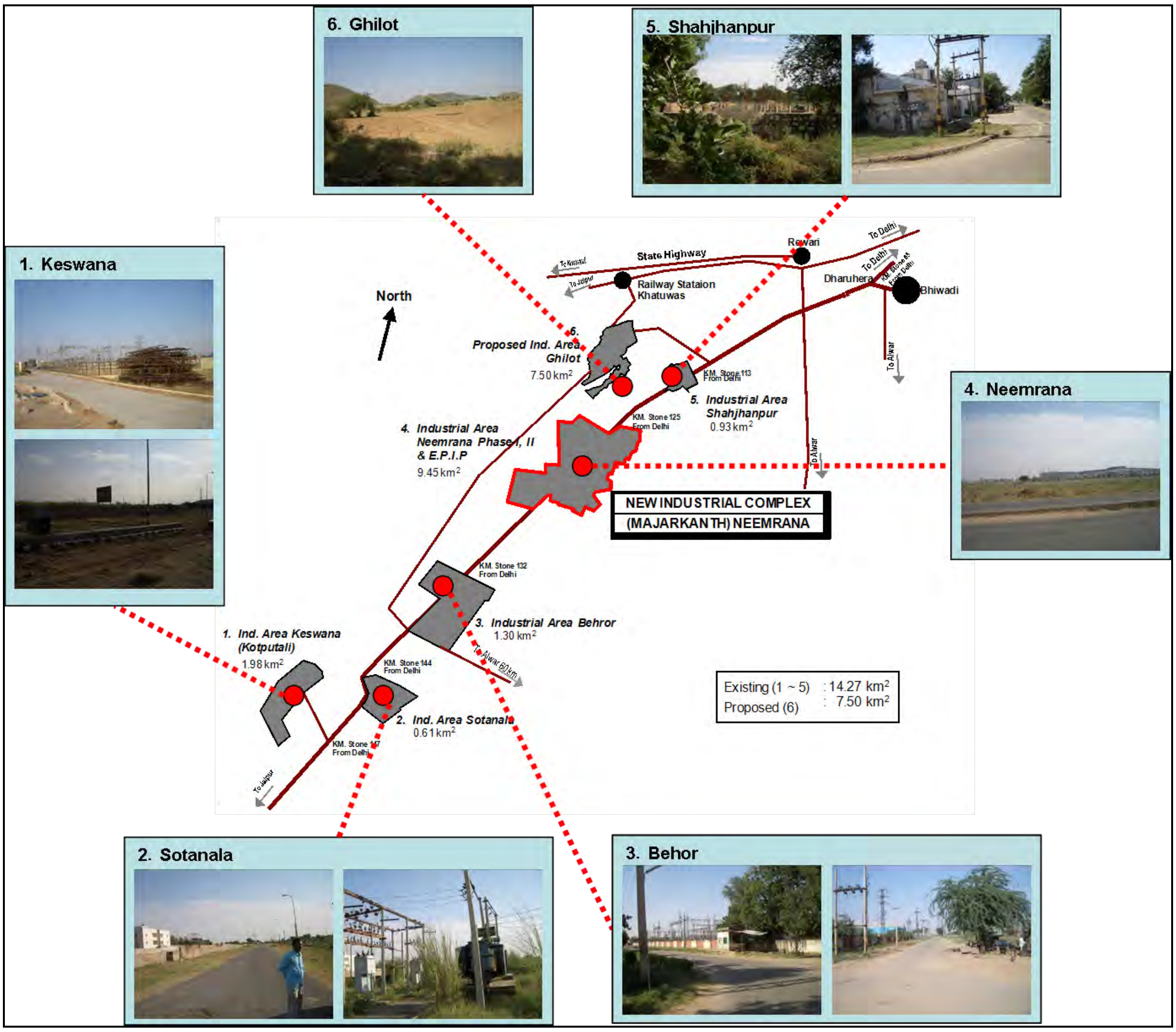


Fig.4.1-2 Current Situation of the Shahjahanpur Development Area

Table 4.1-1 Industrial Areas in Shahjahanpur Development Area

<table>
<tr><th rowspan="2">No</th><th rowspan="2">Industrial Area</th><th colspan="3">Area (km^2)</th><th colspan="5">Existing Area</th><th rowspan="2">Remarks</th></tr>
<tr><th>Existing</th><th>Planned + Expansion</th><th>Total</th><th>Years of Establishment</th><th>Units in Production</th><th>Units in under Construction</th><th>Units of Reserved</th><th>Units of Vacant Plot</th></tr>
<tr><td>1</td><td>Keswana</td><td>1.98</td><td>-</td><td>1.98</td><td>1992</td><td>8</td><td>-</td><td>-</td><td>1</td><td>This is the existing industrial area located about 147 km away from Delhi, where eight (8) companies including paper manufacturer, Japanese chemical factory, etc. are in operation.
Access road is maintained, but it is about 2 km away from the national highway No. 8.
It equips a 132 kV substation of RVPN.</td></tr>
<tr><td>2</td><td>Sotanala</td><td>0.61</td><td>-</td><td>0.61</td><td>2000</td><td>45</td><td>-</td><td>-</td><td>2</td><td>This is the existing industrial area located about 144 km away from Delhi, where forty-five (45) companies including liqueur factory, textile factory, etc. are in operation. Any large company does not exist in this industrial area.
Easy access is secured because of the location along the national highway No. 8.
Electric power is received from Keswana industrial area through 33 kV overhead distribution lines.</td></tr>
<tr><td>3</td><td>Behror</td><td>1.3</td><td>0.72</td><td>2.02</td><td>1981</td><td>187</td><td>-</td><td>-</td><td>4</td><td>This is the existing industrial area located about 132 km away from Delhi, where one hundred eighty-seven (187) companies including interior corporation, auto parts factory, etc. are in operation.
Easy access is secured because of the location along the national highway No. 8.
It equips a 220 kV substation of RVPN.</td></tr>
<tr><td rowspan="5">4</td><td>Phase-I</td><td>2.61</td><td rowspan="4">9.53</td><td>2.61</td><td>1992</td><td>107</td><td>-</td><td>-</td><td rowspan="4">55</td><td rowspan="5">This is the existing industrial complex located about 125 km away from Delhi. It has been developed dividing into four (4) regions where one hundred eighty-six (186) companies in total are in operation.
Easy access is secured because of the location along the national highway No. 8.
It equips the 220 kV substation of RVPN.
NIC has the industrial complex exclusively for Japanese companies, where eleven (11) factories are in operation, six (6) factories are under construction, and eleven (11) factories secure the land.</td></tr>
<tr><td>Phase-II</td><td>1.27</td><td>1.27</td><td>2007</td><td>18</td><td>-</td><td>-</td></tr>
<tr><td>EPIP</td><td>0.85</td><td>0.85</td><td>2006</td><td>50</td><td>-</td><td>-</td></tr>
<tr><td>NIC</td><td>4.72</td><td>14.25</td><td>2007</td><td>11</td><td>6</td><td>11</td></tr>
<tr><td>Total</td><td>9.45</td><td>9.53</td><td>18.98</td><td>-</td><td>186</td><td>6</td><td>11</td><td>55</td></tr>
<tr><td>5</td><td>Shahjahanpur</td><td>0.93</td><td>2.12</td><td>3.05</td><td>1982</td><td>82</td><td>-</td><td>-</td><td>4</td><td>This is the existing industrial area located about 113 km away from Delhi, where eighty-two (82) companies including home appliances manufacturer, textile factory, etc. are in operation.
Easy access is secured because of the location along the national highway No. 8.
It is the 132 kV substation of RVPN. New construction of a substation is required according to the further development plan. (Site for additional substation has been already secured)</td></tr>
<tr><td>6</td><td>Ghilot</td><td>-</td><td>16.56</td><td>16.56</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>This is the newly projected industrial area located in the west of Shahjahanpur. Large area has been secured and boundary stakes are placed.
Road of about 3 m width is only available for access from the national highway No. 8 to the industrial area, and it runs through a residential area. Access road will be required in the future.
Electric power infrastructure is not maintained. Any corporation has not moved into this industrial area as of October, 2011. In the north, there is the projected site for the Khatuwas Station to be a hub-station of the exclusive railways for freight between Delhi and Mumbai.</td></tr>
</table>

4.1.2 Issues

As for the electric power system in Rajasthan, information on the transmission and distribution lines of the 132 kV, 33 kV and 11 kV shows that the number of accident and elapsed accident time are within the allowable standards (refer to Table 3.2-5), however, a lot of power failures in the distribution system due to accidents and obstacles have occurred actually.

An electric receiving status record of a company (Company T) in the NIC, who is provided with electric power through 11 kV distribution line, is shown in Fig.4.1-3. According to this record, 109 times of power failures occurred in 89 days from March 15, 2011 to July 12, 2011 (no record in May). The power supply was relatively stable in March and April but the power failures occurred 4 to 5 times a day from June this year so far. And average time of power failure of approximately 133 minutes per day was recorded. In addition, fluctuation of the frequency in the range of 49.1 Hz to 52 Hz and the voltage of 5% to 6% occurs

As mentioned above, in fact, it is found that the reliability of power in the Shahjahanpur Development Area including the NIC is not acceptable and does not meet the JVVN’s standards. Therefore, the gross issue in the power supply for the firms that have extended and will extend their business in the Shahjahanpur Development Area, is frequency and time of power failure. These situations are derived from the various kinds of problems mentioned in Chapter 3, the expected major factors causing these situations are summarized below.

- ♦ Shortage of power supply
- ♦ Insufficient transmission network
  - • Shortage of transmission facilities
  - • Deterioration of transmission facilities
- ♦ Insufficient distribution system
  - • Shortage of distribution network
  - • Deterioration of distribution network
- ♦ Large electricity loss
- ♦ Insufficient operation and maintenance
  - • Lack of technology for operation and maintenance works
  - • Shortage of budget for operation and maintenance
- ♦ Insufficient measures for energy conservation by consumers

The RVUN is engaged in the power generation in Rajasthan. Its electricity supply is anticipated to be short by the year 2012, but surplus of 30% of the supply is expected after 2013 or 2014 at peak time according to the comparison of installed capacity (75% of total capacity) and electric power demand in the 12th five-year plan (2012 to 2017) (refer to Table 3.2-3).

IPP is recommended for development of electric power plant according to the Rajasthan State's policy on electric power development. Thus, development or expansion of electric power plants by the state government is regarded as less priority.

Based on the above mentioned backgrounds, analysis of the solutions to the listed issues are carried out. The results are shown in Fig. 4.1-4.

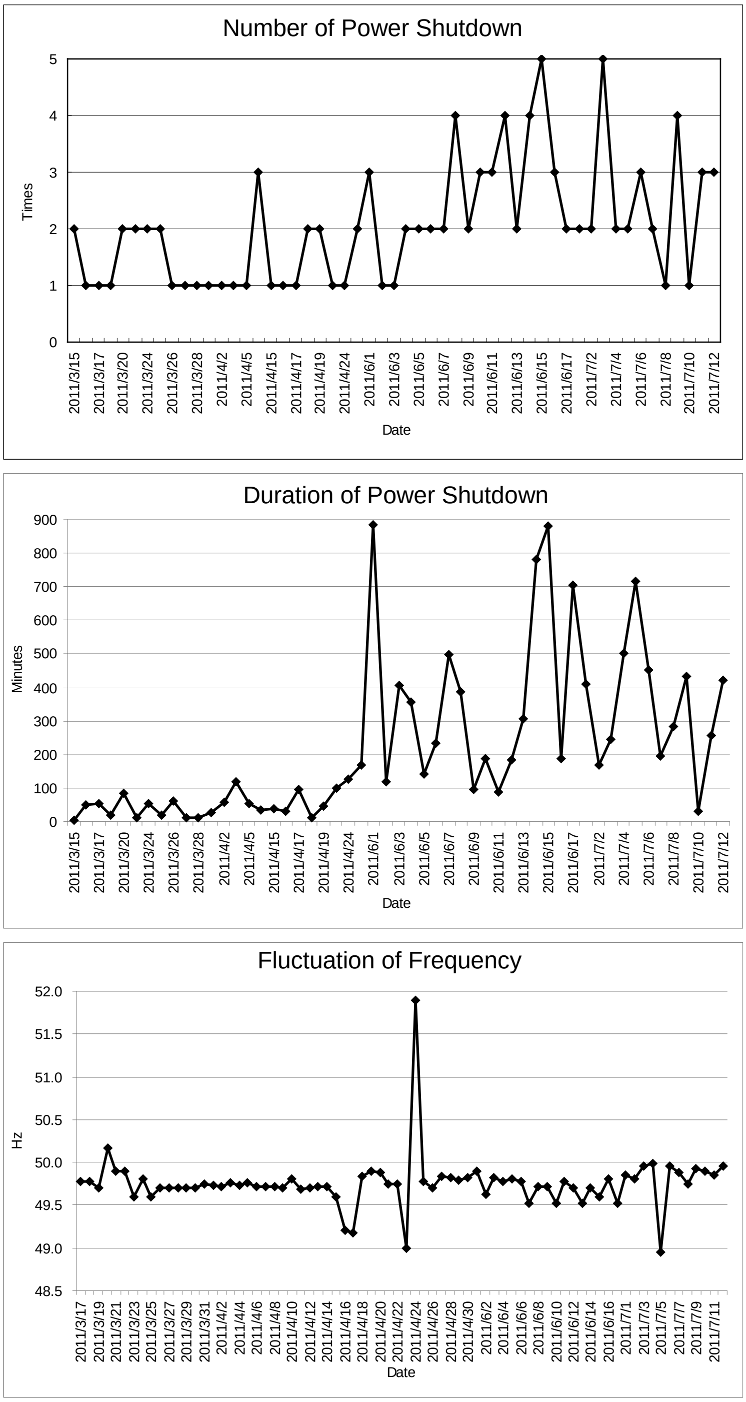


Fig.4.1-3 Electric Receiving Status Record of Company T

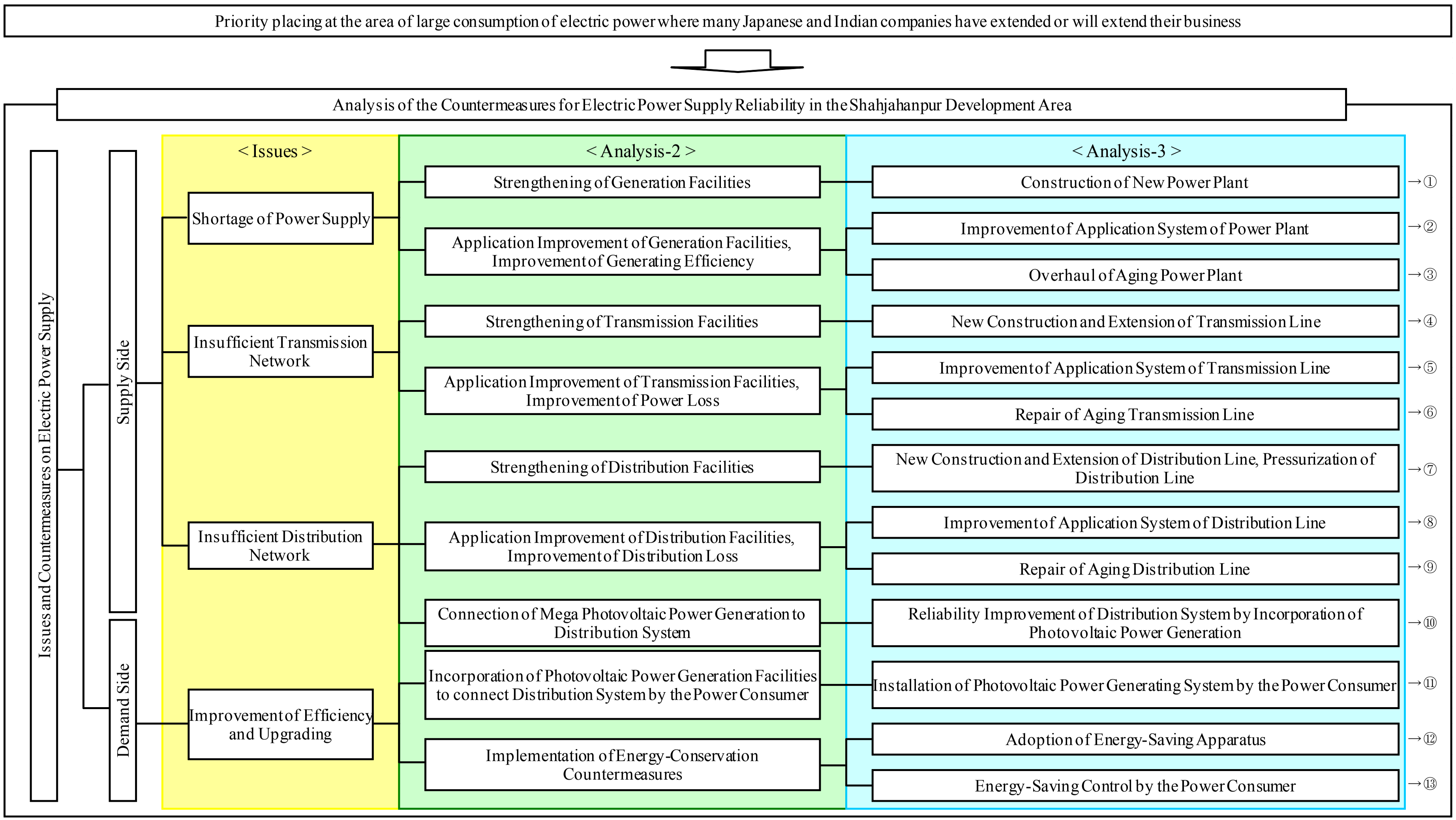


Fig.4.1-4 Issues and the Countermeasures for Electric Power Supply

4.1.3 General Plan of the Challenges

Following challenges are recommendable.

① Development and strengthening of power generation facilities
② Development and strengthening of power transmission network
③ Development and strengthening of power distribution network
④ Improvement of operation and maintenance capacity of the personnel concerned
⑤ Self measures by consumers

Among challenges to improve reliability of power system in the Shahjahanpur Development Area, it is supposed that advance Japanese technologies of new construction or extension of gas-fired power plant, arrangement of power distribution grid and automatic distribution system would be available to solve the issues.

Another possibility will be the development of renewable energy source. Since the renewable energy promotion is progressing in India and Rajasthan is suitable for solar power generation from the viewpoint of meteorological conditions, the Japanese predominant technologies in PV power generation and operation would be applicable to solve the issues.

Moreover, NEDO has a plan to develop the PV power generation plant to be connected to the existing power grid in the NIC. According to RIICO, there is suitable areas for PV power generation near the Shahjahanpur Development Area.

In this Study, based on the power quality indicators in Rajasthan (refer to Table 3.2-5), the goals and targets are established as follows.

Table 4.1-2 Goal and Target

Super Goal	Improve the electric power quality at the Shahjahanpur Development Area to create attractive environment for investment promotion
Goal	- Drastic decrease of frequency of power failure occurrence - Decrease of power loss
Object	- Supply of the higher reliable power - Appropriate operation and maintenance of electric power facilities
Target index	Frequency of power failure occurrence : 18 times/year Time duration of power failure : 8 hour/year Voltage fluctuation : ±1% of the rated voltage

Based on Fig.4.1-4 and Table 4.1-2, the screening to select effective challenges was made in Fig.4.1-5. The eight (8) recommendable challenges were selected.

Analysis-3		Evaluation and Explanation	Specific Challenges	
① Construction of New Power Plant	△	Coverage of future supply can be expected	New construction and extension of gas-fired power plant, and incorporation of highly efficient power generation technology	1
② Improvement of Application System of Power Plant	×	Interconnection of new power plant and existing plant is difficult	–	
③ Overhaul of Aging Power Plant	×	Interconnection of new power plant and existing plant is difficult	–	
④ New Construction and Extension of Transmission Line	×	It will lead to extremely extensive countermeasure due to required system stability by means of efficient system extension plan	–	
⑤ Improvement of Application System of Transmission Line	△	System stability by efficient system improvement will be expected	- System control technology of direct current transmission - Improvement of 3-phase load balance	2
⑥ Repair of Aging Transmission Line	×	Repair will become nation-widely extensive not only for the aging transmission line in the Rajasthan	–	
⑦ New Construction and Extension of Distribution Line, Pressurizing of the Distribution Line	○	Major distribution line in the objective area is of overhead 11 kV having less supply capacity and less supply reliability	Strengthening power supply capacity and reliability by arranging the underground distribution line of 33 kV	3
⑧ Improvement of Application System of Distribution Line	○	Power control will be secured by the hour-to-hour and accurate demand grasp	Installation of smart meter and precise application of automatic distribution operating system	4
⑨ Repair of Aging Distribution Line	○	Aging of 11 kV overhead line is progressing. Transmission capacity and lightning resistance design, etc. must be reviewed.	Incorporation of 33 kV underground line, enlargement of 11 kV overhead line in size, adoption of automatic distribution operating system to distribution system, replacement of aging transformer	5
⑩ Reliability Improvement of Distribution System by Incorporation of PV Power Generation	○	Direct connection of mega PV power generation to distribution system	Connect mega PV power generating system directly to distribution line to control it by automatic distribution operating system	6
⑪ Installation of PV Power Generating System by the Consumer	○	Improvement of power supply reliability by installing PV power generating system by the consumer	Installation of PV power generating system by the consumer, and control by means of automatic distribution operating system	7
⑫ Adoption of Energy-Saving Apparatus	△	Individual response by the consumer	Control by automatic distribution operating system of the energy-saving apparatus installed by the consumer	8
⑬ Energy-Saving Control by the Consumer	×	Individual response by the consumer	–	

Legend:
○ : Good, △ : Preferable, × : Not recommendable

Fig.4.1-5 Screening of Challenges and Project Formation

4.2 Possibility of Application of Japanese Technology

In the Section 4.1, the effective challenges have been selected based on the issues in the power sector of Rajasthan. First of all, the selected eight (8) challenges are explained below. Moreover, possible predominant solutions with Japanese technology taking into account of the issues in the power sector of Rajasthan are evaluated and selected with following procedures.

Procedure	Explanation	Result
1	Japanese technologies and other Japanese latest ones for the specific challenges selected in Fig.4.1-5 are widely extracted.	Table 4.2-1
2	The technologies may not be applicable in India because of those prices and other circumstances, even if they have advantages in Japan's market. From such view points, the advantage and effectiveness of Japanese technologies in Indian is evaluated.	
3	The Japanese technologies for the solution evaluated as higher and lower predominance are scrutinized in those performance, cost and application record.	Table 4.2-2

(1) Electric Power Supply Side

1 Construction of New Power Plant

Current power supply meets the power demand up to 2013, however, electric power development is further required.

- ♦ To meet the increasing power demand thereafter, larger amount of power supply is expected by incorporating high capacity and high efficient gas-fired generator (1,000 MW class) developed by Japanese technology.

2 Improvement of Application System of Transmission Line

System stability and loss are to be reduced by means of system extension plan and improved application.

- ♦ Production operation at semiconductor, textile or chemical industries will be stopped or their required qualities will be lowered in case of instantaneous voltage drop in the system due to lightning accident, etc. Appropriate installation of arresting equipment is effective for such accident.
- ♦ Improvement of 3-phase load balance is effective for reducing power transmission loss.

♦ Large amount of power transmission and avoidance of short-circuit capacity increment, can be expected by means of direct current power transmission.

3 New Construction, Strengthening and Pressurization of Power Distribution Facilities

When the strengthening of distribution system in the Shahjahanpur Development Area by incorporating 33 kV system having higher reliability is implemented, the higher reliable power supply to the firms requiring such reliability can be expected.

♦ Power supply in the Shahjahanpur Development Area is currently executed mainly by 11 kV overhead distribution line, and such trouble as power failure by lightning accident or shortage of power distribution capacity has occurred. Underground distribution line of large capacity of 33 kV is effective for such trouble avoidance. Actually some firms in the NIC are receiving the power through the 33 kV underground distribution line at their cost. They are enjoying highly reliable electricity from the 33 kV line.

4 Efficient Application of Power Distribution System

Automatic distribution operating system is recommendable to the Shahjahanpur Development Area for the purpose of application improvement of the distribution line of the Area.
Establishment of the automatic distribution operating system will lead to efficient application of distribution system and application improvement of distribution line.

♦ Automatic supervision from the control room of the automatic switching (ON/OFF) installed on the poles at the divided sections of distribution line, is recommendable.

♦ Accident detection by the switch having built-in sensor, and computerized acquisition of such measured data as voltage, current, accident wave, etc. are recommendable, furthermore precise management of voltage/current in the distribution line through the accumulation of database and its acquisition in common can be obtained much more than current system.
Shortening of accident restoration time by earlier detection of accident and prevention of accident by the accident-sign detection, can be obtained also. These arrangements are expected to be effective for the system application to minimize the distribution line loss and prevention of further accident by means of automatic detachment of the sections where accident has occurred.

♦ Installation of smart meter is effective for accurate power consumption amount by the consumer, and will contribute to the power company’s income increase owing to the deduction of metering work expenses, by which power consumption control at the

demand side can be expected for optimum distribution system application.
Supervisory system of power supply amount will be a solution against electricity theft as well.

5 Repair of Aging Distribution Facilities

Aging 11 kV overhead distribution system in the Shahjahanpur Development Area is progressing, thus, review of power transmission capacity and lightning resistance design is required.

- ♦ Necessity of future strengthening of power consumption is anticipated and power failure due to accident or trouble has occurred in the large power consumption firms at the Shahjahanpur Development Area on the existing 11 kV overhead distribution line.

For resolving these issues, it is effective that distribution capacity is increased by pressurizing the 11 kV line to 33 kV and accident of lightning and line-cut by incorrect operation of crane will be avoided by placing the underground distribution line aiming the power supply increase and accident prevention.

- ♦ Replacement of aging transformer will result in power increase and accident prevention.
- ♦ Establishment of advanced distribution system by incorporating automatic distribution operating system in the Shahjahanpur Development Area will contribute to efficient operation of the distribution facilities there.
- ♦ Energy-saving by means of reduction of distribution loss and inspection and maintenance of the distribution facilities is expected.

6 Reliability Improvement of Distribution System by Incorporating PV Power Generating System

Reliability improvement of power grid by interconnection between distribution system and mega PV generating system.

- ♦ Related authority of Rajasthan is keen to develop PV power generation as renewable energy because of its advantageous location having much solar irradiation and desert in the western area for facility installation.
- ♦ Participation in the PV power generation business form the private sector is encouraged through the Rajasthan Renewable Energy Corporation (RREC).
  49 projects are registered as of September 2011 with total output of 1,524 MW.
  The state government advocates the PV power generation development of 10,000 MW to 12,000 MW in 10 to 12 years from now on, and the first phase of the development is planned to produce 400 MW by 2017.

Whereas, NEDO has been implementing demonstrative research of 5 MW in the NIC.

When the PV power generating facilities as an isolated power source are directly connected to the automatic distribution operating system in the Shahjahanpur Development Area, control of power supply with the automatic distribution system according to the local power demand will realize stability of power supply and improvement of power supply reliability.

(2) Demand Side

7 Installation of PV Power Generating System by the Consumer

The firms that have extended or will extend their business activities to the Shahjahanpur Development Area install PV power generating facilities by themselves connecting them to the distribution system directly in order to improve the reliability of power system.

- ♦ Facility cost of the PV power generating system has become inexpensive these years. Further, "Feed in Tariff" that the consumer sells the electricity produced by his PV power generation facilities at high rate to the electric power company becomes popular.
- ♦ The Shahjahanpur Development Area is extremely large and suitable for the location where the PV power generating facilities are installed, thus, this plan will be another business opportunity for the firms who will become power producer.
- ♦ Since the factories there are not large scale, large effect will not be gained even if only one factory connects to the distribution system in terms of scale-merit.
  Namely, the PV power generating facilities must be installed by many firms there to control them as an isolated power source in the automatic distribution operating, such system realize the stability of power supply or its improvement of reliability.

8 Application of Energy-Saving Apparatus

Inter-links between individual response by the consumer and automatic distribution operating system are attempted.

- ♦ Adopt the energy-saving apparatus to the apparatus being used by the consumer. Moreover, the consumer will receive more benefits by means of load deduction on account of power system improvement by himself.
- ♦ Improvement of power supply reliability in the whole grid and control of scheduled power interruption and power demand will be realize by means of control of the energy-saving apparatus owned by the consumers from the control center of the automatic distribution operating system.

Table 4.2-1 (1) Study and Evaluation on Application of Japanese Technology

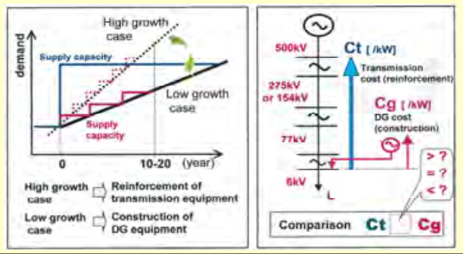
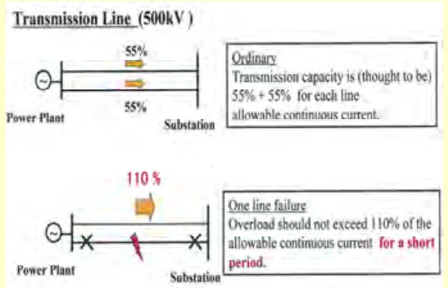
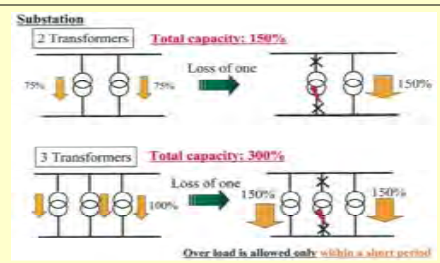
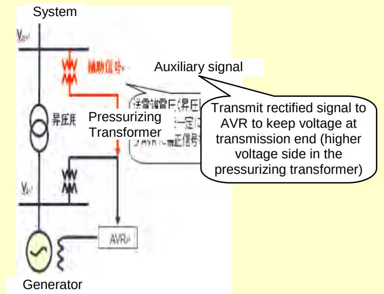
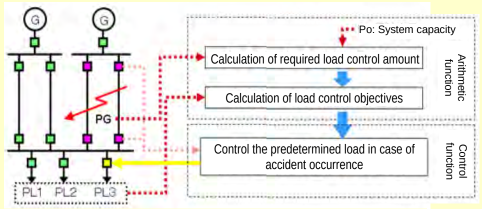
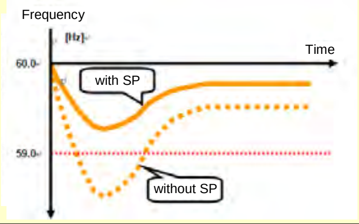
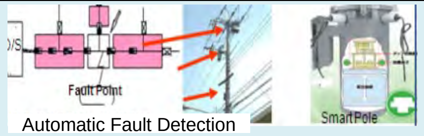
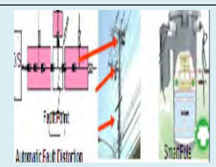
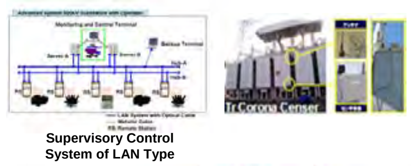
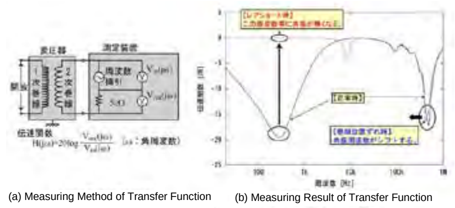
Issue	No. in Fig. 4.1-5	Challenges	Possible Predominant Japanese (Latest) Technology for Solution	Outline of Technology	Predominance of Japanese Technology	Evaluation	Remarks
Shortage of Power Supply	1	Construction of new or additional thermal power plant	Super critical coal-fired thermal power generation	Secure plant efficiency of 40% to 41% by raising steam pressure to 24 MPa and steam temperature to 565°C	In addition to technology predominance of Japanese companies, Indian (BHEL), Korean, Russian and Chinese companies are developing similar technology. Russian company got contract for ultra super critical plant firstly planned in India.	No specific Japanese predominance 【×】	
			Ultra super critical coal-fired thermal power generation	Secure plant efficiency of 41% to 43% by raising steam pressure to 31 MPa, steam temperature to 565°C or steam pressure to 25 MPa and steam temperature to 600°C	Japanese companies have predominance. Japanese-licensed ultra super critical plant has commissioned recently in China for the first time. Fabrication in India seems to be hard due to the license.	【○】	
			Advanced ultra super critical coal-fired thermal power generation	Secure plant efficiency of 46% to 48% by raising steam pressure to 35 MPa and steam temperature to 700°C from the ultra super critical thermal power generation's	This technology is under development by Japanese companies, so imminent utilization is impossible.	Technology under development 【×】	To be utilized in the future
			Gas turbine combined cycle generator of large capacity and high efficiency	Secure plant efficiency of more than 50% using F-type gas turbine (300MW class /unit), G-type (340MW class/unit) or J-type (460MW/unit)	Only MHI has this technology, and MHI has developed J-type overwhelmingly in the world.	Japanese technology has much predominance for 300 to 450MW class turbine unit. 【○】	
Insufficient Transmission Facilities	2	Solution against instant voltage-down in the power transmission facilities (Power quality improvement)	Technology of instantaneous voltage-drop of lightning resistance device for power transmission	 Lightning Resistance Device; Algorithm for Apparatus Function Evaluation	Influences due to instantaneous voltage drop or shutdown in the transmission route will affect the production at semiconductor, textile, chemical and silk manufacturers, and possibly lead to production stoppage or quality deterioration. Lightning resistance device is used in Japan to prevent those risks.	Japanese technology has predominance. 【○】 Based on the implementation of surge analysis of the extent for device installation in the area where lightning damage has occurred, its effectiveness and costs must be examined for application.	The device is broadly used for 33 kV to 275 kV ever since 1980. Arcing horn type which is more compact, lighter and cheaper than lightning resistance device is developed and practically used for 77 kV class.
		Reinforcement of power transmission network	Technology of controlling direct current transmission system		Direct current transmission system has already introduced in India for transmit the power by coal-fired thermal power plant in south-western area to large power consumption area (Deli, Mumbai, etc.). However, Japanese technology of controlling the direct current system for continuous operational function and power stabilization function can be identified as predominance.	Japanese technology has predominance 【○】	Transmission technology by direct current is to be applied to whole India, and is not applicable to the solution in the vicinity of Rajasthan State.
		System reinforcement plan and application improvement	Technology for improving system reinforcement plan: Example of system reinforcement plan		Japan keeps world tope level in stable power supply. System reinforcement according to local power demand estimation so as to avoid supply shortage is being implemented in Japan as illustrated in the left column.	India has its reinforcement plan of the facilities to meet the power supply reliability target. In this point, Japan does not have extreme predominance. 【△】	This improvement is applicable to whole India. As to the reinforcement of the trunk line system and its application are not directly applicable to the solution for reliability improvement in the vicinity of Rajasthan.
			Technology for improving system reinforcement plan: Example of transmission line reinforcement plan		For respective transmission lines, reinforcement is done at the necessary time to avoid power failure even when accident occurs for reliable supply.		
			Technology for improving system reinforcement plan: Example of transformer reinforcement		Similar to transmission line reinforcement plan, timely reinforcement of the transformer to avoid power failure even in case of accident of the transformer at substation is being carried out for reliable supply.		

Table 4.2-1 (2) Study and Evaluation on Application of Japanese Technology

Issue	No. in Fig. 4.1-5	Challenges	Possible Predominant Japanese (Latest) Technology for Solution		Outline of Technology	Predominance of Japanese Technology	Evaluation	Remarks
Insufficient Transmission Facilities	2	System reinforcement plan and application improvement	Application improvement technology	PSVR (Power System Voltage Regulator) technology		This technology is to keep the rated voltage at the higher side in the pressurizing transformer nearest to the system side, different from ordinary AVR, to contribute to improvement of system stability and transmission loss.	Trunk system in India consists of complicated application of system operation in combination of ultra high voltage alternate current and direct current facilities with preparation of system application standard. Japanese technology of power supply reliability improvement maintaining the higher system voltage to reduce transmission loss will not be introduced instantly but to be referential. 【△】	
				SPS (Special Protection Scheme) technology		In case of specific large accident occurs, necessary load is to be shut-down based on the predetermined value. Range of frequency drop can be restrained to avoid further accident by this technology.		
Insufficient Distribution Facilities	3	Arrangement of distribution network (reinforcement by 33 kV)	Conventional distribution technology of 33 kV		33 kV distribution is used worldwide.	Indian contractors are familiar with 33 kV distribution.	No specific Japanese predominance. 【×】	
			Automatic fault detector			This system offers higher power supply reliability in Japan. Acquisition of accident portion by sequential fault detection system and transmission to the sound portion are specific Japanese technology which has effective shortening of power failure time duration.	Japanese technology has much predominance. 【○】	
			Smart pole (Transformer with Automatic Voltage Regulation)			Technology to control the lower system voltage by means of unit transformer, is of specific Japanese technical function.	Japanese technology has much predominance. 【○】 Smart pole for 6.6 kV for lower voltage is practically used, but the same for 33 kV for lower voltage is to be developed in the future.	
	4 7 8	Automatic distribution operating system	Automatic distribution operating system, Smart meter		- Accurate measurement, ensured charge of power consumption charge and energy-saving Demand Side Management (DSM). - Optimum control of dispersion type power source inclusive of solar power generation and demand.	- Due to stimulating DSM by smart grid and promotion of energy-saving, technology of smart grid will further developed in Japan. - Smart meter is arranged in country-wide in Italy, and will be rapidly arranged in the advance countries including Japan.	Japan has internationally competitive technology. 【○】	Combination with above-mentioned detector
	5	Arrangement of distribution network (Repair of aging facilities)	Monitoring sensor technology of the corona in transformer		 Supervisory Control System of LAN Type  (a) Measuring Method of Transfer Function (b) Measuring Result of Transfer Function Transfer Function of 2nd Coil of On-Pole Transformer by Simulation of Normal/Abnormal Coil	This technology is not applied to on-pole transformer, but to rotor and large transformer.	Japanese technology has predominance. 【○】	
			Detection technique of layer shot of on-pole transformer (inter-phase short)			This technology is to measure the fluctuation of frequency characteristics in the impedance of transformer coil. This will effective for prevention of power failure, but the measuring must be done while power failure and maintenance cost will increase. Frequency characteristics of specific transformer must be prepared as pre-requisite data, and special know-how for evaluation is required as well.	Japanese technology has low predominance. 【×】	Detectors are sold by American manufacturers for large transformer.
	6 7	Large scale PV power generation	Solar power generation and control technology		Direct connection of the solar power generating source to the existing system	Japan has internationally higher level technology including the latest technology of direct connection to system.	Competitors in the world are increasing. 【△】	

Legend in evaluation column ○ : Higher predominance of Japanese technology application, △ : Lower predominance of Japanese technology application, × : No predominance of Japanese technology application

Table 4.2-2(1) Possible Predominant Solution with Japanese Technology

Issue	No.	Applicable Technology	Outline				Reason of Selection			
			Characteristics	Advantage	Disadvantage	Note	Other Similar Technology	Technical Predominance	Cost	Application Record
Shortage of Power Supply	1	Ultra super critical coal-fired thermal power generation	Improve plant efficiency raising steam pressure and temperature	Improvement of efficiency and reduction of CO_2 emission	Higher facility cost Longer construction time	Flue gas treatment facilities (EP, DeNOx, DeSOx) are required.	Already practically applied in Europe and America	Japanese companies have predominance.	Cost of Japanese companies' is competitive for ultra-modern technology	Japanese electric power companies have numerous records.
		Gas turbine combined cycle generator of large capacity and high efficiency	High efficient combined cycle generation using gas combustion at higher temperature	Higher plant efficiency, and reduction of CO_2 emission. Inexpensive construction cost. Shorter construction period	Higher repair cost due to periodical replacement of combustion equipment		Already practically applied in Europe and America	Japanese companies have predominance.	Cost of Japanese companies' is competitive for ultra-modern technology.	Much experience in Japan except for J-type turbine, which is utilized in KEPCO only, and expected to be developed further.
Insufficient Transmission Facilities	2	Technology of instantaneous voltage-drop of lightning resistance device for power transmission	Effective for instant voltage drop by electrical shock and shut-down of transmission route, and broadly used	Minimized precise checking works after electrical shock and improved power quality	Effectiveness for cost must be examined.	Effective for instant voltage drop prevention for 2 to 3 phase in case of double circuit, and effective for transmission route shut-down prevention for 3 to 4 phase	Some application abroad is reported in the thesis of IEEE.	Advantageous in high voltage, scale compactness and light aiming concept	Japanese companies have price competitiveness for ultra-modern technology.	Used in Japanese power companies broadly since 1980
		Technology of controlling direct current transmission system	Transmission by direct current has much more stable system than by alternate current, and can transmit large amount of power regardless of distance.	D/C transmission has system stability, no problem about short circuit increase and can transmit large amount of power to long distant area.	High costly converter station facilities (DC / AC) at both ends are required.	Examination and evaluation of affects by direct current transmission system on the higher harmonics wave, buried decorative illumination and terrestrial magnetism, must be done.	Comparison with ultra high voltage alternate current transmission, is required.	Issues of system stability and short circuit capacity according to system expansion, will not occur and large amount of power transmission for long distance can be achieved.	Comparison with ultra high voltage alternate current transmission on the transmission capacity, transmission distance and system issues must be done. However, direct current transmission is more advantageous in terms of about 500 km transmission on overhead line and more than 50 km with cable.	Latest control technology has been incorporated in the direct current transmission system at Kii Channel in Japan constructed by KEPCO.
		System reinforcement plan - System reinforcement plan - Transmission line reinforcement plan - Transformer reinforcement plan	Own power supply reliability target is established by countries and electric power companies respectively in order to plan and implement the system reinforcement facilities.	Japanese standards for system planning aimed to achieve high reliability of power supply, is of superior international level.	Considerable facility expansion is necessary to keep high power supply reliability, which is costly.	Optimum system planning is to be established considering power supply area demand side needs, electric consumption charge, etc.	Respective countries and electric power companies have their own standards in view of circumstances in power field.	It can not be generally identified that Japanese technology stands alone since each country has its own applicable most suitable standard.	Cost comparison can not be generally identified since the cost for high reliable system is likely to be expensive and variable according to the target reliability.	System reinforcement planning is established by respective electric power companies.
		PSVR (Power System Voltage Regulator)	This mode can also set up the higher system voltage in addition to let VA reactive supply from generator be easy, by which stability improvement and system loss deduction in case of system accident can be attempted.	Improvement of system stability and deduction of system loss can be attempted.	Since the higher system voltage will be incorporated, attention must be paid so as not to over-raise the voltage.	In addition to attention to over-raising system voltage, insulation level of the equipment concerned must be checked.	Comparison with AVR function to control the voltage at generator terminal and its combination with pressurizing transformer tap, will be required.	Quick responsiveness to system stability. Deduction of transmission loss by means of the higher system voltage setting is attempted.	Cost is inexpensive because of only the change of AVR setting point.	KEPCO has usage record.
		SPS (Special Protection Scheme)	SPS can restrain the system frequency drop to some level in case of huge power dropping.	Chain blackout can be minimized against serious system accident.	Risks of unnecessary load rejection due to fail inspection and local incorrect operation, are expected.	Risk to unnecessary load rejection is to be paid attention.	Transmittal load rejection system by simple relay in case of serious accident, will be a similar technology.	This device is equipped with calculator in Japan and can minimize accidents influenced by serious accident by means of load rejection.	Cost will be several score times of PSVR's due to necessity of provision of constant monitor and supervisory calculation system.	Similar protection system is used at electric power companies in Japan.

Table 4.2-2(2) Possible Predominant Solution with Japanese Technology

Issue	No.	Applicable Technology	Outline				Reason of Selection			
			Characteristics	Advantage	Disadvantage	Note	Other Similar Technology	Technical Predominance	Cost	Application Record
Insufficient of Distribution Facilities	3	Automatic Fault Detector	Cyclic action of switch detects the location of accident without reclosed relay. Setting up of communication line allows recovery time shorter.	The detail location of accident in distribution line system is detected within 8 blocks. Quick power distribution to the normal area is available.	The cyclic power distribution after accident may cause the expansion of accident area in the case of direct earth system or short circuit trouble.	Advantage of installation in the system with low accident rate is less. Equipment development for underground distribution system is required.	Developed in Japan. Re-closed system is applied in EU.	The accident point is specifically detected.	20kV switching equipment is relatively expensive due to low production amount.	AFDC is not usually applied to aerial system(6kV, 20kV).
		Smart pole (Transformer with Automatic Voltage Regulation)	Lower voltage can be controlled at respective transformer by tap-switching at primary side coil.	High quality voltage control can be secured.	Large scale of equipment, 200,000 times of life expectancy of tap-switch but no need for inspection or maintenance until the end of life expectancy	Equipment development for 33 kV system is required. Developed jointly by KEPCO and TEPCO with TEPCO's restriction for usage	Tap-changeable manual transformer is broadly used.	Precise voltage control can be done at local part.	Cost of Japanese product is higher than Chinese.	Smart pole is practically used for 6 kV system. Capacity is less than 50 kVA.
	4 7 8	Automatic Distribution Operating System, Smart meter	Precise measuring, Precise grasp of power demand, DSM and Prevention of power stealing	Demand Side Management can be implemented. Monitoring of voltage supply for respective consumers can be secured.	Bilateral transmission path is indispensable for application of WH meter.	Jointly developed by electric power companies with restriction of usage permission	Similar meters are available in Europe and America.	Latest advanced technology having competitiveness	GE and SIEMENS sell world standard types, but price competitiveness of Japanese products is unclear.	Millions of smart meters have been installed worldwide so far.
	5	Monitoring sensor technology of corona in transformer	Detection of interior condition of large transformer bushing by the sensor that can detect frequency when partial discharge	No need for transformer operation stop to take out bushing oil, and continuous internal detection is ensured.	Higher cost due to provision of sensor and computer, etc. compared with gas analysis in oil	Jointly developed by KEPCO and Kanden Engineering Corp. Necessary to check patent and sale system	Checking system of transformer using AE sensor is generally developed and implemented abroad.	Almost no inspection record using AE sensor of the inside of bushing of large transformer. KEPCO and Kanden Engineering Corp. have carried out research.	Cost of Japanese product is higher than Chinese.	KEPCO has carried out demonstration tests on the transformer.
	6 7	Solar power generation and control technology	Generating efficiency has upgraded recently at lower cost.	Clean energy without emitting CO_2	Unstable generation due to natural energy	Effective in the automatic distribution operating system	Wind power or tidal power is another natural energy.	Japanese companies have superior technology, particularly in control technology, but less competitiveness in cost.	Cost of Japanese product is higher than Chinese.	Broadly applied in the world

4.3 Evaluation of Screening of the Possible Challenges

4.3.1 Screening of the Possible Challenges

In consideration of the necessary priority of the challenges to be taken and application possibility of solution with Japanese technologies for the purpose of improving the power supply reliability at the Shahjahanpur Development Area, the followings are recommended as the specific projects.

Table 4.3-1 Evaluation Screening of Possible Challenges

		Challenges	Specific Concept of Challenges	Evaluation Screening	Result
Improvement of Power Supply Reliability	Power Supply Side	[1] Construction of new power plant	New or add-on gas-fired power plant Incorporation of highly efficient power generation technology	Installed capacity will exceed expected power demand and involvement of IPP is encouraged in Rajasthan.	×
		[2] Improvement of application system of transmission line	Countermeasures against instantaneous voltage drop Control technology input to transmission system by direct current Improvement of 3-phase load balance	Difficult, since the transmission system, extends not only to Rajasthan but also to whole India	×
		[3] New construction, extension and pressurizing of distribution line	Strengthening power supply capacity and supply reliability by arranging the underground distribution line of 33 kV	Because of higher reliability of 33 kV distribution line, power supply quality improvement to the firms extending their business activities to the objective areas is remarkably expected.	○
		[4] Improvement of application system of distribution line	Incorporation of smart meter and automatic distribution operating system	Accurate and automatic meter-reading by smart meter, prevention against power theft and demand side control, will be effective. Improvement effects for power supply reliability by automatic distribution operating system are considerably expected.	○
		[5] Repair of aging distribution line	Enlargement in size of 11 kV overhead distribution line, replacement of aging transformer etc.	Not so outstanding effects of power supply reliability improvement by repair of aging distribution facilities are expected.	△
		[6] Improvement of distribution system reliability by means of PV power generation	Connect large capacity of PV power generation directly to distribution line and control it by automatic distribution operating system	Developed are is of optimum location for PV power generation. PV power generation will increase in the future worldwide with large effect, but will be developed by independent power producers generally.	△
	Demand Side	[7] Installation of PV power generating facilities by the consumer	PV power generating system installed by the consumer will be controlled by automatic distribution operating system.	Control of PV power generating system by the consumer will be difficult.	×
		[8] Energy-saving control by the consumer	Control by automatic distribution operating system of the energy-saving apparatus installed by the consumer	Control of energy-saving apparatus by the consumer will be difficult	×

Legend
○ : Possible challenge to be recommended
△ : Challenge with small profit or, implemented by IPP
× : Challenge not recommended

4.3.2 Recommendable Projects

The outline of the two (2) recommendable projects, which are selected from the eight (8) challenges by the screening study is shown in Table 4.3-2.

Table 4.3-2 Outline of Recommended Projects

Project	New Construction, Expansion and Pressurizing of Distribution line	Improvement of Distribution Operating System
Outline	Power supply enhancement and reliability by arranging 33 kV underground distribution line	Installation of smart meter and incorporation of PV power generation as an isolated power source into the automatic distribution operating system
Objective Area	Shahjahanpur Development Area	Shahjahanpur Development Area
Project Developer	JVVN	JVVN
Beneficiary (Power demand side)	Firms that have extended or will extend business activities to the area	Firms that have extended or will extend business activities to the area
Applicable Japanese Technology	Advanced distribution technology - Concept of Automatic fault detection system - Transformer with automatic voltage regulation equipped with LRT	Automatic distribution operating system and Smart meter
Project Period	5 years	5 years
Construction Costs	Japanese Yen 14,300,000,000.- for the Shahjahanpur Development Area Japanese Yen 9,500,000,000.- for the NIC only	Japanese Yen 2,000,000,000.-

Outline of the Shahjahanpur Development Area is shown in Fig4.3-1, the arrangement of the 33 kV distribution system for the NIC is shown in Fig.4.3-2, and conceptual drawing of automatic distribution operating system is shown in Fig.4.3-3.

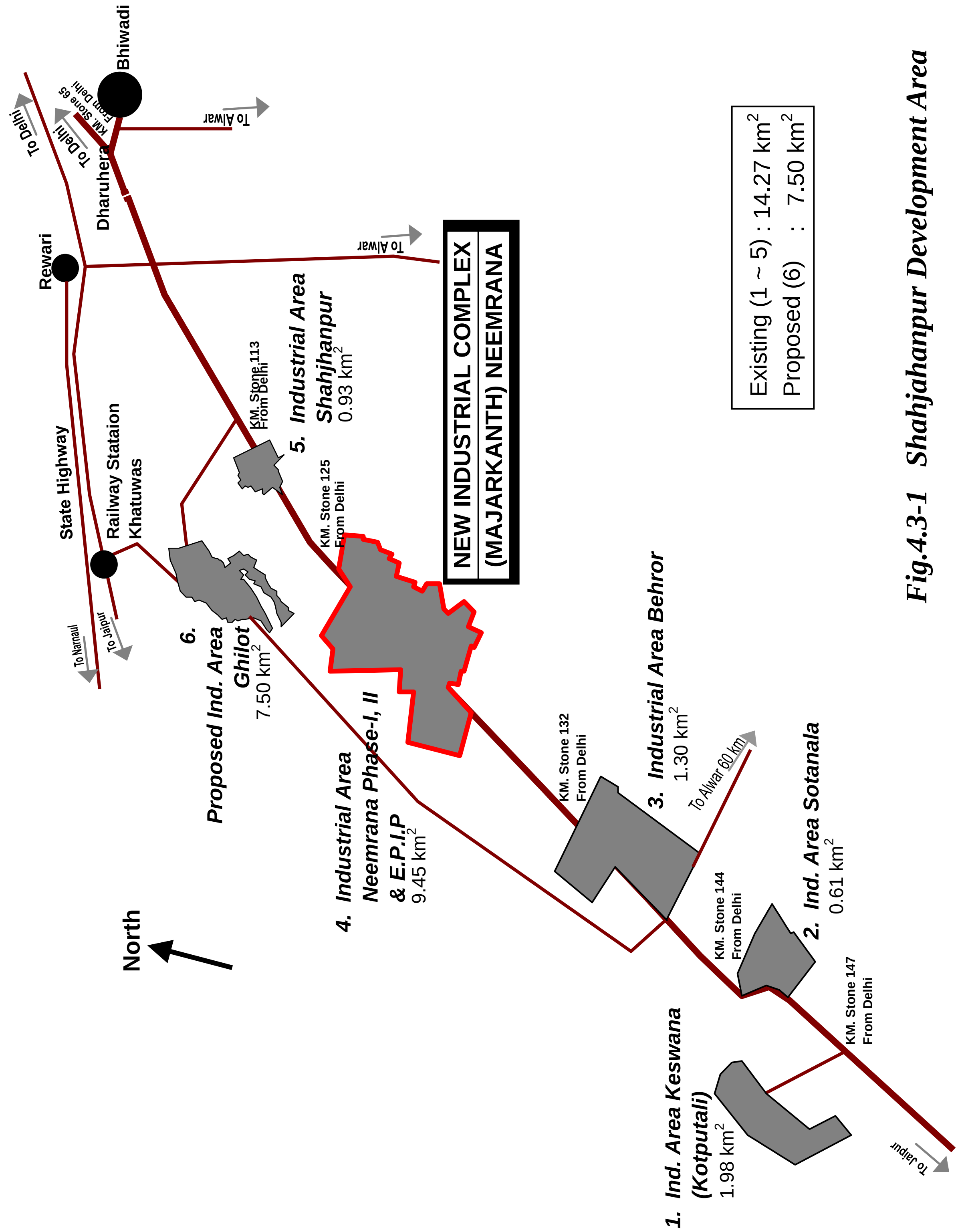


Fig.4.3-1 Shahjahanpur Development Area

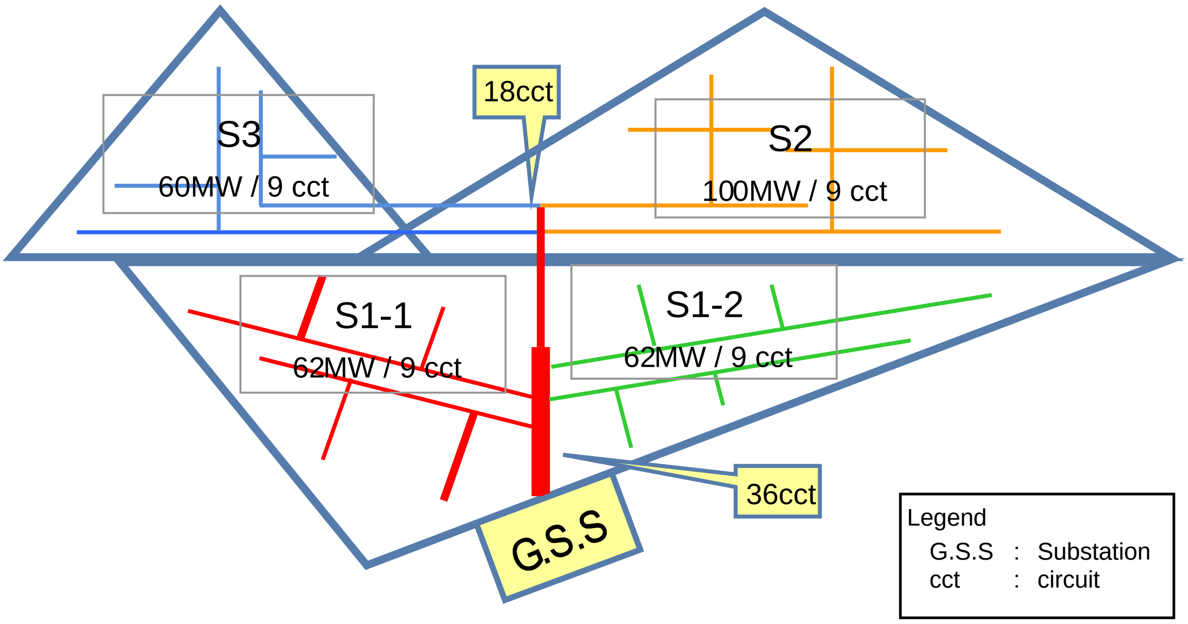


Fig.4.3-2 Arrangement of 33 kV Distribution System for the NIC

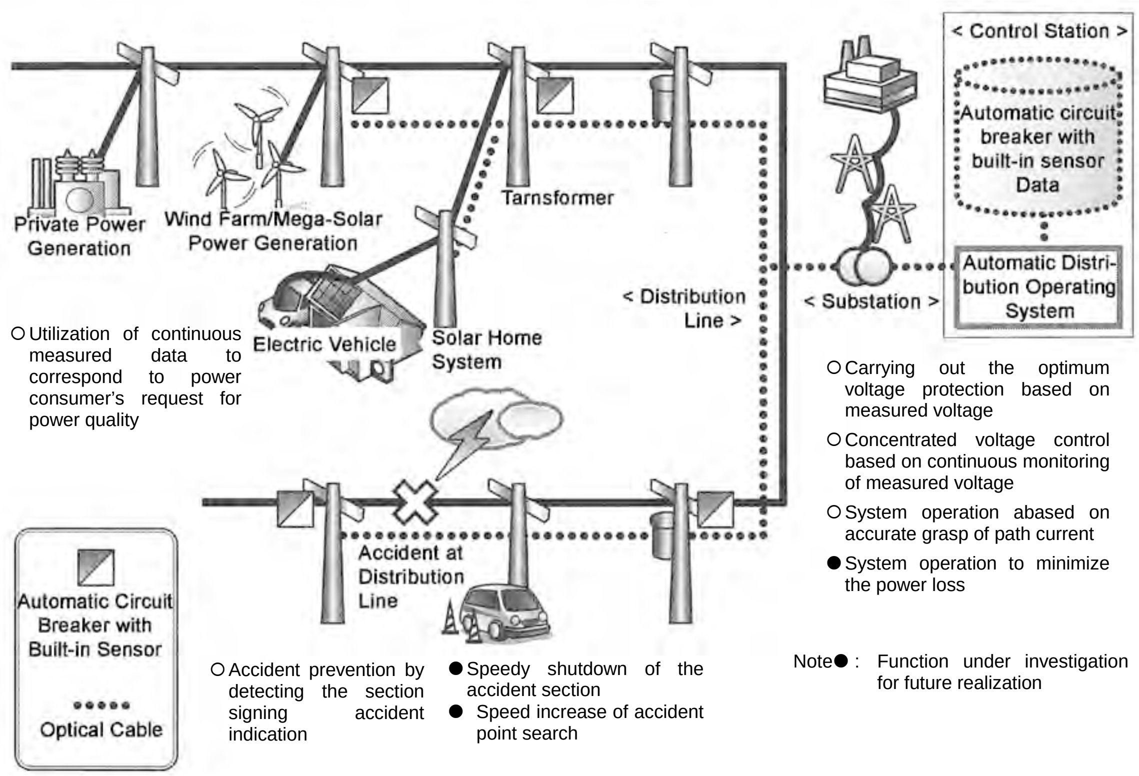


Fig.4.3-3 Conceptual Drawing of Automatic Distribution Operating System

(Source：Future smart grid of electricity)

CHAPTER 5

RECOMMENDED PROJECTS

CHAPTER 5 RECOMMENDED PROJECTS

5.1 Project Plan

5.1.1 General

As for the recommended challenges described in Chapter 4, the following project schemes are recommended toward the distribution network at the Shahjahanpur Development Area.

① Basic Scheme : 33 kV distribution network arrangement
② Additional Scheme : Establishment of automatic distribution operating system

The “Basic Scheme” is a fundamental scheme and “Additional Scheme” is the further scheme in addition to the “Basic Scheme”.

Advanced distribution technologies of automatic fault detector and transformer with automatic voltage regulation can be applied to the basic scheme, and those of automatic distribution operating system and smart meter can be applied to the additional scheme, as the solutions with Japanese technology, by which improvement of system reliability and system loss in the Shahjahanpur Development Area will be expected to achieve the target for this Study.

The survey results to the following items are arranged in order to examine the possibilities of the realization of the recommended projects.

1) Outline of the Project
2) Current circumstances and issues as well as the objectives of the Project
3) Overall project costs and approximate estimation of the amount of Japan ODA Loan portion.
4) Project implementation schedule
5) Structures of the project implementation (governmental authority of the objective state, organization of implementing authority, applicable technology, financial analysis)
6) Structure of project operation, operational services, financial plan, counter plan corresponding to business right
7) Environmental and social impact assessment
8) Relationship with other related authorities (private enterprise, financial donor, non-governmental organization, university, governing body)

9) Project effects (quantitative / qualitative effects, effect target)
10) Beneficial effect to Japan side
11) Project significance, necessity and urgency

5.1.2 Project Outline

(1) Project Substances

Project objectives are to enhance the electric power supply reliability and to mitigate the system loss of the project areas by arranging the 33 kV distribution network in the Shahjahanpur Development Area.

The six (6) industrial areas in the Shahjahanpur Development Area are to be the project sites as shown in Fig.4.1-2.

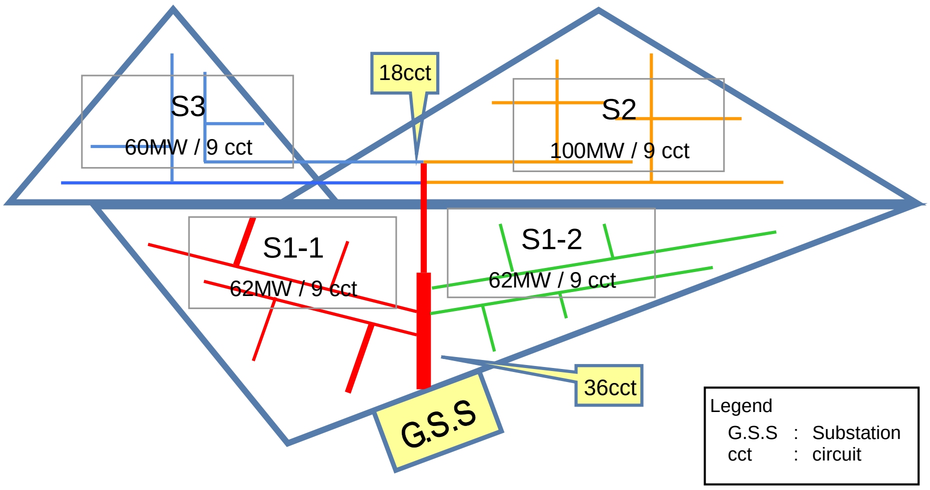
This Project is to be identified as a loan project. Table 5.1-1 shows the fundamental project substances.

Table 5.1-1 Basic Project Scheme

Project Name	33kV Distribution Network Arrangement Project
Purpose	New construction and expansion of 33 kV distribution network so as to supply highly reliable electric power
Current Circumstances and Issues	Frequency and time duration of electric interruption occur a lot and thus sufficient power supply is not ensured.
Necessity and Urgency	Power failure occurs frequently due to insufficient power quality. Financial loss of JVVN and economic loss of firms and of society on account of the power interruption must be dissolved urgently.
Target	New construction and expansion of 33 kV distribution network in the objective area, especially targeting the NIC where many firms are expanding their business activities.
Applicable Japanese Technology and Others	***Applicable Japanese Technology*** - Concept of system of automatic fault detector - Transformer with automatic voltage regulation (equipped with LRT) ***Extent to be applied*** - Abovementioned technologies can be applied to versatile extent, since they can be applied to any distribution networks. ***Experience of Application*** - Automatic fault detector (automatic circuit breaker system) is widely introduced to the electric power companies in Japan. - Transformer equipped with automatic voltage regulation is utilized by the electric power companies in Japan. ***Advantage of Japanese Technology*** - All the above mentioned technology, are being applied in the overhead distribution system (automatic fault detector) and overhead low-voltage distribution system (transformer) and have high technical advantages compared to foreign countries'.
Environmental Aspect	Very little impacts on the natural and social environment due to new construction and/or expansion of the distribution facilities, are expected.
Relation with Private Company, Other Financial Donor, Non-Governmental Organization, etc.	The power generation project is planned in this area, however, there is no authority or organization related to distribution project. - Thermal power generation of 45 MW by Japanese IPP - PV power generation of 5 MW by NEDO, Japan

Objective Area	Shahjahanpur Development Area (NIC)
Implementation Structure / Organization	Implementation Structure : JVVN Cooperation Organization : RIICO, RVPN Supervisory Organization : MOP, DOE
Operating Structure	JVVN
Construction Cost	Approx. 9.5 Billion Japanese Yen (NIC)
Project Cost	Approx. 14.2 Billion Japanese Yen (NIC)
Approximate Financial Amount by Japan	Approx. 11.1 Billion Japanese Yen (NIC) (about 77% of project cost)
Project Period	About 5 years
Project Indicators and Target	Frequency of power interruption : 18 times/year Duration of power interruption : 8 hours/year Voltage fluctuation : rated voltage ± 1%
Project Effect	Deduction of frequency and duration of power interruption from 809 hours/year to 8 hours/year
	Increase of power distribution company's income of about 350 Million JPY per year at the NIC
	Deduction of power consumer's self-generating amount by approximately 800 hours/year
	Promotion of increasing new firms' business expansion
Possibility of Horizontal Application of Japanese Technology	Applicable Japanese technologies are common to distribution network of different voltage, thus, they ca be applied horizontally to all distribution networks of any voltage level. The technologies are expected to be applied to other distribution networks in India.
Expected Technical Cooperation	Technical cooperation is to be implemented for the purpose of 1) Technical improvement for power distribution, 2) Technical improvement of operation, 3) Technical improvement of maintenance, 4) Improvement of knowledge about Japanese technology, and 5) Assistance for promotion of the project. ・Training and Lecture ・Dispatching Technical Advisor ・Technical Cooperation - Technology for establishing reliable distribution network (Review of electric power standard, maintenance technology, and update for the facilities) - Pilot Project/ Demonstrative Test ・Soft-component in the Project Operation and maintenance of Japanese technology introduced

Project Image	The 33kV distribution network is to be newly constructed and/or expanded targeting 6 industrial areas in the Shahjahanpur Development Area. Number of circuit and distribution line extension to be established in the NIC are as shown below.



Item	Area	Load	No. of cct	Conduit Length	Cable Length	No. of Joint
	9.1 km^2	282MW	36 cct	34.8 km	223 km	600

Outline of 33 kV Distribution Network to be supplied to the Loads at the NIC

Others	Further deduction of power interruption duration time and improvement of system voltage can be expected by incorporating the applicable Japanese technologies. However, in consideration of the higher costs and local needs on power quality, the project seems to have some barriers to be overcome. It is required to facilitate the understandings of effectiveness of Japanese technologies and to make close discussion and arrangement with related agencies. On the other hand, implementation of the pilot project/demonstrative test will be effective for promotion of the future introduction in terms of verification of the advantage of the Japanese technologies, and technical cooperation for operation and maintenance of the advanced technologies can be expected as a soft component of the project.

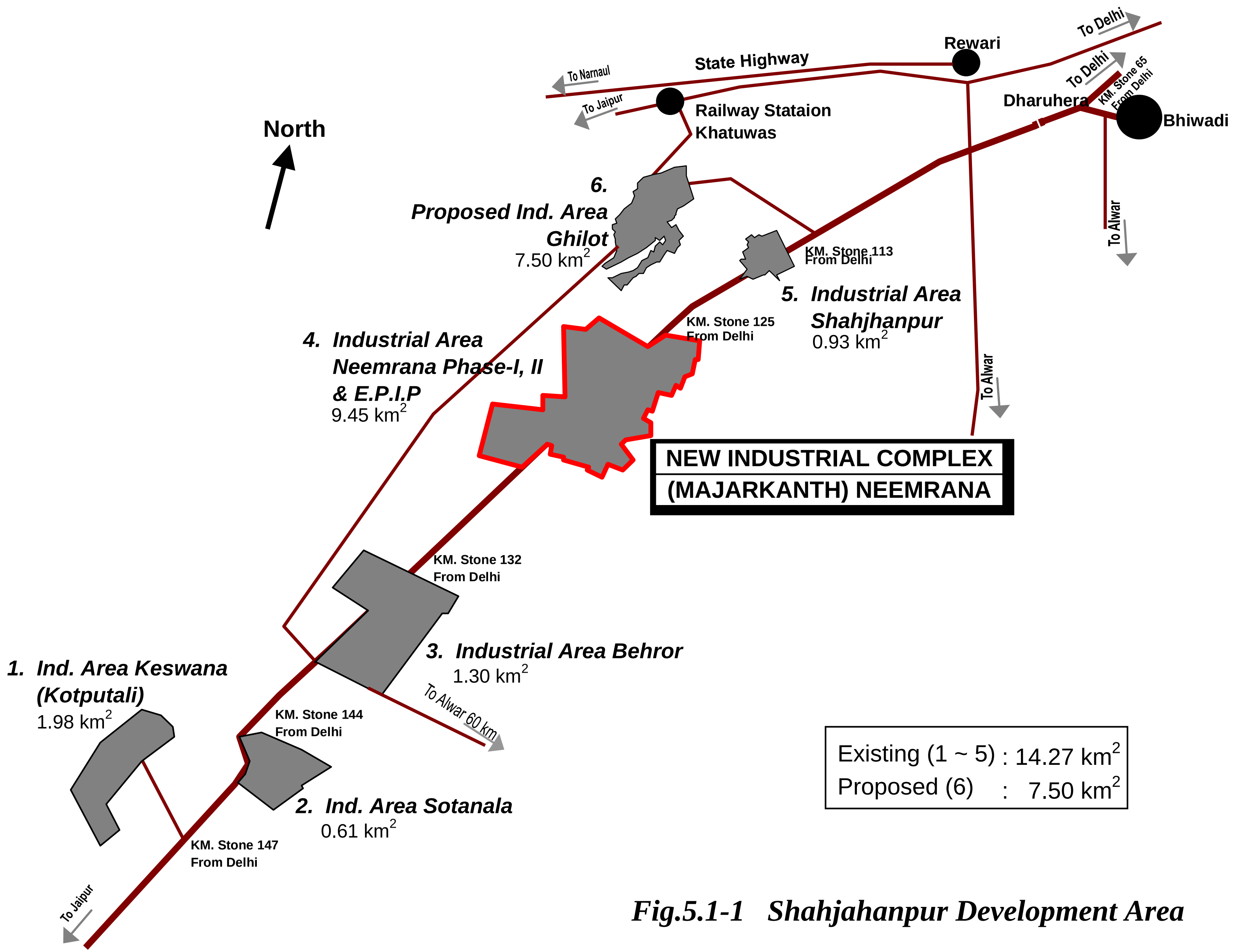


Fig.5.1-1 Shahjahanpur Development Area

(2) Project Plan

1) Development priority at the six (6) industrial areas

The objective six (6) areas at the Shahjahanpur Development Area are not substantially or evenly arranged for land development, access roads and electric power supply with larger differences at respective areas.

Such being the circumstances, proposed project implementation has been classified in terms of its priority in consideration of future development being planned by the authorities concerned, progress of infrastructure at each industrial area and future business activity expansion, for the purpose of beneficial effects of the projects.

Following table shows the development priority judging from the land area, number of plot, access road and existence of substation.

Table 5.1-2 Development Priority of the 6 Industrial Areas

Industrial Area		Exiting Area (km^2)	Total Area (km^2) (Existing + Expansion)	Plot	Access	S/S	Priority
1	Keswana	1.98 (2)	1.98 (5)	9 (5)	2 km to western direction from the road No.8	132kV	3
2	Sotanala	0.61 (5)	0.61 (6)	47 (4)	Alongside the road No.8	-	3
3	Behror	1.30 (3)	2.02 (4)	191 (2)		220kV	2
4	Neemrana	9.45 (1)	14.25. (2)	258 (1)		220kV	1
5	Shahjahanpur	0.93 (4)	3.05 (3)	82 (3)		132kV	2
6	Ghilot	-	16.56 (1)	-	-	-	4

( )shows the order

Since the NIC has vast area and a lot of plots, electric power demand is high, and furthermore access road thereto and sub-station are arranged. Thus, this area has been evaluated as the first priority to be developed under the proposed project.

The Behror and Shahjahanpur are evaluated as the second priority rank in terms of plot numbers, access road and existence of sub-station. Although these areas are small, the future power demand is judged as to be increased considering the expansion plan.

The Keswana and Sotanala are evaluated as the third priority because of small land area and small numbers of plot.

The Ghilot is an industrial area under planning with no arrangement of such infrastructures as access road and power supply. Future development plan is unclear there. Thus, this area is excluded from construction cost estimate and will be examined whether or not to be arrangement target through future survey.

[Development Phase]

1st Phase (first priority)	:	Neemrana
2nd Phase (second priority)	:	Behror, Shahjahanpur
3rd Phase (third priority)	:	Keswana, Sotanala
4th Phase (last priority)	:	Ghilot

2) Conditions for distribution network plan at the NIC

It is required to forecast ultimate power demand to determine the power supply system as premise in the new construction and/or expansion of 33 kV distribution network plan in the NIC.

Based on the site conditions, the project plan has been established as follows:

- Block : 4 blocks in total consisting of each 2 blocks at the north and south areas demarcating the existing road
- Power demand density : 35MW/km^2 (calculated from the defined consumers' data)
- Distribution method : Norma/reserve switching for 3 circuits as one group, or 3 circuits π loop network without adopting both methods mixed
- Capacity of distribution line : 60 MW supply by one group of 3 circuits. About 240 MW in total for 4 groups in the whole area is expected
- Cable size : 300 mm^2 with 250A of current

Fig.5.1-2 shows the concept of 33 kV distribution network plan by means of normal/reserve switching method or 3 circuits π loop network method in the NIC according to abovementioned conditions.

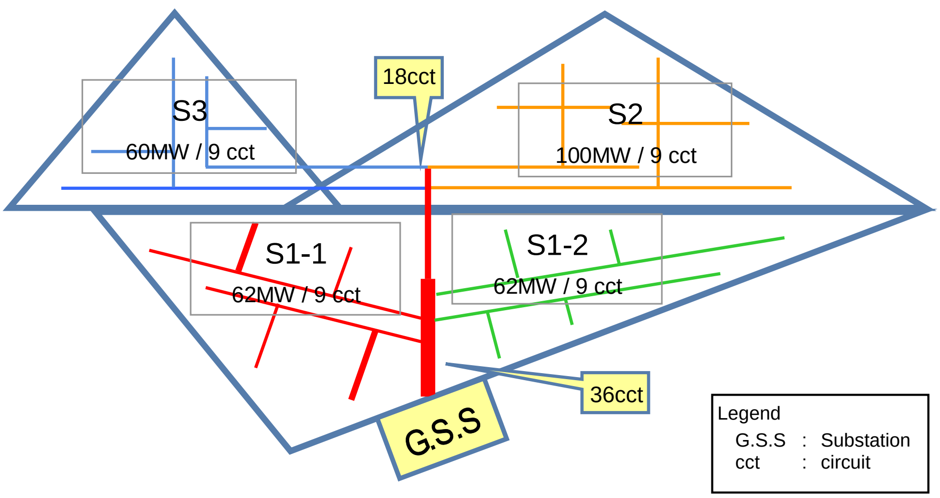


Fig.5.1-2 Concept of 33 kV Distribution Network in the NIC

3) Composition of Network

Various combinations in the composition of network can be selected, namely, overhead line or underground line for equipment facilities, and tree-like distribution system (normal/reserve switching system) or π loop system for power system structure.

The said overhead line or underground line is selected from the viewpoint of required power reliability, overall consideration of entire plan, demand increase, local characteristics, new system construction, system expansion, etc.

New and expansion network by means of underground line is adopted in consideration of the required power reliability, the existing equipment conditions and future development plan in the NIC.

Selection of either tree-like distribution system or π loop system for power system structure, is to be determined in consideration and by evaluation of restricting conditions, consumer's needs, etc. The π Loop System distribution system is selected from the viewpoint of reliability.

Table 5.1-3 shows the comparison of characteristics of both systems.

Table 5.1-3 Comparison of Tree-Like Distribution System with π Loop Network

System Composition	Characteristics
Tree-Like Distribution System with Normal/ Reserve Switching Method	- In comparison with π Loop System, accident occurrence probability is high because of many joints. - Easier new construction and expansion of the facilities - Lower cost (because of small quantity of cable installation) - In case all the power consumers receive 33 kV, power branches must be verified for their possibility of realization. System variations are to be considered to change the power supply method, depending on either supply by overhead line according to the requirements of the respective consumers or power receiving by 1 circuit/underground line or power receiving by more than 2 circuits. - It takes time to accident search and restoration, provided emergency power transmission just after the accident can be done in a short time.
π Loop System	- Accident occurrence probability is comparatively low because of small numbers of joints. - Rather difficult new construction and expansion of the facilities - Higher cost (because of low circuit utilization ratio and large quantity of cable installation) - Short time for accident search and restoration, provided longer time than tree like distribution system for emergency power transmission just after the accident - Automatic distribution operating system can be adopted for detection of the accident section - Construction cost is higher than that of the tree-like distribution system

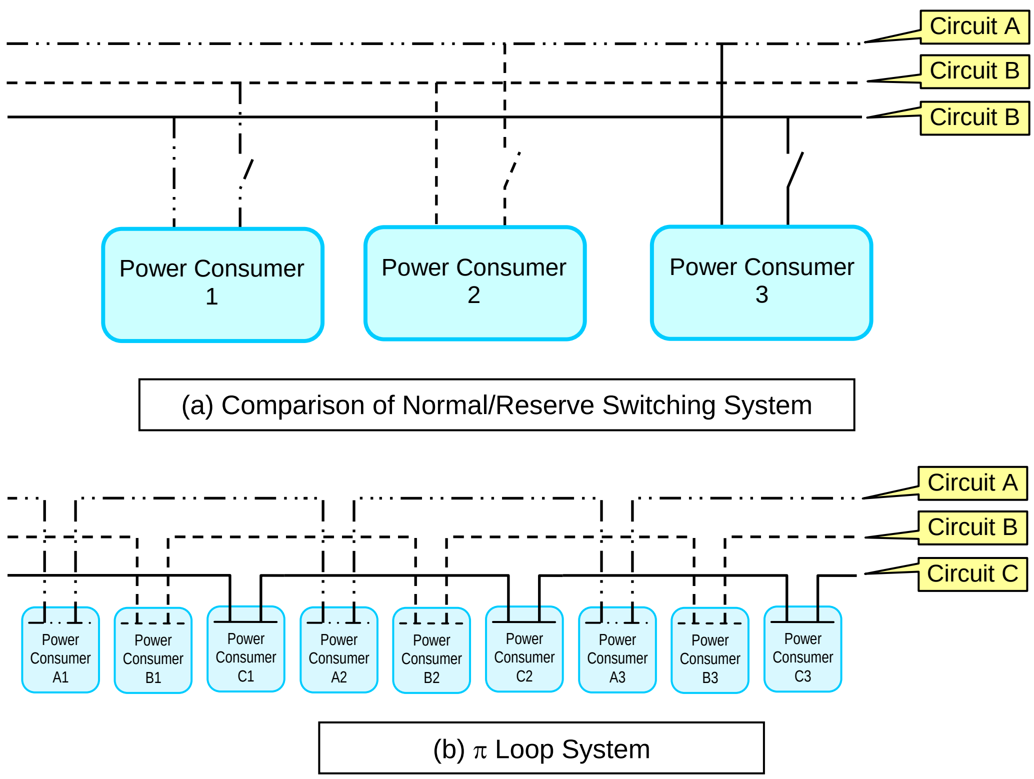


Fig.5.1-3 System Component of Tree-Like Distribution System and π Loop Network

5.1.3 Construction Cost

(1) Estimate Step of Approximate Construction Cost

Firstly rough construction cost is estimated for new construction and expansion of the 33 kV distribution network of the NIC (1st development phase), then the construction cost of all the other areas is estimated by the pro rata basis of area based on the cost for the NIC.

(2) Estimation Method of Approximate Construction Cost

The said cost for the NIC is to be estimated using the unit rate of construction cost of respective facilities, with the following conditions.

- π Loop System is applied.
- Unit construction cost rate of the conduit route, is to be 20 times of that for 33 kV overhead line.
- Unit rates of the equipment of joint, automatic fault detector and transformer with automatic voltage regulation function, are to be of those in Japan.

(3) Estimation of Total Construction Cost of the 33 kV Distribution Network Project

Following shows total construction cost amounting approximately 9.5 Billion in Japanese Yen.

Table 5.1-4 Construction Cost of the 33 kV Distribution Network Project in the NIC

Construction Work Item	Construction Cost (Upper; Million JY, [Lower]:Million INR)			Remarks
	Import Procurement	Local Procurement	Total	
33kV Distribution Line	7,200 [4,000]	1,800 [1,000]	9,000 [5,000]	- Standard cost of JVVN - Equipment at cable joint is of the rate for Japanese one
Line Outlet Facilities of 33kV Line at Substation	0	91 [50.6]	91 [50.6]	Standard cost of JVVN
Automatic Fault Detector	115 [63.9]	0	115 [63.9]	Per Japanese equipment rate
Transformer with Automatic Voltage Regulation	288 [160]	0	288 [160]	Per Japanese equipment rate
Total	**7,603** **[4,223.9]**	**1,891** **[1,050.6]**	**9,494** **[5,274.5]**	

Details of estimation are as follows.

1) 33kV distribution line works: Japanese Yen 9,000 Million

The cost is estimated based on the standard cost of JVVN and the rate of Japanese equipment.

2) Line outlet facilities of 33 kV line at substation: Japanese Yen 91 Million

- JVVN's standard construction cost rate; JPY 3.8 Million / circuit
  quantity: 36 circuits, amount; JPY 91,440 Million (36 × JPY 2,540,000)

3) Automatic detection system of accident section; Japanese Yen 115 Million

- JPY 534 thousand/point (by Japanese manufacturer)
  JPY 534 thousand × 6 points × 36 circuits = JPY 115,344 thousand

4) Transformer with automatic voltage control function: Japanese Yen 288 Million

- JPY 1,335 thousand/set (by Japanese manufacturer)
  JPY 1,335 thousand × 6 points × 36 circuits= JPY 288,360 thousand

Total estimated construction cost of other areas estimated by the area prorate basis per the cost of the NIC as above, becomes about Japanese Yen 14.3 Billion (about INR 7,960 Million) in the Shahjahanpur Development Area.

Table 5.1-5 Construction Cost of Six (6) Areas

No.	District (Plot)	Area (km^2)	Construction Cost (Upper; Million JY, [Lower]:Million INR)	Remarks
1	Keswana	1.98	1,989	
			[1,105.1]	
2	Sotanala	0.61	613	
			[340.5]	
3	Behror	1.3	1,306	
			[725.6]	
4	Neemrana	9.45	9,494	Basic Cost estimated in detail
			[5,274.5]	
5	Shahjahanpur	0.93	934	
			[519.1]	
6	Ghilot	0	0	Future-planned area
			[0.0]	
Total	Shahjahanpur Area	14.27	14,336	
			[7,964.8]	

When the construction of new substation for power distribution is required, in the Shahjahanpur Development Area, total construction cost will increase accordingly.

Necessity of the new substation should be examined in the next detailed study.

5.1.4 Project Implementation Schedule

Earliest possible implementation of this project is recommended in consideration of its significance, necessity and urgency as described hereinafter.

As shown in Table 5.1-6, minimum five (5) year project time starting from the design is estimated, depending especially on the required time for design, selection of the contractor(s) and construction.

Alternatively, it is recommended to divide the area by area in order to shorter the construction time as practicable as much.

Table 5.1-6 Project Implementation Schedule

Elapsed year	1st	2nd	3rd	4th	5th
Detailed Design	⇨				
Selection of Contractor(s)		⇨			
Procurement and Construction			⇨	⇨	⇨

5.1.5 Project Implementation Structure (Government Authority, Organization of Project Implementation, Technology, Financial Analysis)

It is required to cope with new construction and expansion of transmission line and substation for the system development of the 33 kV distribution network in the Shahjahanpur Development Area, for which it is desirable to cope with the relevant organizations to let DOE/MOP role as the top management, RVPN in charge of transmission line and substation, JVVN in charge of 33 kV distribution network and RIICO in charge of road and side walk aiming at harmonized project implementation.

Roles and responsibilities of JVVN, RVPN and RIICO are as follows:

- JVVN: Project implementation organization, arrangement of substation and route of 33 kV distribution line up to respective power consumers in the industrial areas (Implementation Structure)
- RVPN: Arrangement of transmission line and substation
- RIICO: Arrangement of road and side walk at the 33 kV distribution line route in the industrial areas

5.1.6 Project Operation Structure (Operation Service, Financial Plan, Counter Plan corresponding to Business Right)

JVVN will be main organization for the operation of the this Project. JVVN is responsible for development and operation of the distribution network. Necessary cooperative adjustment with RIICO is required since RIICO is in charge of development of industrial areas and maintenance of road as well.

5.1.7 Environmental and Social Impact Assessment

As shown in Table 3.4-1, grant of the EC in the electric power sector in India is required for hydropower, thermal power and nuclear power generations. This Project is classified as power distribution, therefore, the application of the EC is not required.

JVVN, as the project implementation structure, normally does not apply the EC for development and repair of distribution network. As discussed among the parties concerned about the necessity of survey for environmental and social considerations for this Project, it is recognized that detailed survey is not required because negative factors against environment and society are little.

The environmental and social considerations are discussed in detail in Chapter 7.

5.1.8 Relationship with Other Organizations (Private Companies, Financial Donors, Non-Governmental Organizations, Universities, Self-Governing Body, etc.)

This project is closely related to JVVN, RVPN, and RIICO, and the issue of relationship with other organizations is not obvious, and will be examined in the next study.

5.1.9 Confirmation of Project Effects (Quantitative, Qualitative Effects and Effects Target)

Table 5.1-7 shows target and indicator, in line of the JVVN's standards, of the Project to measure project effects.

Table 5.1-7 Target and Indicator

Super Goal	Improve the electric power quality at the Shahjahanpur Development Area to create attractive environment for investment promotion
Goal	- Drastic decrease of frequency and time of power failure - Decrease of power loss
Object	- Supply of the higher reliable power - Appropriate operation and maintenance of electric power facilities
Indicator and Target	Frequency of power failure occurrence : 18 times/year Time duration of power failure : 8 hours/year Voltage fluctuation : ± 1% of the rated voltage

5.1.10 Beneficial Effect to Japan

Project effects when implemented will largely be efficacious to the Japanese companies expanding their business activities in the NIC.
Substances of project effects are described in the following Section 5.1.11.

5.1.11 Significance, Necessity and Urgency of the Project

Expansion plan of the industrial area has been already determined in the NIC however, the firms including Japanese ones in the NIC are facing low quality of electric power supply.

Due to insufficient arrangement of distribution network there, Japanese firms are embarrassed with low electric power quality and with cost-burden of self-generating facilities.
They are eagerly expecting the earliest possible dissolve of these problems. Once the 33 kV distribution network project is implemented and commissioned, immediately effective enhancement of power quality is expected and contributes to the promotion of business expansion of firms including Japanese ones into the NIC.

Technology utilized in this Project is common to distribution network of different voltage, thus, they can be applied horizontally to all distribution network of any voltage level. That is, this technology is applicable also to projects in other sites of India. It is expected that this technology will be widely applied.

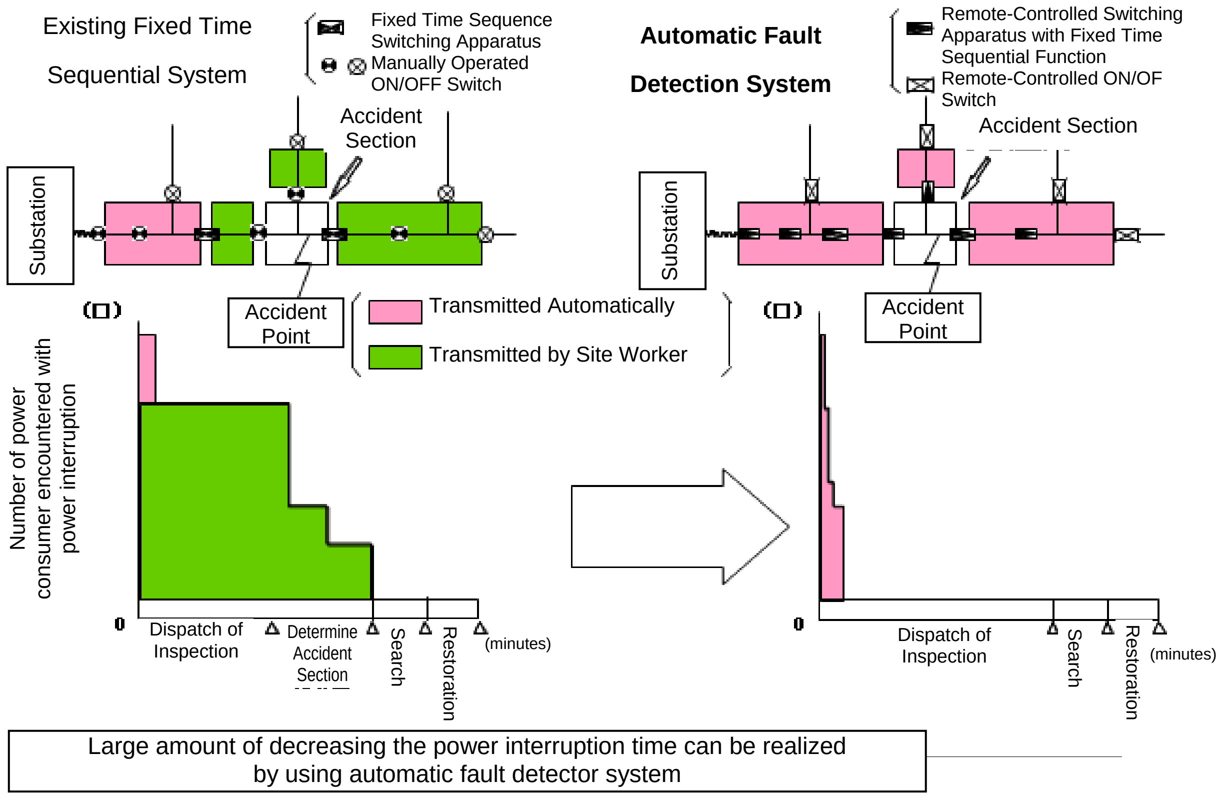
5.1.12 Applicable Japanese Technology

Japanese technologies to be recommended in this Project are automatic fault detector and transformer with automatic voltage regulation. These technologies can be applied to distribution networks that spread horizontally. It has wide scope of application and much experience in Japan. The technologies automatic fault detector and transformer with automatic voltage regulation are introduced below.

(1) Automatic Fault Detector

Automatic fault detector is the system that detects faults automatically and recovers electric power from power failures as early as possible in the sections except for fault section. It enables to minimize the impact by power failures due to accidents and to reduce the recovery time. This system is widely adopted by electric power companies in Japan and contributes to sustainable high quality of electric power in Japan.

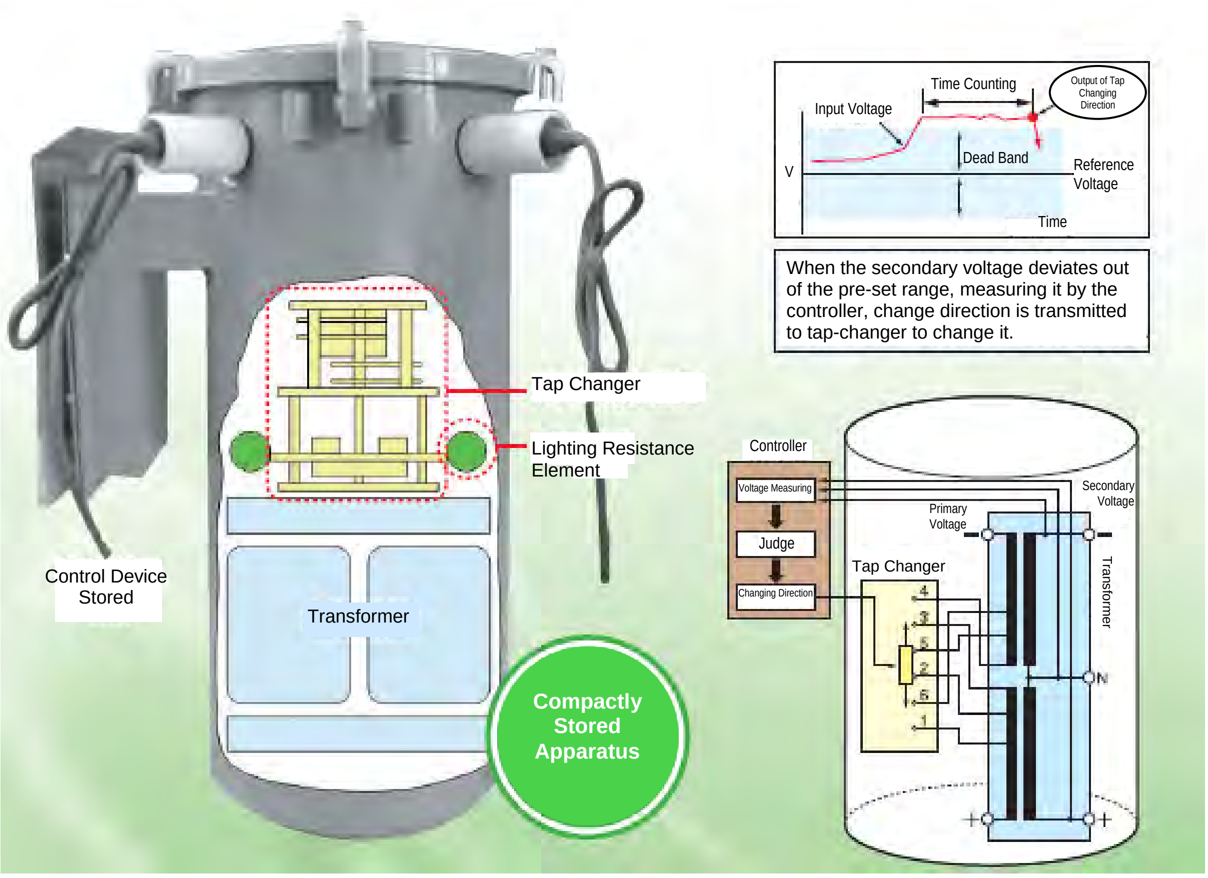
Effects of Automatic Fault Detection System



(2) Transformer with Automatic Voltage Regulation

Voltage of distribution line tends to fluctuate according to variety of generating power source in a grid and increase of decentralized generating plants such as solar power generation connecting to the distribution network.

As a countermeasure for the said tendency, transformer with automatic voltage regulation function has been developed. In Japan, as shown in the following figure, compact on-pole transformer with automatic voltage regulation has been developed, commercialized, and generally utilized. This system is of advantageous Japanese technology to enhance the power quality.



5.1.13 Technical Cooperation

Technical cooperation is very important for understanding of Japanese technology by India side, effective operation of the Project, and horizontal development in India. Training, dispatch of experts, technical cooperation project, and soft component during the Project implementation are involved in the technical cooperation.

Technical cooperation is to be implemented for the purpose of 1) Technical improvement for power distribution, 2) Technical improvement of operation, 3) Technical improvement of maintenance, 4) Improvement of understanding and knowledge about Japanese technology, and 5) Assistance for implementation of the Project. Especially, improvement of understanding and knowledge about Japanese technology by Indian side is indispensable for the Project implementation.

Personnel of MOP and JVVN are to be invited to Japan to make lectures for the purposes of 1) to 4) mentioned above and site visits. Especially, training specialized for Japanese technology must be effective. Participants could enhance their understanding by visiting power distribution facilities and operation systems of Japanese electric companies. Also, visual demonstration of automatic recovery process of distribution system through computer simulation will help to understand the values of the Japanese technologies.

It is desirable to dispatch experts to JVVN who is the implementation agency of the Project in order to provide with assistance especially focusing on 4) and 5).

It is required to widely implement the technical cooperation project for the purposes of 1) ~ 4) mentioned above to improve the quality of electric power. In addition, review of power distribution standards and acquisition of life cycle management technology including technology for maintenance and update of facilities must be important. When the high quality distribution network system such as Japanese one is introduced in India, the existing Indian standards related to power distribution will be required to be reviewed. Therefore, the technical cooperation to examine and revise the standards taking into account of present situation and requirements of India will be expected. Followings are expected as main contents in the technical cooperation.

- Standards for establishment of distribution network;
  Strategies of distribution network establishment and timing of its expansion.

- Establishment of indicators and targets for power quality target, and selection of solution;
  Knowledge and conditions for introduction of voltage guarantee facilities and advanced technologies.

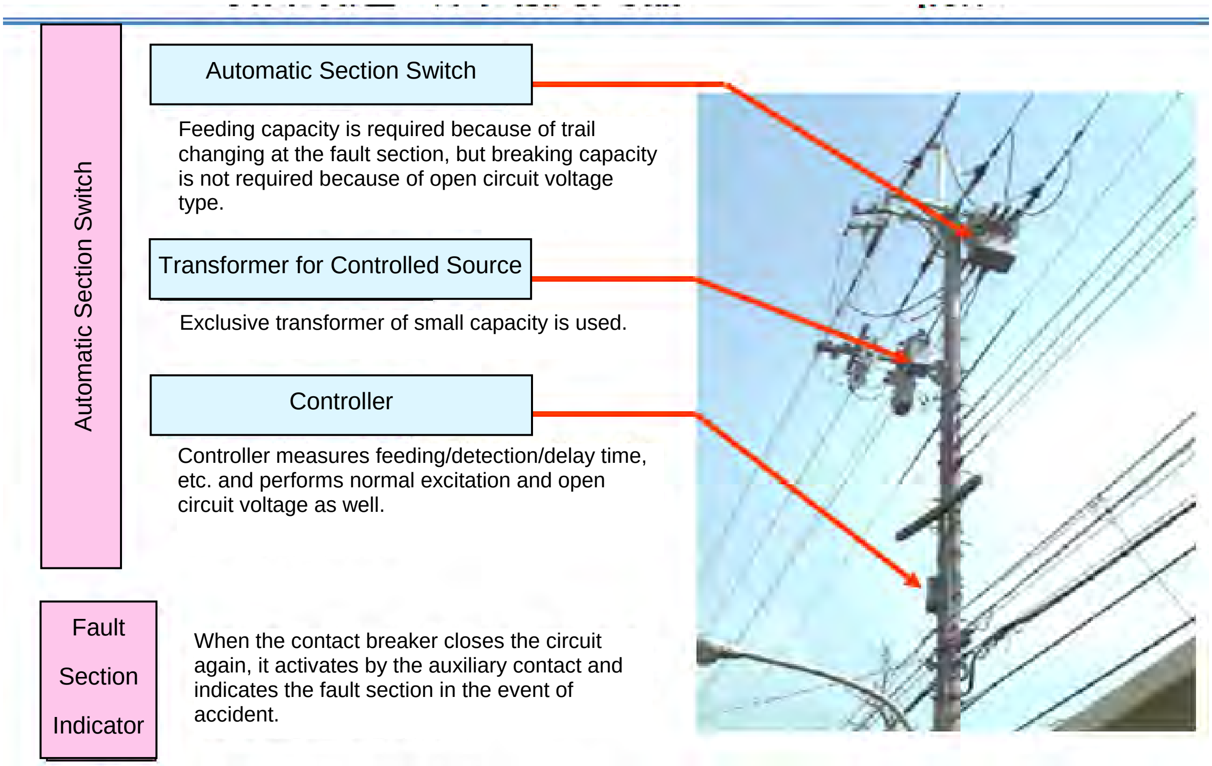
- Inspection technology;
  Technology in automatic supervisory system utilizing Japanese sensor technology, or in strengthening of inspection on the basis of actual operation and preventive measures.

- Technology of life cycle management
  Life cycle management technology including maintenance, update, database, and budget.

It must be very effective to implement the pilot project to show the usefulness of Japanese technology. Moreover, it is recommendable to have opportunities to diffuse Japanese technologies to the central government and organizations concerned in India for wide and further application of the Japanese technologies.

Operation and maintenance technologies for the latest system, such as automatic fault detector, are provided for the soft component in the Project. Automatic fault detector, not like conventional manual switching system, requires control and transmitting system, therefore, technical cooperation in terms of operation and maintenance of the advanced system, will be required for training of regular operation and maintenance works and trouble-shooting responses.

Automatic Fault Detection System



5.1.14 Results of Discussion with Indian Governmental Authority

In view of the results of the Study, JVVN understands the necessity to improve the electric power supply reliability in the distribution system toward the consumers in the Shahjahanpur Development Area.

JVVN is thinking that further site investigation and its analysis and evaluation should be implemented and the detailed project report should be prepared in order to promote JICA's proposed project still more. Necessary further study conforming to JVVN's intention are described in Section 8.2.

5.1.15 Implementation Method of Project

This project is of improving the power supply reliability in the project site by introduction of Japanese technologies. There are issues and tasks to implement this Project such as concretizing of the project, enhancement of knowledge and understanding of Japanese technology in India, and restrictions in Indian electric power standards.

Therefore, it is required to overcome these issues and proceed the preparation for smooth introduction of the system by implementation of lectures and trainings as well as technical cooperation before or concurrently with the feasibility study and discussion for implementation of the Project. Also, it must be very effective to implement the pilot project to demonstrate the usefulness and availability of Japanese technologies.

5.2 Additional Project Scheme

5.2.1 Outline of the Project

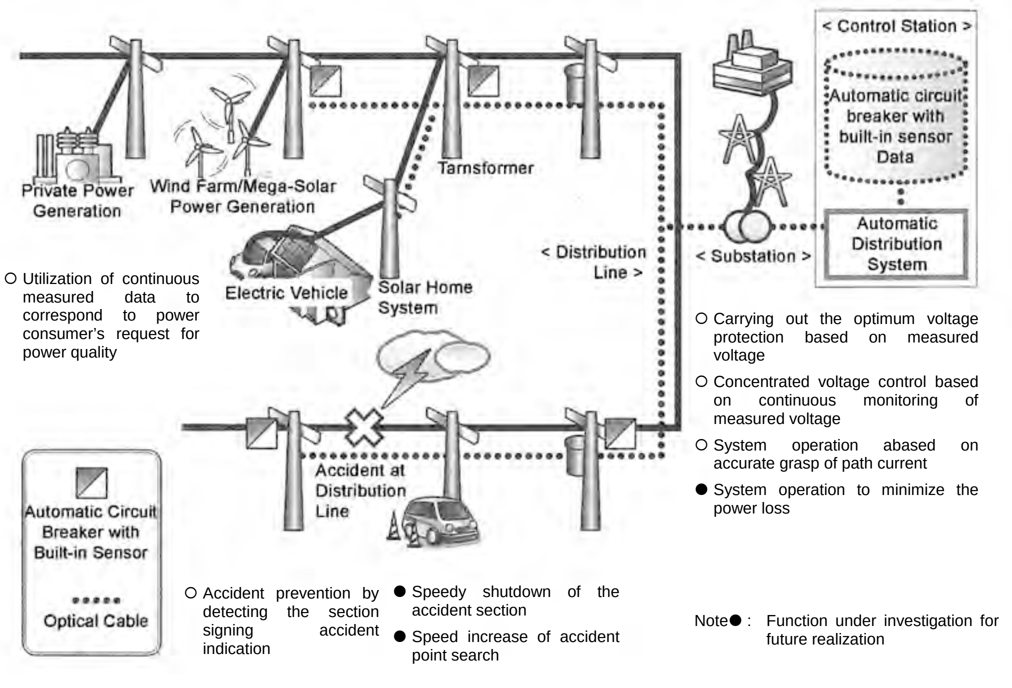
Following is Details of “Additional Scheme” mentioned in Section 5.1.1 (General of Project Plan).

This Project is to introduce the automatic distribution operating technology using smart meters to Shahjahanpur Development Area in order to improve power supply reliability (stability of power grid) and reduce the power loss in this area.

Table 5.2-1 Additional Project Scheme Plan

Project Name	Automatic Distribution Operating System Installation Project
Purpose	- Reduction of duration and extent of power interruption due to accidents by introduction of the automatic distribution operating system with automatic fault detector. - Accurate metering and fair electric charge are ensured by installation of a smart meter. Find out the spot and amount of power leakage and theft. - Effective operation of PV power generation in the automatic distribution operating system.
Current Circumstances and Issues	- Non-technical power loss (by incorrect metering and power theft) is large in India. Therefore, smart maters will be installed to reduce this power loss. Also, power demand can be controlled by DSM by smart meters.
Project Substances	- Metering system will be installed in the project area in order to reform the metering works. - Enhancement of functions of power grid operation system is implemented by introduction of automatic distribution operating system.
Applicable Japanese Technology	***Applicable Japanese Technology*** - Installation and operation of smart meter - Operational and application technology of automatic distribution operating system - Transformer with automatic fault detector ***Extent to be applied*** - Abovementioned technologies can be applied to versatile extent, since they can be applied to any distribution networks. ***Experience of Application*** - Automatic fault detection system (automatic circuit breaker system) is widely introduced to the electric power companies in Japan. - Japan has experience of installation of smart meter. - Automatic distribution operating system is widely utilized in Japan. ***Advantage of Japanese Technology*** - The automatic distribution operating system and automatic fault detector, are being applied in the overhead distribution system (automatic fault

Objective Area	Shahjahanpur Development Area
Implementation Structure / Organization	Implementation Structure : JVVN Cooperation Organization : RIICO Supervisory Organization : MOP, DOE
Operating Structure	JVVN
Construction Cost	Japanese Yen 2 Billion
Project Period	Approximately 5 years
Project Effects	- Precise volume of supplied electricity can be measured. - Variable power supply, such as power consumption charge classified by usage time rage, can be introduced. - Omitted power consumption charge collection by power-stealing, can be avoided to collect the charge fully. - Man-power expenses for metering work can be reduced. - Amount and spot of power-stealing can be identified.
	- Reduction of duration of power interruption by automatic detection of fault section - Optimum measures against voltage fluctuation based on measured voltage - Centralized voltage control based on constant monitoring of voltage. - System operation based on precise current monitoring at each segment.
	- Solar power generating facilities can be put into practical use sufficiently.
	- Efficient use of electric power facilities can be realized by means of DSM. - Stable supply voltage, enhanced corresponding to small size decentralized generating plant and timely construction or expansion of power facilities can be attempted by utilization of information from the sensor system.

	detector) and overhead low-voltage distribution system (transformer) and have high technical advantages compared to foreign countries'. However, the smart meter has less advantage so far.	Possibility of Horizontal Application of Japanese Technology	These Japanese technologies can be applied to distribution system regardless of voltage and route, therefore they will be widely applicable for other distribution companies and areas in India.
Environmental Issues	No specific issue exists	Expected Technical Cooperation	Following are expected technical cooperation. ・ Training and Lecture ・Dispatching Technical Advisor ・Technical Cooperation including Pilot Project ・Soft-component in the Project
Relation with Private Company, Other Financial Donor, Non-Governmental Organization, etc.	Power generating project is planned in this area, however, there is no authority or organization related to distribution project. - Thermal power generation of 45 MW by Japanese independent power producer - PV power generation of 5 MW by NEDO, Japan		
Project Image	 Source; Future Electric Smart Grid		
Others	Although Introduction of automatic distribution operating system and smart meter is planned in the Project, establishment of a smart gird is a target of the Project in the future. In Japan, the four (4) pilot project to establish a smart grid is being implemented so far. Therefore, it can be considered to develop a project in India based on the evaluation of the verification tests for establishment of the smart grid which are currently implemented in four (4) regions in Japan.		

Outlines of the additional scheme of this Project are described as follows. As for structures of project implementation, structure of project operation, environmental and social impact assessment, relationship with other related authorities, and results of discussion with Indian governmental authority are included in the base scheme, please refer to the Section 5.1.

5.2.2 Construction Cost

Construction cost of automatic distribution operating system varies according to the system to be established. Although, the main components of the project are considered as the installation of automatic fault detection system and smart meters so far, the components will be possibly revised with the progress of technology. The cost, herein, is estimated at 2 billion Yen based on the examples of adopting same-scale automatic distribution operating system in Japan.

5.2.3 Project Implementation Schedule

Construction period for three (3) years is estimated, thus the project period will be about 5 years as long as that of the base scheme.

5.2.4 Confirmation of Project Effects

The Project has large effects including cost effect by comprehension of accurate power consumption, prevention of power theft, and reduction of meter readers in relation to smart meters, and technical effect such as time reduction of power failures by detection of fault section, measures for optimum voltage based on measured voltage, and control of integrated voltage based on full-time monitoring of voltage.

5.2.5 Significance, Necessity and Urgency of the Project

Expansion plan of the industrial area has been already determined in the NIC however, the firms including Japanese ones in the NIC are facing low quality of electric power supply.
Due to insufficient arrangement of distribution network there, Japanese firms are embarrassed with low electric power quality and with cost-burden of self-generating facilities.

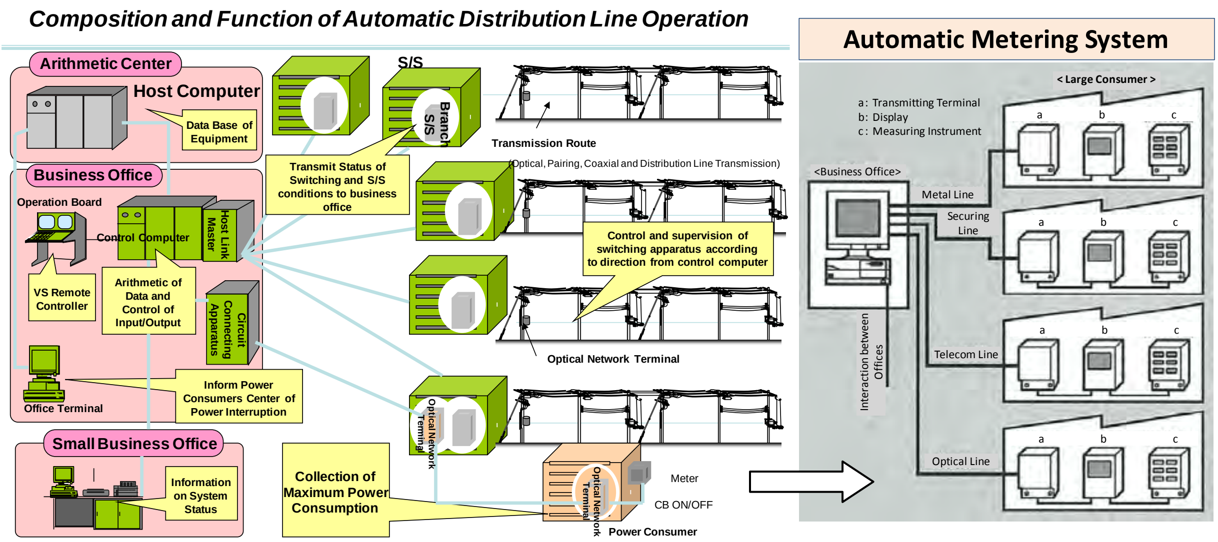
Technology for this Project is common to distribution network of different voltage, thus, they can be applied horizontally to all distribution network of any voltage level. That is, this technology is applicable also to projects in other sites of India. It is expected that this technology is widely applied.

5.2.6 Applicable Japanese Technology

Following shows a referential introduction concept and application of automatic distribution operating system with automatic fault detector which is one of major advantageous Japanese technologies.

(1) System Composition

In general, this system is equipped with automatic circuit breakers in each segment and automatic metering system.



(2) Effect of the System

Main effects expected are the enhancement of power quality by operating automatic fault detector and reduction of man-power cost of metering work and mitigation of mis-metering. The effectiveness of automatic fault detector is referred to Section 5.1.13.

5.2.7 Technical Cooperation

Technical cooperation is very important for understanding of Japanese technology by India side, effective operation of the Project, and horizontal development in India. Training, dispatch of experts, technical cooperation project, and soft component during the Project implementation are involved in the technical cooperation.

It must be very effective to implement the pilot project to show the usefulness of Japanese technology. Moreover, it is recommendable to have opportunities to diffuse Japanese technologies to the central government and organizations concerned in India for wide and further application of the Japanese technologies.

5.2.8 Implementation Method of Project

Following studies are necessary for implementation of the Project.

- Current situations and problems of the WHmeter should be analyzed, and the evaluation of adequacy and necessity of shifting to the smart meter should be studied.
- In order to expand IT (Information Technology) networks in the objective area for introduction of automatic distribution operating system, software development and hardware installation and operation are necessary. Its function and system configuration should be specified, and the viability of the system introduction should be evaluated.

Therefore, it is required to overcome these issues and proceed the preparation for smooth introduction of the system. Also, introduction of automatic distribution operating system and the smart meter is planned in this Project with the aim to establish the smart grid in the future. It can be considered to develop a project in India based on the evaluation of the verification tests for establishment of the smart grid which are currently implemented in four (4) regions in Japan.

Therefore, implementation of lectures and trainings as well as technical cooperation before or concurrently with the feasibility study and discussion for implementation of the Project. Also, it must be very effective to implement the pilot project to demonstrate the usefulness and availability of Japanese technologies.

CHAPTER 6

PROJECT COST AND ECONOMIC AND FINANCIAL ANALYSIS

CHAPTER 6 PROJECT COST AND ECONOMIC AND FINANCIAL ANALYSIS

6.1 Basic Conditions

(1) Exchange Rate

Exchange rates, for which averaged values during the recent one year from September 16th, 2010 to September 15th, 2011 were applied, are shown below.

- Japanese Yen (JPY) versus US Dollar (US$)	US$ 1	=	JPY	81.377 -
- Japanese Yen versus India Rupee (INR)	JPY 1	=	INR	0.554 -
- US Dollar versus India Rupee	US$ 1	=	INR	45.036 -

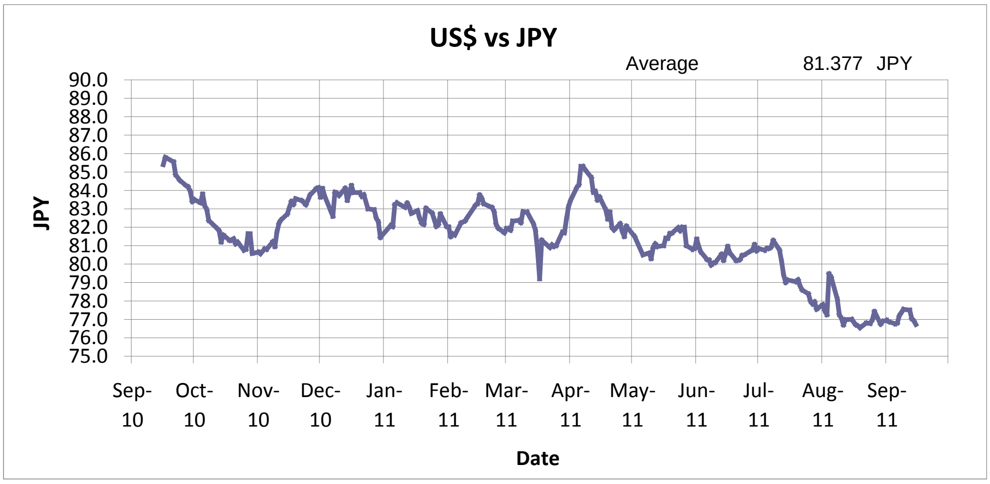


Fig.6.1-1(1) Exchange Rate (US$ vs. JPY)

(Source : Website of Bank of Japan)

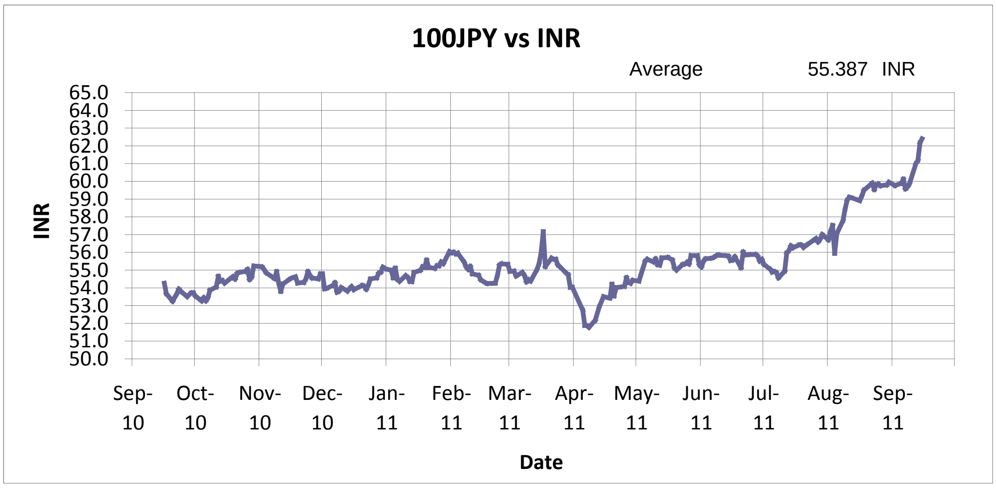


Fig.6.1-1(2) Exchange Rate (JPY vs. INR)

(Source : Website of Reserved Bank of India)

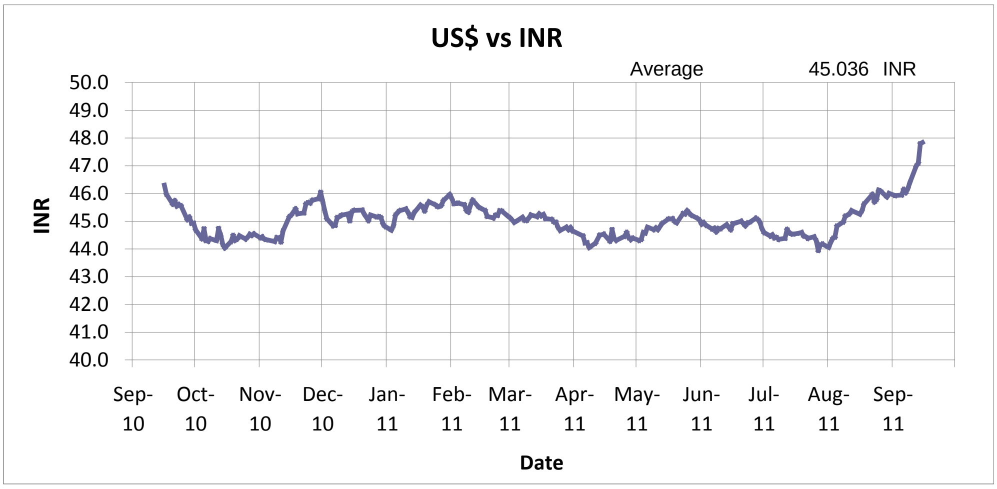


Fig.6.1-1(3) Exchange Rate (US$ vs. INR)

(Source : Website of Reserverd Bank of India)

(2) Annual Price Escalation Rates

Annual price escalation rates in foreign currency and local currency are assumed.

The price escalation rate in foreign currency is assumed as 0% and that in local currency is done as 8% with reference to the consumer price index of India.

- Foreign Currency 0.0 %/year
- Local Currency 8.0%/year

Table 6.1-1 Consumer Price Index (CPI) [Industrial Workers: General Index]

Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Average	Incremental Rate
2006/07	120	121	123	124	124	125	127	127	127	127	128	127	125.0	-
2007/08	128	129	130	132	133	133	134	134	134	134	135	137	132.8	6.2%
2008/09	138	139	140	143	145	146	148	148	147	148	148	148	144.8	9.0%
2009/10	150	151	153	160	162	163	165	168	169	172	170	170	162.8	12.4%
2010/11	170	172	174										172.0	5.7%
Average														8.3%

Note) Base: CPI-2001 = 100

(Source : Handbook of statistics on the Indian Economy, 2009-10, Reserve Bank of India)

(3) Physical Contingency Rate

The physical contingency rate is basically 5%.

(4) Cost of Engineering Services

The rate of 5 % to construction costs is accounted for cost of engineering services.

(5) Cost of Project Administration

The rate of 2.5 % to local portions of construction costs is accounted for cost of project administration.

(6) Cost for Land Acquisition

The objective areas of the project are owned by RIICO, thus, cost for land acquisition does not add up.

(7) Base time for cost estimation

Base time for estimation of base costs is October, 2011.

(8) Project Cost Estimation Procedure

The project cost is estimated in line with following procedures.

i) Base Cost Estimation
ii) Estimation of Price Escalation Cost [Base Cost x Price Escalation Rate]
iii) Estimation of Physical Contingency [(Base Cost + Price Escalation Cost) x Physical Contingency Rate]
iv) Project Cost Estimation [Base Cost + Price Escalation Cost + Physical Contingency]

6.2 Project Costs

(1) Construction Cost

The project is of new installation and improvement of 33kV distribution line for the existing NIC. As shown in Chapter 4, the construction cost is about 9.5 billion JPY.

(2) Project Cost Estimation

The project cost, as shown in Table 6.2-1, is estimated based on the construction cost and above-mentioned conditions.

The calculation formula for each item is summarized below.

- **Price Contingency**

$$PC = BCx(1+R_1)^T - BC$$

- **Physical Contingency**

$$PyC = (BC + PC)xR_2$$

- **Project Cost**

$$Pr\,C = BC + PC + PyC_2$$

where,	PC	:	Price Contingency
	PyC	:	Physical Contingency
	PrC	:	Project Cost
	R1	:	Annual Escalation Rate (%)
	R2	:	Physical Contingency Rate (%)
	T	:	Median of the objective works (Year & Month) - Base time of the cost estimation (year)

Table 6.2-1 Project Cost

Basic Conditions

(1)	Exchange Rate	US$ 1 = JPN Yen	81.377
		INR 1 = JPN Yen	1.805
		INR 1 = US$	0.022
(2)	Price Escalation Rate	Foreign Currency (F/C)	0.0 %
		Local Currency (L/C)	8.0 %
(3)	Physical Contingency Rate		5.0 %
(4)	Base Cost Estimating Time		October, 2011
(5)	Work Schedule in Year		

33kV Distribution Line	3.5
33kV Feeder of Sub-Station	3.5
Automatic Fault Detector	3.5
Trans with Automatic Voltage Regulation	3.5
Consultant Services	2.5
Project Administration	2.5
Land Acquisition	0

Note) Work Schedule = (Median of the Object Work) - (Base Year of Cost Estimation)

(6)	Cost for Consultant Services	Rate to Construction Cost	5.0 %
(7)	Administration Cost	Rate to Construction Cost of L/C	2.5 %

Project Cost

		Project Name	33kV Line F/C (JPY)	33kV Line L/C (INR)
Base Cost	Construction Cost	33kV Distribution Line	7,200,000,000	1,000,000,000
		33kV Feeder of Sub-Station	0	50,600,000
		Automatic Fault Detector	115,000,000	0
		Trans with Automatic Voltage Regulation	288,000,000	0
		Total Construction Cost	7,603,000,000	1,050,600,000
		Total Cost in JPY	9,499,333,000	
	Consultant Services		380,150,000	52,530,000
	Project Administration		0	131,569,709
	Total		**7,983,150,000**	**1,234,699,709**
	Total in US$		**10,211,782,975**	
Price Contingency	Construction Cost	33kV Distribution Line	0	309,131,112
		33kV Feeder of Sub-Station	0	15,642,034
		Automatic Fault Detector	0	0
		Trans with Automatic Voltage Regulation	0	0
		Total Construction Cost	0	324,773,146
		Total Cost in JPY	179,929,721	
	Consultant Services		0	11,144,683
	Project Administration		0	27,913,624
	Total		**0**	**363,831,453**
	Total in JPY		**656,715,773**	
Physical Contingency	Construction Cost	33kV Distribution Line	360,000,000	65,456,556
		33kV Feeder of Sub-Station	0	3,312,102
		Automatic Fault Detector	5,750,000	0
		Trans with Automatic Voltage Regulation	14,400,000	0
		Total Construction Cost	380,150,000	68,768,658
		Total Cost in JPY	504,277,428	
	Consultant Services		19,007,500	3,183,734
	Project Administration		0	7,974,167
	Total		**399,157,500**	**79,926,559**
	Total in JPY		**543,424,939**	
Project Cost	Construction Cost	33kV Distribution Line	7,560,000,000	1,374,587,668
		33kV Feeder of Sub-Station	0	69,554,136
		Automatic Fault Detector	120,750,000	0
		Trans with Automatic Voltage Regulation	302,400,000	0
		Total Construction Cost	7,983,150,000	1,444,141,804
		Total Cost in JPY	10,589,825,956	
	Consultant Services		399,157,500	66,858,417
	Project Administration		0	167,457,500
	Total		***8,382,307,500***	***1,678,457,721***
	Total in JPY		***11,411,923,687***	

6.3 Economic and Financial Analysis

6.3.1 Loan and Disbursement Schedule

(1) General Terms and Conditions of Japanese ODA Loans

There are two (2) types of Japanese ODA Loans. One is general ODA Loan and the other is Climate Change oriented ODA Loan. The applicable ODA lone type will be finally determined based on the discussion and negotiation between both governments. In this study, it is assumed that the general ODA Loan is applied. The applicable interest rate is categorized based on income level, etc., India belongs to Low-Income country[1].

Table 6.3-1 General Terms and Conditions of Japanese ODA Loans
(Effective from April 1st, 2011)

Income Level	GNI per capita (2009)	Condition	Standard/ Option	Interest Rate (%)	Payment Period (years)	Grace Period (years)	Conditions for Procurement
Lower-Income Countries	996 US$ - 1,905 US$	General Terms	Standard	1.40	30	10	Untied
			Option 1	0.80	20	6	
			Option 2	0.70	15	5	
		Preferential Terms	Standard	0.65	40	10	Untied
			Option 1	0.55	30	10	
			Option 2	0.50	20	6	
			Option 3	0.40	15	5	
		STEP	Standard	0.10	40	10	Tied
			Option	0.10	30	10	
Consulting Services		For consulting services, the interest rate will be minimal (0.01%) and the repayment, grace periods and conditions for procurement will be the same as those for main components.					

- STEP (Special Terms for Economic Partnership) is set and reconsidered on January 15 every year to make a tied aid eligible.

(Source : Website of JICA)

Based on the above-mentioned table, the terms and conditions of the loan for these projects formulated in this Study are assumed as follows.

1 (Source : Income Basis Categorization in major countries (Categorization of UN and World Band), http://www.jica.go.jp/activities/schemes/finance_ co/about/standard/class2011.html)

Table 6.3-2 Conditions of the Loan

ODA Loan Condition			Note
IDC and Interest for main portion	%	1.40	Applicable to Low-Income Countries
IDC and Interest for Consulting Service	%	0.01	
Finance Close	Year	2011	Engineer's assumption
Repayment Term	Year	30	Applicable to LDC Low-Income Countries excluding Grace period of 10 years
Grace Period	Year	10	Applicable to Low-Income Countries
Service Charge	%	0.0	Applicable to undisbursed amount up to the year, Engineer's assumption

Note) IDC: Interest During Construction

(2) Disbursement Schedule and Project Cost

According to Indian applicable laws and so on, rates of import duties and valuable added taxes are of 26.85% and 4.0%, respectively. Therefore, the project cost are summarized in Table 6.3-3.

Meanwhile, annual expenditures in construction cost, consultant fee and project administration cost are planned based on those rates shown in Table 6.3-4.

Table 6.3-3 Summary of Project Cost

1 US$ = 81.377 JPY= 0.554 INR 1 INR = 0.022 US$

Case 1 33kV Line	Base Cost Total	Base Cost L/C	Base Cost F/C	Price Contingency L/C	Price Contingency F/C	Physical Contingency L/C	Physical Contingency F/C	Base Cost + Contingencies L/C	Base Cost + Contingencies F/C	Total (JPY) Base + Contingency	Total (US$) Base + Contingency	Total (INR) Base + Contingency
1. Construction Cost	**9,499,400,000**	**1,896,400,000**	**7,603,000,000**	**586,200,000**	**0**	**124,200,000**	**380,200,000**	**2,606,800,000**	**7,983,200,000**	**10,590,000,000**	**130,134,000**	**19,115,500,000**
1.1 33kV Distribution Line	9,005,100,000	1,805,100,000	7,200,000,000	558,000,000	0	118,200,000	360,000,000	2,481,300,000	7,560,000,000	10,041,300,000	123,392,000	18,125,100,000
1.2 33kV Feeder of Sub-Station	91,300,000	91,300,000	0	28,200,000	0	6,000,000	0	125,500,000	0	125,500,000	1,542,000	226,500,000
1.3 Automatic Fault Detector	115,000,000	0	115,000,000	0	0	0	5,800,000	0	120,800,000	120,800,000	1,484,000	218,100,000
1.4 Trans with Automatic Voltage Regulation	288,000,000	0	288,000,000	0	0	0	14,400,000	0	302,400,000	302,400,000	3,716,000	545,800,000
2. Consultant Fee for Supervision	**475,000,000**	**94,800,000**	**380,200,000**	**20,100,000**	**0**	**5,700,000**	**19,000,000**	**120,600,000**	**399,200,000**	**519,800,000**	**6,388,000**	**938,300,000**
2.1 Consultant Services	475,000,000	94,800,000	380,200,000	20,100,000	0	5,700,000	19,000,000	120,600,000	399,200,000	519,800,000	6,388,000	938,300,000
Subtotal (Eligible Portion)	**9,974,400,000**	**1,991,200,000**	**7,983,200,000**	**606,300,000**	**0**	**129,900,000**	**399,200,000**	**2,727,400,000**	**8,382,400,000**	**11,109,800,000**	**136,522,000**	**20,053,800,000**
3. India Portion (Non-eligible Portion)	**2,825,400,000**	**2,490,100,000**	**335,300,000**	**50,400,000**	**0**	**14,400,000**	**0**	**2,554,900,000**	**335,300,000**	**2,890,200,000**	**35,516,000**	**5,217,000,000**
3.1 Administration	237,500,000	237,500,000		50,400,000		14,400,000		302,300,000	0	302,300,000	3,715,000	545,700,000
3.2 Land Acquisition	0	0		0		0		0	0	0	0	0
3.3 Tax and Duties	2,587,900,000	2,252,600,000	335,300,000					2,252,600,000	335,300,000	2,587,900,000	31,801,000	4,671,300,000
1) Import Duties 26.85%	2,143,500,000	2,143,500,000						2,143,500,000	0	2,143,500,000	26,340,000	3,869,100,000
2) Valuable Added Tax 4%	444,400,000	109,100,000	335,300,000					109,100,000	335,300,000	444,400,000	5,461,000	802,200,000
Total Cost	**12,799,800,000**	**4,481,300,000**	**8,318,500,000**	**656,700,000**	**0**	**144,300,000**	**399,200,000**	**5,282,300,000**	**8,717,700,000**	**14,000,000,000**	**172,038,000**	**25,270,800,000**
Total Cost (Excluding Tax and Duties)	**10,211,900,000**	**2,228,700,000**	**7,983,200,000**	**656,700,000**	**0**	**144,300,000**	**399,200,000**	**3,029,700,000**	**8,382,400,000**	**11,412,100,000**	**140,237,000**	**20,599,500,000**

Table 6.3-4 Rates of Expenditures

Items	Disbursement Schedule (%)						
Year	2012	2013	2014	2015	2016	2017	2018
Construction Cost	0.0%	0.0%	0.0%	35.0%	45.0%	20.0%	0.0%
Consultant Fee	0.0%	10.0%	15.0%	25.0%	30.0%	20.0%	0.0%
Administration Cost	0.0%	10.0%	15.0%	25.0%	30.0%	20.0%	0.0%
Remarks	Finance Close						Operation

Given above-mentioned conditions, the disbursement schedule of the project cost is estimated as shown in Table 6.3-5. The each ODA loan and own fund portion in the project cost is allocated in Table 6.3-6, the ODA loan portion out of the project cost is about 11.1 billion JPY, which is equivalent to 20.1 Billion INR, 137 Million US$.

Table 6.3-5 (1/2) Disbursement Schedule

(Unit: JPY) (M. US$)

Project No.1	Cost as of 2011	Rate for Escalation or Tax	Construction Period 2012	2013	2014	2015	2016	2017	2018	2019	Total	Total (M. US$)
1. Foreign Currency Portion for Works	**8,382,400,000**	0.0%	**0**	**39,920,000**	**59,880,000**	**2,893,920,000**	**3,712,200,000**	**1,676,480,000**	**0**	**0**	**8,382,400,000**	**103.0**
1. Construction Cost	7,983,200,000		0	0	0	2,794,120,000	3,592,440,000	1,596,640,000	0	0	7,983,200,000	98.1
2. Consultant Fee	399,200,000		0	39,920,000	59,880,000	99,800,000	119,760,000	79,840,000	0	0	399,200,000	4.9
2. Local Currency Portion for Works	**2,727,400,000**	0.0%	**0**	**12,060,000**	**18,090,000**	**942,530,000**	**1,209,240,000**	**545,480,000**	**0**	**0**	**2,727,400,000**	**33.5**
1. Construction Cost	2,606,800,000		0	0	0	912,380,000	1,173,060,000	521,360,000	0	0	2,606,800,000	32.0
2. Consultant Fee	120,600,000		0	12,060,000	18,090,000	30,150,000	36,180,000	24,120,000	0	0	120,600,000	1.5
Grand Total of Works	**11,109,800,000**		**0**	**51,980,000**	**77,970,000**	**3,836,450,000**	**4,921,440,000**	**2,221,960,000**	**0**	**0**	**11,109,800,000**	**136.5**
3. Local Currency Portion for Administration	**302,300,000**	0.0%	**0**	**30,230,000**	**45,345,000**	**75,575,000**	**90,690,000**	**60,460,000**	**0**	**0**	**302,300,000**	**3.7**
1. Administration Cost	302,300,000		0	30,230,000	45,345,000	75,575,000	90,690,000	60,460,000	0	0	302,300,000	3.7
2. Land Acquisition	0		0	0	0	0	0	0	0	0	0	0.0
4. Import Duties												
1. Construction Cost	7,983,200,000	26.85%	0	0	0	750,221,220	964,570,140	428,697,840	0	0	2,143,489,200	26.3
Subtotal	**2,143,489,200**		0	0	0	750,221,220	964,570,140	428,697,840	0	0	2,143,489,200	26.3
5. Value Added Tax												
F/C portion	8,382,400,000	4.0%	0	1,596,800	2,395,200	115,756,800	148,488,000	67,059,200	0	0	335,296,000	4.1
L/C portion	2,727,400,000	4.0%	0	482,400	723,600	37,701,200	48,369,600	21,819,200	0	0	109,096,000	1.3
Subtotal	**444,392,000**		0	2,079,200	3,118,800	153,458,000	196,857,600	88,878,400	0	0	444,392,000	5.4
6. Total Project Cost excluding IDC												
F/C Portion												
(1) Procurement and Construction	8,382,400,000		0	39,920,000	59,880,000	2,893,920,000	3,712,200,000	1,676,480,000	0	0	8,382,400,000	103.0
L/C Portion												
(1) Procurement and Construction	2,727,400,000		0	12,060,000	18,090,000	942,530,000	1,209,240,000	545,480,000	0	0	2,727,400,000	33.5
(2) Import Duties	2,143,489,200		0	0	0	750,221,220	964,570,140	428,697,840	0	0	2,143,489,200	26.3
(3) Value Added Tax	444,392,000		0	2,079,200	3,118,800	153,458,000	196,857,600	88,878,400	0	0	444,392,000	5.5
Subtotal	**13,697,681,200**		**0**	**54,059,200**	**81,088,800**	**4,740,129,220**	**6,082,867,740**	**2,739,536,240**	**0**	**0**	**13,697,681,200**	**168.3**
( ) in M. US$				**(0.66)**	**(1.00)**	**(58.25)**	**(74.75)**	**(33.66)**			**(168.3)**	

Table 6.3-5 (2/2) Disbursement Schedule

(Unit: JPY) (M. US$)

Project No.1	Cost as of 2011	Rate for Escalation or Tax	Construction Period 2012	2013	2014	2015	2016	2017	2018	2019	Total	Total (M. US$)
7. JICA Loan Arrangement												
(1) JICA Loan	**11,109,800,000.0** JPY											
Main Portion of F/C & L/C in Works	10,590,000,000.0		0	0	0	3,706,500,000	4,765,500,000	2,118,000,000	0	0	10,590,000,000	130.1
Consulting Service Portion	519,800,000.0		0	51,980,000	77,970,000	129,950,000	155,940,000	103,960,000	0	0	519,800,000	6.4
JVVN/GoR Own Fund	2,890,181,200.0		0	32,309,200	48,463,800	979,254,220	1,252,117,740	578,036,240	0	0	2,890,181,200	35.5
Cumulative Loan Amount for main portion			0	0	0	3,706,500,000	8,472,000,000	10,590,000,000	0	0	-	-
Cumulative Loan Amount for Consulting Service			0	51,980,000	129,950,000	259,900,000	415,840,000	519,800,000	0	0	-	-
IDC for main portion	244,629,000.0	1.40%	0	0	0	25,945,500	85,249,500	133,434,000	0	0	244,629,000	3.0
IDC for Consulting Service	111,758.0	0.01%	0	2,599	9,097	19,493	33,787	46,782	0	0	111,758	0.0
Total IDC to be burden by JVVN/GoR	244,740,758.0		0	2,599	9,097	25,964,993	85,283,287	133,480,782	0	0	244,740,758	3.0
(2) Own Fund by JVVN/GoR												
JVVN/GoR Own Fund exceeding JICA Loan	2,890,181,200.0		0	32,309,200	48,463,800	979,254,220	1,252,117,740	578,036,240	0	0	2,890,181,200	35.5
IDC (to be paid by JVVN/GoR)	244,740,758.0		0	2,599	9,097	25,964,993	85,283,287	133,480,782	0	0	244,740,758	3.0
Service Charge for Undisbursement	0.0	0.0%	0	0	0	0	0	0	0	0	0	0.0
Total JVVN/GoR Own Fund	3,134,921,958.0		0	32,311,799	48,472,897	1,005,219,213	1,337,401,027	711,517,022	0	0	3,134,921,958	38.5
( ) in M. US$				**(0.40)**	**(0.60)**	**(12.35)**	**(16.43)**	**(8.74)**			**(38.52)**	
8. Total Cost and Finance Arrangement	**14,244,721,958**		**0**	**84,291,799**	**126,442,897**	**4,841,669,213**	**6,258,841,027**	**2,933,477,022**	**0**	**0**	**14,244,721,958**	175.0
	( ) in M. US$		**(0.00)**	**(1.04)**	**(1.55)**	**(59.50)**	**(76.91)**	**(36.05)**			**(175.05)**	(175.05)
JICA Loan Amount **(Debt)**	11,109,800,000	**78.0%**	0	51,980,000	77,970,000	3,836,450,000	4,921,440,000	2,221,960,000	0	0	11,109,800,000	136.5
Own Fund by JVVN/GoR exceeding JICA Loan	2,890,181,200		0	32,309,200	48,463,800	979,254,220	1,252,117,740	578,036,240	0	0	2,890,181,200	35.5
Total IDC and Service Charge	244,740,758		0	2,599	9,097	25,964,993	85,283,287	133,480,782	0	0	244,740,758	3.0
Total Fund by JVVN/GoR **(Equity)**	3,134,921,958	**22.0%**	0	32,311,799	48,472,897	1,005,219,213	1,337,401,027	711,517,022	0	0	3,134,921,958	38.5

IDC: Interest During Construction

Table 6.3-6 Project Cost Allocation

1USD = 81.377 JPY 1JPY = 0.554 INR
1USD = 45.036 INR

(JPY)

Case1 33KV Line Project	Total Investment		
Total	**14,244,700,000**	JPY	100.0%
JICA Loan	11,109,800,000	JPY	78.0%
JVVN/GoR Own Fund (inc. IDC)	3,134,900,000	JPY	22.0%

Base Cost	Physical Contingency	Price Contingency	Other Costs (IDC etc.)	Total Investment
12,799,800,000	656,700,000	543,500,000	244,700,000	**14,244,700,000**
89.9%	4.6%	3.8%	1.7%	100.0%

(US$)

Case1 33KV Line Project	Total Investment		
Total	**175,046,000**	US$	100.0%
JICA Loan	136,523,000	US$	78.0%
JVVN/GoR Own Fund (inc. IDC)	38,523,000	US$	22.0%

Base Cost	Physical Contingency	Price Contingency	Other Costs (IDC etc.)	Total Investment
157,290,000	8,070,000	6,679,000	3,007,000	**175,046,000**
89.9%	4.6%	3.8%	1.7%	100.0%

(INR)

Total	Total Investment		
Total	**25,712,500,000**	INR	100.0%
JICA Loan	20,053,800,000	INR	78.0%
JVVN/GoR Own Fund (inc. IDC)	5,658,700,000	INR	22.0%

Base Cost	Physical Contingency	Price Contingency	Other Costs (IDC etc.)	Total Investment
23,104,300,000	1,185,400,000	981,000,000	441,700,000	**25,712,400,000**
89.9%	4.6%	3.8%	1.7%	100.0%

IDC: Interest During Construction

6.3.2 Benefits

Benefits are estimated on the following procedure.

No.		Items	Data / Output		Utilized Information for Estimation (No.)
1	1	Selection and arrangement of Data/ Information to be utilized	Information on RIICO Industrial Area	**Area**	-
	2			**Number of Plot**	-
	3			**Power Utilization**	-
	4		Information from an Operating Company in the Neemrana Industrial Area	**Time of Power Shutdown**	-
	5			**Electricity Cost of Captive Power**	-
	6		Information on Power Tariff of JVVN	**Power Tariff**	-
2		Data Analysis/ Estimation	**Power Utilization** in a plot of Neemrana and Shahjahanpur Industrial Areas		1-2, 1-3
3		Data Analysis/ Estimation	**Power Utilization** in existing NIC		1-2, 2
4		Data Analysis/ Estimation	**Daily Averaged Power Shutdown Time** per a day in existing NIC		1-4
5		Estimation	Economical or Financial **Benefits in** existing NIC		1-5, 1-6, 3, 4

(1) Power Utilizations in the Objective Area

The objective area for the Project is the Shahjahanpur Industrial Area including the NIC developed by RIICO. The outlines of the industrial areas composing the Shahjahanpur Industrial Area are shown in Table 6.3-7. The Shahjahanpur Industrial Area is composed of five (5) existing industrial areas and one (1) under-construction area.

Although the project will expand to the whole Shahjahanpur Industrial Area in the future, the objective area in the study is the existing industrial area of NIC, which ranks 1st priority area (Phase-I). The existing NIC has a total area of 9.45km^2 which is about 66% of a total area of the existing Shahjahanpur Industrial Area (14.27km^2). And the area of the whole Shahjahanpur Industrial Area including expansion and development plan is 43.2km^2.

Table 6.3-7 Outlines of the Shahjahanpur Industrial Area

No.			1	2	3	4					5	6	Total
						Neemrana							
Name of Industrial Area		Unit	Keswana	Sotanala	Behror	Phase-I	Phase-II	EPIP	New Industrial Complex	Total	Shahjahanpur	Ghilot	
Existing Area		km^2	1.98	0.61	1.30	2.61	1.27	0.85	4.72	9.45	0.93		14.27
Planned Area		km^2										7.50	7.50
Expansion Area (Plan)		km^2			0.72	9.53				9.53	2.12	9.06	21.43
Total Area		km^2	1.98	0.61	2.02	2.61	1.27	0.85	14.25	18.98	3.05	16.56	43.20
Existing Area	Year of Establishment	Year	1992	2000	1981	1992	2007	2006	2007	-	1982	-	-
	Units in Production		8	45	187	107	18	50	11	186	82		508
	Units in Under Construction		NA	NA	NA	NA	NA	NA	6	6	NA	NA	6
	Units of Reserved		NA	NA	NA	NA	NA	NA	11	11	NA	NA	11
	Units of Vacant Plot		1	2	4	55				55	4	NA	66
	Area of Vacant Plot	km^2	NA	NA	NA	0.98				0.98	NA	NA	0.98
Remarks									Japanese Area				

(Source : Information provided by RIICO, Industrial Areas at A Glance - Unit Neemrana, Detail of existing & Proposed expansion/new industrial areas in SNB, and Industrial Land in Rajasthan, etc.)

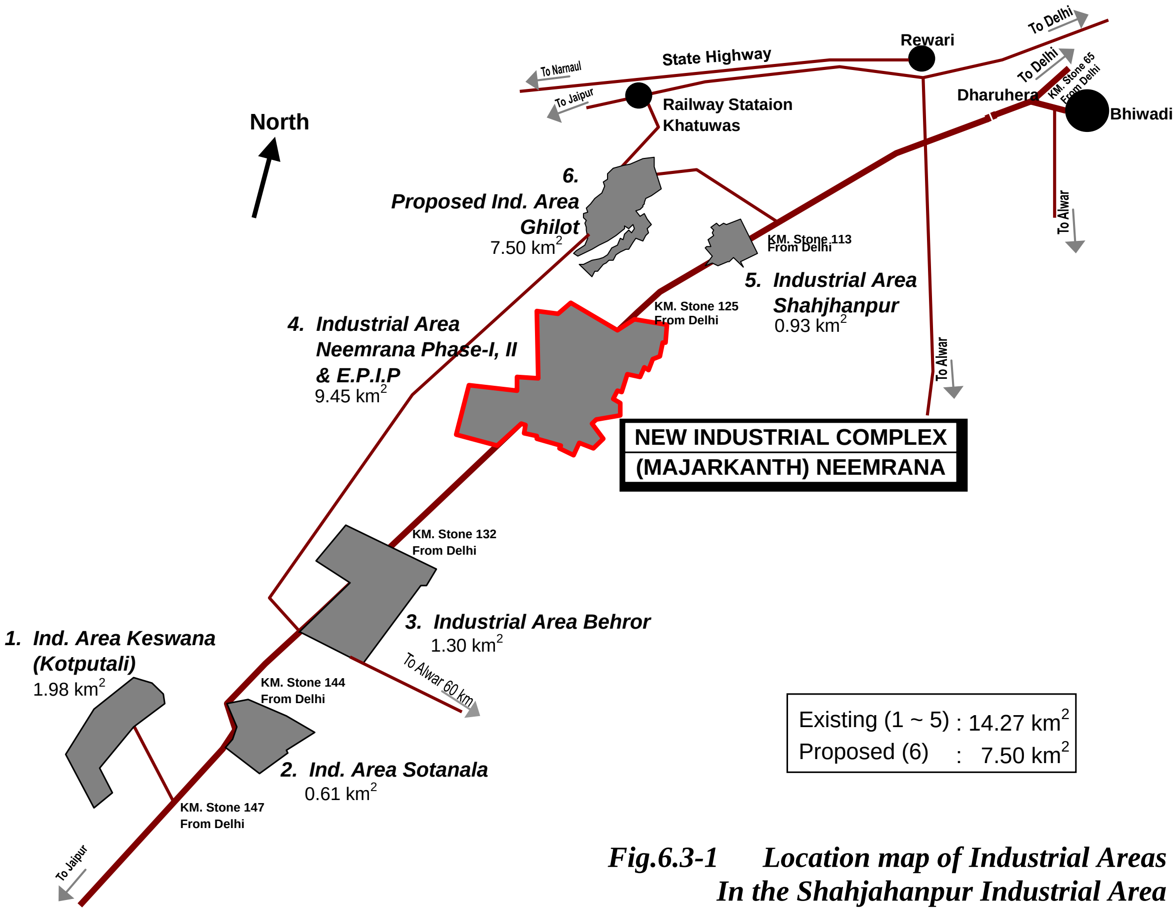


Fig.6.3-1 Location map of Industrial Areas In the Shahjahanpur Industrial Area

(Source : Provided by RIICO)

Such as brewery factories, automobile parts factories, electric products factories, and fabrication factories are operating in the NIC. The electricity of these factories in the NIC is mainly supplied from the following sub-stations.

i) Neemrana Sub-station (220 kV)

ii) Shahjahanpur Sub-station (132 kV)

Some of these sub-stations are providing to the Shahjahanpur Industrial Area other than the NIC. These sub-stations provided electric power energy of 142,000 MWh from March to June, 2011. The monthly average energy of electric power supply reaches 36,000 MWh and average power demand comes to 50 MW.

(Source : RIICO)

It is assumed that this supplied electricity will be considerably increased because of the extension of the industrial area and production in the vacant plots. As of July, 2011, there are one hundred eighty six (186) running factories in the NIC and eighty two (82) running factories in the Shahjahanpur Industrial Area. Therefore, the average power energy in a factory is approximately 4,500 kWh/day (approximately 187 kWh/hour).

Table 6.3-8 Power Utilization

No.		Unit	4	5	Total	Calculation/	
Name			Neemrana	Shahjahanpur		Source	
Area	Developed	km^2	9.45	0.93	10.38	a	RIICO
	Planned	km^2	9.53	2.12	11.65	b	RIICO
	Total	km^2	18.98	3.05	22.03	c	a + b
Number of Plot	Occupied	unit	186	82	268	d	RIICO
	Vacancy/Under construction	unit	72	4	76	e	RIICO
Power Supply	Monthly Average	kWh	36,000,000		-	f	RIICO
	Monthly Average per occupied plot	kWh/unit	134,328		-	g	f / g
	Daily Average per occupied plot	kWh/unit	4,478		-	h	g / 30
	Hourly Average per occupied plot	kWh/unit	187		-	i	h / 24

Base on the data, the amount of the power utilization in the Shahjahanpur Industrial Area is estimated as shown below. The objective area in Phase-I is the NIC, therefore the power consumption in the objective area is assumed as 48,246 kWh per hour. Plots which are not presently running are included in the assumed power consumption, because the plots are expected to be occupied after completion of the project.

Table 6.3-9 Estimation of Power Utilization in the Shahjahanpur Industrial Area

No.			1	2	3	4	5	6	Total	Calculation/ Source	
Name of Industrial Area		Unit	Keswana	Sotanala	Behror	Neemrana	Shahjahanpur	Ghilot			
Existing Area		km^2	1.98	0.61	1.30	9.45	0.93		14.27	a	RIICO
Planned Area		km^2						7.50	7.50	b	RIICO
Expansion Area (Plan)		km^2			0.72	9.53	2.12	9.06	21.43	c	RIICO
Total Area		km^2	1.98	0.61	2.02	18.98	3.05	16.56	43.20	d	a+b+c
Existing Area	Units in Production	Unit	8	45	187	186	82		508	e	RIICO
	Units in Not Production	Unit	1	2	4	72	4		83	f	RIICO
Estimation	Existing Area/Units in Production	km2	0.220	0.013	0.007	0.037	0.011		0.024	g	a/(e+f)
	Number of Plots in Planned Area	Unit						203	203	h	g x b [1)]
	Number of Plots in Expansion Area	Unit			103	258	193	245	799	i	g x c [1)]
Power Supply	Hourly power utilization for Producing Units	kWh	1,496	8,415	34,969	34,782	15,334	0	94,996	j	e x 187kwh (Table 6.3-8)
	Expected hourly power utilization for Non-producing units	kWh	187	374	748	13,464	748		15,521	k	f x 187kwh (Table 6.3-8)
	Expected hourly power utilization for Planned Area	kWh						37,961	37,961	l	h x 187kwh (Table 6.3-8)
	Expected hourly power utilization for Expansion Area	kWh			19,261	48,246	36,091	45,815	149,413	m	i x 187kwh (Table 6.3-8)
	Actual hourly power utilization in Existing Area (Producing Units)	kWh	1,496	8,415	34,969	34,782	15,334	0	94,996	n	=j
	Actual hourly power utilization in Existing Area (Non-producing Units)	kWh	187	374	748	13,464	748	0	15,521	o	=k
	Future additional hourly power utilization in Planned Area	kWh	0	0	19,261	48,246	36,091	83,776	187,374	p	l+m
	Present hourly power utilization including Non-producing Units	kWh	1,683	8,789	35,717	**48,246**	16,082	0	110,517	q	n+o
	Future power utilization (Existing and Planned Area)	kWh	1,683	8,789	54,978	96,492	52,173	83,776	297,891	r	n+o+p

(2) Power Quality

The records of power shutdown measured by a company, whose electricity is supplied from 11kV distribution line, in the NIC are shown below. According to these records, 109 times power shutdown has occurred from March 15th, 2011 to July 12th, 2011. Meanwhile, averaged shutdown duration in a day is about 133 minutes, equivalent to 809 hours per year.

Table 6.3-10 Power Shutdown of a Factory in the NIC (March 15, 2011 – July 12, 2011)

[Number of Power Shutdown]

Month	March	April	May	June	July	Total
Season	Not farming Season		-	Farming Season		
Number of Power Shutdown	17	17	NA	45	30	109
Number of Day	17	30	-	30	12	89
Monthly Averaged Number of Shutdown per day	1.00	0.57	-	1.50	2.50	1.22
Seasonal Averaged Number of Shutdown per day	0.72			1.79		1.22

[Power Shutdown Time]

Month	March	April	May	June	July	Total
Season	Not farming Season		-	Farming Season		
Power Shutdown Time (minutes)	405	885	NA	6,440	4,112	11,842
Number of Day in the month	17	30	-	30	12	89
Monthly Averaged Shutdown Time per day (minutes/day)	23.8	29.5	-	214.7	342.7	133.1
Seasonally Averaged Shutdown Time per day (minutes/day)	27.4		-	251.2		133.1

(Source : Information from T Company in the NIC)

During shutdown, the private company's own captive power is utilized. Although the electricity tariff of JVVN is about 4.0 INR/kWh[2], the electricity cost including maintenance costs by an owned generator reaches 14 to 15 INR/kWh. Consequently, annual averaged power cost is about 8.0 INR/kWh.

(Source: Information from T Company in the NIC)

The recommended project in this Study aims at improvement of power quality to reduce economical and social losses due to such power shutdown. As mentioned above, the targets are as follows;

- Number of Power Shutdown: 18 times/year
- Total duration of Power Shutdown: 8 hours/year

2 This information is based on the interview survey in July, 2011. From September 8, 2011, the electricity tariff of 5.0 INR/kWh is good in JVVN.

(3) Economical Benefits

Economical benefits arising from the Project is given from reduction of economical losses due to power shutdown, and, so far, a diesel generator is utilized to continue the factory operations and to prevent such losses.

The diesel running cost is about 14 INR/kWh, and the benefits can be considered that this cost is reduced down to 5.0 INR/kWh due to the Project. These economical benefits can be also regarded as those in alternative aspects, in other words, “With-Project” is to implement this Project and ”Without-project” is to own captive generators as present situations.

In addition, the factories are operating even if the higher power cost of 14 INR/kWh is required, therefore it is considered that the economical losses due to the operation stop caused by blackout would be larger.

Provided that the power shutdown never occur, diesel generators will be unnecessary. The initial investment cost for the installation of the diesel generators can be added up in the economical benefits. However, considering it is unrealistic, it is assumed that such economical benefits are not added up.

The conditions for estimation and expected benefits are shown below.

[Conditions for Estimation]

i) It is assumed that average daily shutdown time is 133.1 minutes at present and that will be 1.3 minutes (8 hours/ year) after completion of the Project. Therefore daily average reduction time of power shutdown will be 131.8 minutes (about 2.2 hours).

ii) The power charges are basically 5.0 INR/kWh supplied by JVVN and 14 INR/kWh by captive generators.

iii) The improvement of power quality will make industrial areas attractive in terms of investment, therefore it is assumed that all areas are occupied after completion of the Project.

iv) It is considered that the benefits of the Project are reduced electricity costs by reduction of shutdown time.

The economical annualized benefit comes to 379 million INR (629 million JPY, 7.7 million US$).

Table 6.3-11 Annualized Economic Benefits by the Project

No.				1	2	3	4	5	6	Total	Remarks
Name of Industrial Area			Unit	Keswana	Sotanala	Behror	Neemrana	Shahjahanpur	Ghilot		
Existing Area	Hourly power utilization for Producing Units		kWh	1,683	8,789	35,717	48,246	16,082	0	110,517	Table 6.3-9 q
	Power Shutdown Time		hour	2.2						-	131.8 minutes
	Loss of power supply in a day		kWh	3,703	19,336	78,577	106,141	35,380	0	243,137	
	Electricity Cost in a day	with-case	INR	18,515	96,680	392,885	530,705	176,900	0	1,215,685	5 INR/kWh
		without-case	INR	51,842	270,704	1,100,078	1,485,974	495,320	0	3,403,918	14Rp/kWh
		(without-case)-(with-case)	INR	33,327	174,024	707,193	955,269	318,420	0	2,188,233	
	Yearly difference of electricity cost		INR	12,164,355	63,518,760	258,125,445	348,673,185	116,223,300	0	798,705,045	
	Annualized benefits		INR	12,164,355	63,518,760	258,125,445	**348,673,185**	116,223,300	0	798,705,045	
Annualized benefit (Existing Area)			INR	12,164,355	63,518,760	258,125,445	**348,673,185**	116,223,300	0	798,705,045	
			JPY	21,957,319	114,654,801	465,930,406	**629,373,980**	209,789,350	0	1,441,705,856	1JPY= 0.554 INR
			US$	270,103	1,410,400	5,731,536	**7,742,099**	2,580,675	0	17,734,813	1US$= 45.036 INR
Planned Area (Future Additional)	Hourly power utilization for Producing Units		kWh	0	0	19,261	48,246	36,091	83,776	187,374	Table 6.3-9 p
	Power Shutdown Time		hour	2.2						-	131.8 minutes
	Loss of power supply in a day		kWh	0	0	42,374	106,141	79,400	184,307	412,222	
	Electricity Cost in a day	with-case	INR	0	0	211,870	530,705	397,000	921,535	2,061,110	5 INR/kWh
		without-case	INR	0	0	593,236	1,485,974	1,111,600	2,580,298	5,771,108	14Rp/kWh
		(without-case)-(with-case)	INR	0	0	381,366	955,269	714,600	1,658,763	3,709,998	
	Yearly difference of electricity cost		INR	0	0	139,198,590	348,673,185	260,829,000	605,448,495	1,354,149,270	
	Annualized benefits		INR	0	0	139,198,590	348,673,185	260,829,000	605,448,495	1,354,149,270	
Total annualized benefit (Existing and Planned Area)			INR	12,164,355	63,518,760	397,324,035	697,346,370	377,052,300	605,448,495	2,152,854,315	
			JPY	21,957,319	114,654,801	717,191,399	1,258,747,960	680,599,819	1,092,867,319	3,886,018,617	1JPY= 0.554 INR
			US$	270,103	1,410,400	8,822,365	15,484,199	8,372,242	13,443,656	47,802,965	1US$= 45.036 INR

(4) Financial Benefits

Benefit of implementing agencies, such as distribution companies, from the Project is to be incremental income derived from increase of power supply time.

The conditions for estimation and estimated benefits are shown below.

[Conditions for Estimation]

i) It is assumed that average daily shutdown time is 133.1 minutes at present and that will be 1.3 minutes (8 hours/ year) after completion of the Project. Therefore daily average reduction time of power shutdown will be 131.8 minutes (about 2.2 hours).

ii) The power tariff of JVVN is basically 5.0 INR/kWh.

iii) The improvement of power quality will make industrial areas attractive in terms of investment, therefore it is assumed that all plots are occupied after completion of the Project.

iv) It is considered that the benefits of the Project are incremental income derived from increase of power supply time.

The financial annualized benefit comes to 194 million INR (350 million JPY, 4.3 million US$).

Table 6.3-12 Annualized Financial Benefits by the Project

No.			1	2	3	4	5	6	Total	Remarks
Name of Industrial Area		Unit	Keswana	Sotanala	Behror	Neemrana	Shahjahanpur	Ghilot		
Existing Area	Hourly power utilization for Producing Units	kWh	1,683	8,789	35,717	48,246	16,082	0	110,517	Table 6.3-9 q
	Power Shutdown Time	hour	2.2						-	131.8 minutes
	Loss of power supply in a day	kWh	3,703	19,336	78,577	106,141	35,380	0	243,137	
	Money losses per day (=daily benefits)	INR	18,515	96,680	392,885	530,705	176,900	0	1,215,685	5 INR/kWh
	Money losses per year	INR	6,757,975	35,288,200	143,403,025	193,707,325	64,568,500	0	443,725,025	
	Annualized benefits	INR	6,757,975	35,288,200	143,403,025	**193,707,325**	64,568,500	0	443,725,025	
	Annual Additional Salable Power	kWh	1,351,595	7,057,640	28,680,605	**38,741,465**	12,913,700	0	88,745,005	
Annualized benefit (Existing Area)		INR	6,757,975	35,288,200	143,403,025	**193,707,325**	64,568,500	0	443,725,025	
		JPY	12,198,511	63,697,112	258,850,226	**349,652,211**	116,549,639	0	800,947,699	1JPY= 0.554 INR
		US$	150,057	783,555	3,184,187	**4,301,166**	1,433,709	0	9,852,674	1US$= 45.036 INR
Planned Area (Future Additional)	Hourly power utilization for Producing Units	kWh	0	0	19,261	48,246	36,091	83,776	187,374	Table 6.3-9 p
	Power Shutdown Time	hour	2.2						-	131.8 minutes
	Loss of power supply in a day	kWh	0	0	42,374	106,141	79,400	184,307	412,222	
	Money losses per day (=daily benefits)	INR	0	0	211,870	530,705	397,000	921,535	2,061,110	5 INR/kWh
	Money losses per year (=yearly benefits)	INR	0	0	77,332,550	193,707,325	144,905,000	336,360,275	752,305,150	
	Annualized benefits	INR	0	0	77,332,550	193,707,325	144,905,000	336,360,275	752,305,150	
	Annual Additional Salable Power	kWh	1,351,595	7,057,640	44,147,115	77,482,930	41,894,700	67,272,055	239,206,035	
Total annualized benefit (Existing and Planned Area)		INR	6,757,975	35,288,200	220,735,575	387,414,650	209,473,500	336,360,275	1,196,030,175	
		JPY	12,198,511	63,697,112	398,439,666	699,304,422	378,111,011	607,148,511	2,158,899,233	1JPY= 0.554 INR
		US$	150,057	783,555	4,901,314	8,602,333	4,651,246	7,468,698	26,557,203	1US$= 45.036 INR

6.3.3 Economic Analysis

Based on above mentioned conditions, the economic analysis is carried out. The basic conditions of the economic analysis are summarized below.

Table 6.3-13 Basic Conditions for Economic Analysis

Items	Unit	33kV Line Project	Remark
Investment Cost Estimation	M.JPY	14,244.7	Including IDC and Service Charge
	US$	175,046,000	1US$= 81.377 JPY
	M.INR	25,712.4	1JPY= 0.554 INR
Project Cost to be used in the economic analysis	US$	175,046,000	
Detailed Design & Tendering & Construction Period	Years	5.0	
Fixed OM Cost	US$/year	350,092	Engineer's Estimation (0.2 % of Project Cost in economic analysis)
Variable OM Cost	US$/year	150,000	Engineer's Estimation
Service Life Time	Years	25	Engineer's Estimation
Commencement of Operation	Years	2018	
Annualized Benefit (Existing and Planned Area)	US$/year	15,484,199	Neemrana
Annualized Benefit (Existing Area)	US$/year	7,742,099	Neemrana
Annualized Benefit (For Analysis)	US$/year	7,742,099	Existing Area

Since the project EIRR results in 1.8% which is positive value, the economic value of the project is found out. However, the critical discount rate normally utilized in JVVN's analysis is 12%, therefore the project is considered unviable in terms of economy. In addition, B/C becomes 0.4 by using capitalized benefit(B) and cost(C) with a discount rate of 12%.

Given that minimum project EIRR is 12%, the following conditions are satisfied.

- When the rates of F/C and L/C in the construction cost are 50% and 50% respectively, The construction cost is reduced below 37 million JPY which is about 39% to estimated construction cost of 95 million JPY.
- Power cost per kWh is increased more than 28 INR/kWh which is double as much as present power generation cost of 14 INR/kWh.

Table 6.3-14 Result of Economic Analysis

33kV Line Improvement Project Cost	Unit	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
Construction Cost	M.US$	0.00	1.04	1.55	59.50	76.91																										139.00
Fixed OM Cost	M.US$						0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	8.75
Variable OM Cost	M.US$						0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	3.75
Total Cost	M.US$	0.00	1.04	1.55	59.50	76.91	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	151.50

Benefit	Unit	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total
Annualized Benefit	M.US$						7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	193.50
																																0.00
Total Benefit	M.US$	0.00	0.00	0.00	0.00	0.00	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	7.74	193.50

***EIRR =* 1.8%**

(B) - (C)	M.US$	0.00	-1.04	-1.55	-59.50	-76.91	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	

Discount Rate 12% ***B/C =* 0.40**

Present Value		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	Total
Cost	M.US$	0.00	0.93	1.24	42.35	48.88	0.28	0.25	0.23	0.20	0.18	0.16	0.14	0.13	0.11	0.10	0.09	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	95.88
Benefit	M.US$	0.00	0.00	0.00	0.00	0.00	4.39	3.92	3.50	3.13	2.79	2.49	2.23	1.99	1.77	1.58	1.41	1.26	1.13	1.01	0.90	0.80	0.72	0.64	0.57	0.51	0.46	0.41	0.36	0.32	0.29	38.58

6.3.4 Financial Analysis

(1) Methodology of Financial Analysis and Evaluation Criteria

In the financial analysis, Profit & Loss Statement is firstly prepared and then a cash flow is calculated based on the Profit & Loss Statement. Consequently, financial indicators are given from the cash sheet. Financial indicators and evaluation criteria prevailed generally are shown in Table 6.3-15.

Table 6.3-15 Financial Indicators and Evaluation Criteria

Financial Indicators	Feasible Criteria	Remarks
Project IRR (Project Internal Rate of Return)	Project IRR>WACC	Project IRR indicates the internal rate of return of the project provided that the project will be implemented by 100 % of own equity without loan. Therefore, Project IRR indicates the financial characteristic of the project itself because the Project IRR is not affected by loan conditions, such as IDC and interest payment. WACC (Weighted Average Cost of Capital) indicates the average cost of capital (Debt and Equity) to run the business continuously. Project IRR must be greater than the WACC unless the entrepreneur manager will never invest in the project. Higher inflation leads to higher WACC generally. Since inflation rate in India is 8 %, WACC seems to be 10 % and more. Herein, WACC of 12% is applied
ROE (Return on Equity)	ROE> 12~13 %	ROE indicates the return on equity. If the expected ROE is lower return, the entrepreneur manager will invest in other projects of which ROE is higher.
DSCR (Debt Service Coverage Ratio)	DSCR >1.5 (Average) DSCR >1.3 (Each year)	DSCR is an indicator which the Bankers are most concerned. If DSCR is 1.0, all gained money shall be allocated to the interest payment and capital repayment and there is no remaining money.
B/C	B/C > 1.0	B/C is calculated from what capitalized benefit is divided capitalized cost. Since the discount rate of 12% is applied, B/C becomes 1.0 in case that Project IRR of 12% is given.

DSCR, herein, is derived from the following formula.

$$DSCR = \frac{\text{Business Profit} - \text{Corporate Income Tax}}{(\text{Interest Payment} + \text{Capital Repayment})}$$

where, Discount Rate is 12 %.

(2) Conditions for Financial Analysis

The conditions for financial analysis are summarized below.

Table 6.3-16 Conditions for Financial Analysis

1. Power Tariff			
Power Tariff in 2011	INR/kWh	5.00	The power tariff for Large Industry of JVVN
	US$/kWh	0.110	1US$= 0.022 Rp
Base Year	Year	2011	
Average Power Tariff Escalation Rate	%/year	5.0%	Engineers assumption. Tariff increase rate in large industry from 1997 to 2011 is 5.87%.
2. Corporate Income Tax and Depreciation *)			
Corporate Income Tax	%	25%	Domestic and foreign companies are subject to 25% of corporate income tax in India.
Depreciation Method	Straight Line Method		
Depreciation Period	years	25	
3. Import Duties and Value Added Tax *)			
Import Duties	%	26.85%	
Value Added Tax (Consumption Tax)	%	4%	4 % of VAT rate is for capital goods such as machine.

Source regarding TAX: JETRO web-site

4. JICA Loan Conditions			Note
IDC and Interest for main portion	%	1.40%	Applicable to Low-income countries
IDC and Interest for Consulting Service	%	0.01%	
Finance Close	Year	2012	Engineer's assumption
Repayment Term	years	30	Applicable to LDC Excluding Grace period of 10 years
Grace Period	years	10	Applicable to Low-income countries
Service Charge	%	0.0%	Applicable to undisbursed amount up to the year

5. Loan Schedule			Note
Start year of funding for Construction Works	Year	2015	
Start year of funding for Consulting Services	Year	2013	

6. Construction Schedule			Note
Period for design, tendering and construction	Year	5	

7. Salable Energy			Note
Additional Salable Energy (Existing and Planned Area)	kwh/year	77,482,930	Neemrana
Additional Salable Energy (Existing Area Only)	kwh/year	38,741,465	Neemrana
Additional Salable Energy (Used in Analysis)	kwh/year	38,741,465	Existing Area

The change in power tariff of JVVN is summarized in Table 6.3-17. The table shows that the power tariff from 1997 to 2011 has risen with the average increase rate of 5.87%. Therefore, the annual increase rate of power tariff is assumed as 5.0 % in the Study.

Table 6.3-17 Change in Power Tariff of JVVN (Large Industry)

Items	Unit	1997	1999	2001	2007	2011
Energy Charge	10^{-2}INR/kWh	225	259	401	401	500
Increase Rate	%	-	15	55	0	25
Increase Rate from 1997	%	-	15	78	78	122
Annual averaged increase rate of energy charge from 1997 to 2011 in %						5.87

(Source : Prepared by JICA study team based on information from JVVN)

(3) Financial Analysis and Evaluation

The calculation sheets for the financial analysis are shown in Table 6.3-19 and Table 6.3-20. The results show that financial situation will not be so large that financial viability is not found in the Project.

Table 6.3-18 Summary of Financial Analysis

Financial Indicators	Result	Evaluation
Project IRR	Project IRR = 4.0 % < 12 %	All of financial indicators do not satisfy the feasible criteria.
ROE	ROE = 10.2%	
DSCR	Minimum DSCR = 1.13 <1.3 Averaged DSCR = 2.57 <1.5	
B/C	0.28 < 1.0	

In case that the average power tariff of JVVN during study period of financial analysis becomes 55.6 INR/kWh (1.22 US$/kWh), the project will have the project IRR of 12%. In comparison with the power tariffs as of 2011, this power tariff is regarded as 17 INR/kWh which is 3.4 times higher than that of 5.0 INR/kWh. On the other hand, in case that the construction cost is 2.74 billion JPY, which is 29% to estimated construction cost, the project IRR comes to 9.6%. The construction cost of 2.74 billion JPY is assumed that the rates of F/C and L/C are 50% and 50% respectively.

Items	Change in Value	Results of Financial Analysis
Averaged Power Tariff	0.36 US$ /kWh →1.22 US$/kWh	Project IRR = 12.0% (B/C=1.0) ROE = 30.9% Minimum DSCR = 3.38 Averaged DSCR = 8.26
Construction Cost	9.5 billion JPY →27.4 billion JPY (F/C: L/C = 1:1)	Project IRR = 12.0% (B/C=1.0) ROE = 37.0% Minimum DSCR = 3.14 Averaged DSCR = 7.70

Table 6.3-19 Calculation Sheet of Financial Analysis (Profit & Loss Statement)

Profit and Loss Statement									0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Power Tariff	INR	4.76	5.00	5.25	5.51	5.79	6.08	6.38	6.70	7.04	7.39	7.76	8.14	8.55	8.98	9.43	9.90	10.39	10.91	11.46	12.03	12.63	13.27	13.93
	US$	0.105	0.110	0.116	0.121	0.127	0.134	0.140	0.147	0.155	0.163	0.171	0.179	0.188	0.198	0.207	0.218	0.229	0.240	0.252	0.265	0.278	0.292	0.307
Additional Salable Energy	Gwh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74
Additional Sales Revenue	M.US$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	6.30	6.61	6.94	7.29	7.65	8.03	8.44	8.86	9.30	9.77	10.25	10.77	11.31	11.87
Fixed O/M Cost	M.US$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35
Variable O/M Cost	M.US$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
Earning after operation	M.US$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.50	5.80	6.11	6.44	6.79	7.15	7.53	7.94	8.36	8.80	9.27	9.75	10.27	10.81	11.37
Depreciation	M.US$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00
Interest Payment for main portion	M.US$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.82	-1.82	-1.82	-1.82	-1.82	-1.76	-1.70	-1.64	-1.58	-1.52	-1.46	-1.40	-1.34	-1.28	-1.21
Interest Payment for Consulting Service	M.US$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Earning before Tax	M.US$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.68	-3.02	-2.71	-2.38	-2.03	-1.61	-1.17	-0.70	-0.22	0.28	0.81	1.35	1.93	2.53	3.16
Income Tax	M.US$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.07	-0.20	-0.34	-0.48	-0.63	-0.79
Earning after Tax	M.US$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.76	-3.02	-2.71	-2.38	-2.03	-1.61	-1.17	-0.70	-0.22	0.21	0.61	1.01	1.45	1.90	2.37

Profit and Loss Statement		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
Year		2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	Total
Power Tariff	INR	14.63	15.36	16.13	16.93	17.78	18.67	19.60	20.58	21.61	22.69	23.82	25.02	26.27	27.58	28.96	30.41	31.93	33.52	35.20	36.96	38.81	0.00
	US$	0.322	0.338	0.355	0.373	0.391	0.411	0.431	0.453	0.475	0.499	0.524	0.550	0.578	0.607	0.637	0.669	0.702	0.738	0.774	0.813	0.854	0.000
Additional Salable Energy	Gwh	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	38.74	1394.64
Additional Sales Revenue	M.US$	12.47	13.09	13.74	14.43	15.15	15.91	16.70	17.54	18.42	19.34	20.30	21.32	22.39	23.51	24.68	25.92	27.21	28.57	30.00	31.50	33.08	574.66
Fixed O/M Cost	M.US$	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-0.35	-12.60
Variable O/M Cost	M.US$	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-5.40
Earning after operation	M.US$	11.97	12.59	13.24	13.93	14.65	15.41	16.20	17.04	17.92	18.84	19.80	20.82	21.89	23.01	24.18	25.42	26.71	28.07	29.50	31.00	32.58	556.66
Depreciation	M.US$	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	-7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-175.00
Interest Payment for main portion	M.US$	-1.15	-1.09	-1.03	-0.97	-0.91	-0.85	-0.79	-0.73	-0.67	-0.61	-0.55	-0.49	-0.43	-0.36	-0.30	-0.24	-0.18	-0.12	-0.06	0.00	0.00	-35.52
Interest Payment for Consulting Service	M.US$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Earning before Tax	M.US$	3.82	4.50	5.21	5.96	6.74	7.56	8.41	9.31	10.25	11.23	12.25	20.33	21.46	22.65	23.88	25.18	26.53	27.95	29.44	31.00	32.58	346.14
Income Tax	M.US$	-0.95	-1.13	-1.30	-1.49	-1.69	-1.89	-2.10	-2.33	-2.56	-2.81	-3.06	-5.08	-5.36	-5.66	-5.97	-6.29	-6.63	-6.99	-7.36	-7.75	-8.14	-89.97
Earning after Tax	M.US$	2.87	3.37	3.91	4.47	5.05	5.67	6.31	6.98	7.69	8.42	9.19	15.25	16.10	16.99	17.91	18.89	19.90	20.96	22.08	23.25	24.44	256.17

Table 6.3-20 Calculation Sheet of Financial Analysis (Financial Analysis)

Project Cash flow and Project IRR (Million US$)

Items	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2051	2052	2053	Total	Project IRR
							0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	34	35	36		
Investment	0.00	0.00	-0.66	-1.00	-58.25	-74.75	-33.66																						-168.32	
Earning after Operation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.50	5.80	6.11	6.44	6.79	7.15	7.53	7.94	8.36	8.80	9.27	9.75	10.27	10.81	11.37	11.97	12.59	13.24	29.50	31.00	32.58	556.66	
Corporative Income Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.37	-1.45	-1.53	-1.61	-1.70	-1.79	-1.88	-1.98	-2.09	-2.20	-2.32	-2.44	-2.57	-2.70	-2.84	-2.99	-3.15	-3.31	-7.38	-7.75	-8.14	-139.16	
Project Cash flow	0.00	0.00	-0.66	-1.00	-58.25	-74.75	-33.66	4.13	4.35	4.58	4.83	5.09	5.36	5.65	5.96	6.27	6.60	6.95	7.31	7.70	8.11	8.53	8.98	9.44	9.93	22.12	23.25	24.44	249.18	**4.0%**

Equity Cash flow and ROE (Million US$)

Items	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2051	2052	2053	Total	ROE
							0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	34	35	36		
Equity Investment	0.00	0.00	-0.40	-0.60	-12.35	-16.43	-8.74																						-38.52	
Earning after Operation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.50	5.80	6.11	6.44	6.79	7.15	7.53	7.94	8.36	8.80	9.27	9.75	10.27	10.81	11.37	11.97	12.59	13.24	29.50	31.00	32.58	556.66	
Corporative Income Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.07	-0.20	-0.34	-0.48	-0.63	-0.79	-0.95	-1.13	-1.30	-7.36	-7.75	-8.14	-89.97	
Interest Payment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.82	-1.82	-1.82	-1.82	-1.82	-1.76	-1.70	-1.64	-1.58	-1.52	-1.46	-1.40	-1.34	-1.28	-1.21	-1.15	-1.09	-1.03	-0.06	0.00	0.00	-35.52	
Principal Repayment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-4.55	-4.55	-4.55	-4.55	-4.55	-4.55	-4.55	-4.55	-4.55	-4.55	-4.55	-4.55	-4.55	-4.55	-4.55	0.00	-136.53	
Net Cash inflows*	0.00	0.00	-0.40	-0.60	-12.35	-16.43	-8.74	2.76	3.98	4.29	4.62	4.97	0.84	1.28	1.75	2.23	2.66	3.06	3.46	3.90	4.35	4.82	5.32	5.82	6.36	17.53	18.70	24.44	256.12	**10.2%**
DSCR	-	-	-	-	-	-	-	2.51	3.18	3.36	3.54	3.73	1.13	1.21	1.28	1.36	1.44	1.51	1.58	1.66	1.75	1.84	1.93	2.03	2.14	4.80	5.11	-	Ave.	2.57

B/C Discount Rate = **12%**

Present Value	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	40	41	42	Total	B/C
Cost (Investment)	0.00	0.00	0.53	0.71	37.02	42.42	17.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	97.73	
Benefit (after Tax)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.87	1.75	1.65	1.56	1.46	1.38	1.30	1.22	1.15	1.08	1.01	0.95	0.89	0.84	0.79	0.74	0.70	0.65	0.24	0.22	0.21	27.82	**0.28**

Note : Years from 2036 to 2050 are skipped intentionally.

6.4 Summary of Economic and Financial Analysis

In the economic analysis, the economical benefit is assumed "how much operation time of diesel power generators and power generation cost in factories are reduced due to reduction of power shutdown time derived from the project". The results of the economic analysis are summarized below.

1) The project EIRR and B/C result in 1.8% and 0.4, respectively. Since the 1.8% of EIRR is lower than 12% of EIRR being a target value of JVVN, it is considered that the economical efficiency is low.

2) The followings are to be considered to satisfy the JVVN's target value of 12%.

   - Project scale with the construction cost of 3.7 million JPY being 39% to 9.5 million JPY,

   or,

   - Power production cost of 28 INR/kWh by a alternative power source being double as much as that 14 INR/kWh at present.

In the financial analysis, the financial benefit is assumed "how much amount of power sales and income of JVVN are increased due to reduction of power shutdown time derived from the project". The results of the financial analysis are summarized below.

1) The project FIRR and B/C result in 4.0% and 0.28, respectively, in case that the present power tariff is annually increased with the increase rate of 5%.

2) Since the 1.8% of EIRR is lower than 12% of FIRR being a target value of JVVN, it is considered that the financial efficiency is low.

3) The followings are to be considered to satisfy the JVVN's target value of 12%.
   - Project scale with the construction cost of 2.74 million JPY being 29% to 9.5 million

Since the project IRRs in economic and financial view point are positive, the project will be able to gain a certain profit. However, those IRRs are lower than JVVN's target IRR of 12%. In the F/S stage of the project, elaborate study in existing facilities, track records of power shutdown, feasible countermeasures and so on are required. The economic and financial viability should be carefully and elaborately studied.

CHAPTER 7

ENVIRONMENTAL IMPACT ASSESSMENT

CHAPTER 7 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

7.1 Requirement of Environmental and Social Considerations

JICA proclaimed the new "JICA guidelines for environmental and social considerations" (herein after referred to as "JICA Guidelines") on April 1, 2010, consolidated the different guidelines for environmental and social considerations used by the former JBIC and JICA into a single set of guidelines, because of the integration of two agencies. The JICA Guidelines came into effect on July 1, 2010, and are being applied to projects whose applications are made by the project proponents, etc., on and after the effective date of July 1, 2010.

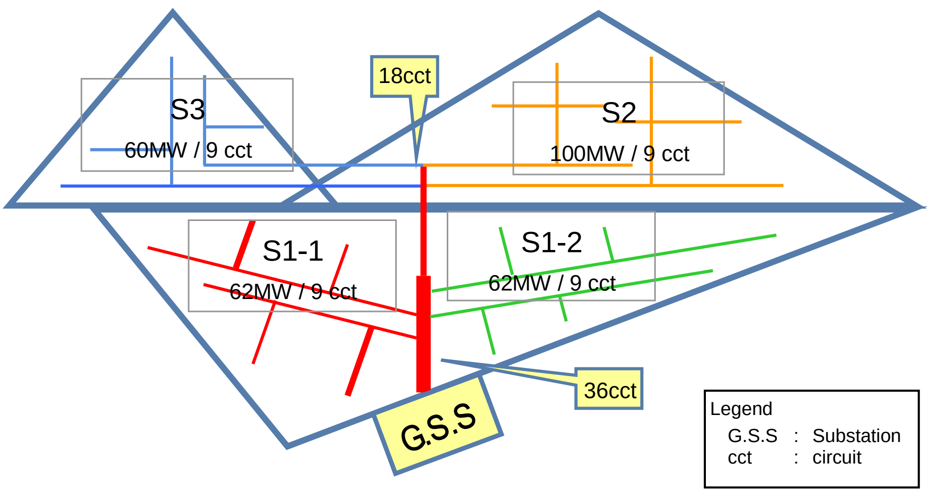
This Study is to formulate projects on improvement of power infrastructure with utilization of Japanese technologies in the Shahjahanpur Development Area in India. As the projects to be proposed in this Study aim to be implemented by Japanese ODA in the future, appropriate studies on environmental and social considerations in line with the JICA Guidelines are required. The social and environmental issues such as land acquisition and resettlement may become serious barriers to implement projects. Hence, it is recommended that the proper investigations and assessments on these matters be made at the initial stage of the projects.

Based on the above understandings, the environmental screening study is carried out taking the components and site conditions of the project into account, and consequently, the proposed Project described in Chapter 5 is classified into the four (4) categories of the JICA Guidelines. Finally, recommendations for the Project implementation in environmental and social aspects are provided.

7.2 Outline of the Project

Outline and target area of the Project are as shown below.

Table 7.2-1 Outline of the Project

<table>
<tr><td>Project Name</td><td>33kV Distribution Network Arrangement Project</td></tr>
<tr><td>Objective Area</td><td>Shahjahanpur Development Area (NIC)</td></tr>
<tr><td>Purpose</td><td>New construction and expansion of 33 kV distribution network so as to supply highly reliable electric power</td></tr>
<tr><td>Implementation Structure</td><td>JVVN</td></tr>
<tr><td>Project Period</td><td>About 5 years</td></tr>
<tr><td rowspan="4">Project Effect</td><td>Deduction of frequency and duration of power interruption from 809 hours/year to 8 hours/year</td></tr>
<tr><td>Increase of power distribution company’s income of about 350 Million JPY per year at the NIC</td></tr>
<tr><td>Deduction of power consumer’s self-generating amount by approximately 800 hours/year</td></tr>
<tr><td>Promotion of increasing new firms’ business expansion</td></tr>
<tr><td>Project Image</td><td>The 33kV distribution network is to be newly constructed and/or expanded targeting 6 industrial areas in the Shahjahanpur Development Area.
Number of circuit and distribution line extension to be established in the NIC are as shown below.


<table>
<tr><td rowspan="2">Item</td><td>Area</td><td>Load</td><td>No. of cct</td><td>Conduit Length</td><td>Cable Length</td><td>No. of Joint</td></tr>
<tr><td>9.1 km^2</td><td>282MW</td><td>36 cct</td><td>34.8 km</td><td>223 km</td><td>600</td></tr>
</table>
Outline of 33 kV Distribution Network to be supplied to the Loads at the NIC</td></tr>
</table>

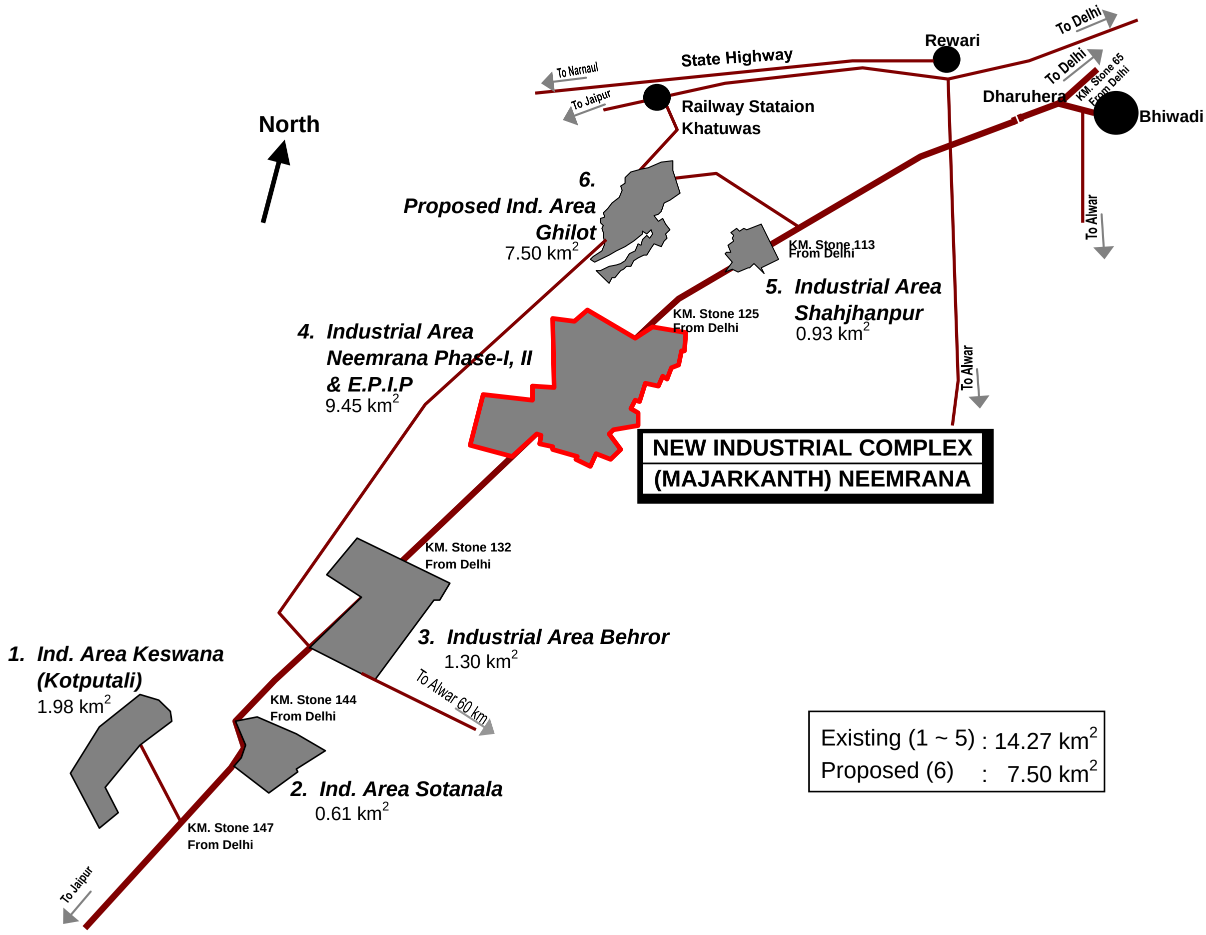


Fig 7.2-1 Location of the Shahjahanpur Development Area

7.3 Circumstances surrounding the Project

7.3.1 Natural Environment

(1) Location

Rajasthan State, which is located at north-west of India and consists of thirty two (32) districts, has the total area of 342,239 km^2 which is the largest among all the states in India. Rajasthan has the boundary of the country between India and Pakistan and that of the states of Uttar Pradesh, Gujarat, Madhya Pradesh and Haryana. The capital of Rajasthan, Jaipur city, is located at the central west part of the State and connecting to Delhi through the highway.

The NIC is located in Behror city of Alwar district which has the boundary between the northwest part of Rajasthan and Haryana. The elevation of the NIC is at 309 m. Along the Route No.8 connecting to Delhi, there are five (5) industrial areas developed by RIICO, namely Shahjhanpur, Neemrana, Behror, Sotanala and Keswana within extent of about 40 km.

(2) Climate

Rajasthan which has the vast area mainly belongs to a desert climate area. According to Koppen's classification, the southwestern part belongs to Aw (tropical savanna climate), the central-western part belongs to BShw (semi-arid climate) and the west part belongs to BWhw (desert climate). The temperature is ranging between 26 and 8 degrees in Celsius in winter and 46 and 26 degrees in Celsius in summer. Annual average rainfall of Rajasthan is 520 mm and the rainfall concentrates on the rainy season between July and September. The season is classified into winter (November - middle of March), summer (middle of March - June), rainy (July - September) and monsoon (September - November).

The climate of the NIC belongs to BShw. The temperature is ranging between 25 and 45 degrees in Celsius in summer, and between 5 and 25 degrees in Celsius in winter. The annual average rainfall and humidity are 620 mm and 53.8%, respectively.

(3) Water Resource

Although Rajasthan has vast area, the most part of the area belongs to the desert climate and a little surface water is available. There are river systems in Rajasthan, namely the Chambal river system (72,032.05 km^2) of the southeastern part of the State, the Luni river system (34,866.40km^2) of the southwestern part, and the Mahi river system (16,551.18 km^2) of the southern part. As the western part of the State has little rainfall and belongs to the climate of BWhw, there are many rivers in which water is observed in the only limited seasons throughout the year.

There are the Sabi river, the Ruparail river, the Sota river, the Kali river and the Kali river in the Sabi river system in Alwar district where the NIC is located.

(4) Protected Area and Eco-system

There are five (5) national parks and twenty three (23) sanctuaries in Rajasthan. The development of villages, road constructions, agriculture and industrial activities are prohibited in the national parks. Outlines of the national parks are shown below.

Table 7.3-1 National Parks in Rajasthan

Park	Outline
Darrah National Park	Darrah National Park which is located at 50km away from Kota in the southern part of the State has the area of 268.5km^2 and has been registered as a national park since 2003. The park consists of three (3) sanctuaries of Darrah, Chambal and Jaswant Sagar and has a hilly area with dense forest. Wild Animals such as wolves, cheaters and boas inhabit in the park.
The Desert National Park	Desert National Park located near Jaisalmer is one of the largest park with the area of 3,162 km^2 in India. The park has been registered as a national park since 1992. Many wild desert animals inhabit in the park. The park is also habitats of birds of prey such as eagles, falcons and so on.
Keoladeo Ghana National Park	Keoladeo Ghana National Park located at outside area of Bharatapur on the Jaipur - Agra highway. Total area of the park is 28.73 km^2 and that of wetland is 11km^2. The park has been registered as a national park since 1981. The park has been registered as a World Natural Heritage and is the only area in India where migratory birds come from Siberia, Central Asia and Southeast Asia.
Ranthambore National Park	Ranthambore National Park located at the southwest plateau of the State between the Banas river and the Chambal river has been registered as a national park since 1980. The park has three lakes and the total area of 392 km^2 which consists of core zone (284 km^2) and buffer zone (108 km^2). Wild animals such as tigers, panthers, hyenas and crocodiles inhabit in the park. Visitors are able to do sightseeing in the park.
Sariska National Park	Sariska National Park located at the west area of Alwar in the northeast part of the State has the area of 273.8 km^2 and has been registered as a national park since 1992. Wild animals such as Bengal tigers, hyenas and boas inhabit in the park.

7.3.2 Social Environment

(1) Population

According to the census conducted in 2011, the population of the Rajasthan is 68,621,000. The growth rate of population from 2001 is 21.44% which is 3.8% higher than that of India's average of 3.8%. While the growth of population is remarkable, the density of population is 200 persons per km^2 which is half of India's average and people who live in the Thar desert reaches to 40% of the total population. The rates of sex are 51.9% of men and 48.1% of women. The population of infants (0 - 6 years old) is 10,505,000 and the rate of the population is 15.3% of the total. The rates of literacy are 80.51% of men and 52.66% of women. The average rate of literacy is 67.06% in total and the difference between men and women is large.

According to the census conducted in 2001, the population of the Alwar district where the NIC is located is 3,570,000 which is the 4th largest among the all districts in Rajasthan.

(2) Religions and Tribes

The religion of the State is composed of Hinduism of 88.8%, Islam of 8.5%, and others of 2.6%. The population of the minority tribes of Rajasthan reaches 12% of the whole State. Its rate is approximately twice as large as the India average. The main tribes are Meena, Bhil, Saharia, Damor and Garasia.

The population of Meena is larger in the Alwar district where the NIC is located.

(3) Economy

The GDP per capita of Rajasthan in 2010 is 722 US$ which is much less than 1,100 US$ of the India's average. The GDP growth rate of Rajasthan in 2006 - 2007 was 4.0% which was half of the India average of 7.7%.

As for the gross national product of the 1990s, the primary industry, including agriculture had occupied more than 50% of it in Rajasthan. The secondary industries are mainly cement industries around Jaipur.

The State government has started to approach the reform of industrial structure to break away from the dependence to the primary industry. Remarkable growth has been seen in secondary industry after establishment of the new industrial policy in 2003 which enhanced the investment to the large and middle industries. Nowadays, much attention is paid to Rajasthan as an attractive investment state following Maharashtra and Gujarat. The State government is promoting development of industrial laws and infrastructures to attract investment of companies.

7.4 Screening and Categorization

7.4.1 Categorization in the JICA Guidelines

According to the JICA Guidelines, all projects are classified into four (4) categories considering the extent of the environmental and social impacts, scale, site condition, etc.

Table 7.4-1 Categorization of JICA Guidelines

Category	Explanation
A	Proposed projects are classified as Category A if they are likely to have significant 12 adverse impacts on the environment and society. Projects with complicated or unprecedented impacts that are difficult to be assessed or projects with a wide range of impacts or irreversible impacts, are also classified as Category A. These impacts may extend a broader area than the project sites or facilities subject to physical construction. Category A, in principle, includes projects in sensitive sectors, projects that have characteristics that are liable to cause adverse environmental impacts, and projects located in or near sensitive areas.
B	Proposed projects are classified as Category B if their potential adverse impacts on the environment and society are less than those of Category A projects. Generally, they are considered that impacts do not extend out of the project, irreversible impacts are few, and normal mitigation measures can be applied.
C	Proposed projects are classified as Category C if they are likely to give minimal or little adverse impact on the environment and society.
FI	Proposed projects are classified as Category FI if they satisfy all of the following requirements: JICA's funding of the projects is provided to a financial intermediary or executing agency; the selection and appraisal of the sub-projects is substantially undertaken by such an institution only after JICA's approval of the funding, so that the sub-projects cannot be specified prior to JICA's approval of funding (or project appraisal); and those sub-projects are expected to have a potential impact on the environment.

Concerning the social and environmental impacts, the scoping of the proposed project is conducted by using the criteria of the JICA Guidelines and acts regarding EIA in India shown in Section 3.3.3. Finally, based on the results of the scooping study, the proposed project is classified into the above categories.

7.4.2 Categorization of the Proposed Project

(1) Scoping

The results of scoping for the proposed Project are shown below.

Table 7.4-2 Results of the Scoping

Item	Check List	Evaluation		Impact of the Project
		Construction Stage	After Commissioning	
1. Anti-Pollution Measures	Air pollution	C	C	Not Applicable
	Water pollution	C	C	Not Applicable
	Soil pollution	C	C	Not Applicable
	Waste	B	C	Construction wastes are generated at the construction stage.
	Noise and vibrations	B	C	Noise and vibrations due to construction works and heavy equipment are expected at the construction stage.
	Ground subsidence	C	C	Not Applicable
	Offensive odors	C	C	Not Applicable
	Geographical features	C	C	The impact due to construction works of the distribution line is minor.
	Bottom sediment	C	C	Not Applicable
	Polluted area	C	C	The project area is out of the d polluted areas designate by CPCB.
	Accidents	B	B	Traffic accidents due to construction vehicles are expected at the construction stage. Few people on the road are seen in the project area. However there are cattle moving on the road. After commissioning, accidents of electric shocks with transformers which are installed near the consumers are expected.
2. Natural Environ-ment	Protected Area	C	C	There is the Sariska National Park 60 km away from the NIC. However the impacts on the part are not expected because it is far enough.
	Biota and ecosystems	C	C	The main structures constructed in the Project are 33 kV distribution lines of underground cables. Underground cables give less impact on biota and eco-systems than overhead cables. In addition, little impact on biota and eco-systems is expected because the Project area is in the developed industrial area.
	Global warming	C	C	Not Applicable
	Coastal and Sea Area	C	C	As Rajasthan where the project area is located is inland, impacts on coastal and sea area are not expected.
3. Social Environm ent	Involuntary resettlement	B	C	Depending on the 33 kV distribution line route, resettlements of local residents are expected.
	Local economies, such as employment, livelihood, etc.	C	C	Not Applicable
	Land use and utilization of local resources	C	C	The Project area is compartmented as an industrial complex. Therefore impacts on land use would be minimized by planning the wiring route along the compartmented zones appropriately.
	Social institutions such as social infrastructure and local decision-making institutions	C	C	Not Applicable
	Existing social infrastructures and services	C	C	Not Applicable
	Poor, indigenous, or ethnic people	C	C	Not Applicable
	Misdistribution of benefits and damages	C	C	Not Applicable
	Local conflicts of interest	C	C	Not Applicable
	Gender	C	C	Not Applicable
	Children's rights	C	C	Not Applicable
	Infectious diseases such as HIV/AIDS	C	C	Not Applicable
	Cultural heritage	C	C	As the main structures constructed in the Project are 33 kV distribution lines of underground cables, little impact on cultural heritage is expected. There are no officially designated cultural heritage and sightseeing sites around the Project area.
	Scenery	C	C	The main structures constructed in the project are 33 kV distribution lines of underground cables. Underground cables give less impact than overhead cables.
	Border of the State and Country	C	C	Not Applicable

Evaluation A : Serious impacts are expected, B : Some impacts are expected, C : Impact is not expected or minimized.

Fig. 7.4-1 Road Condition in the NIC

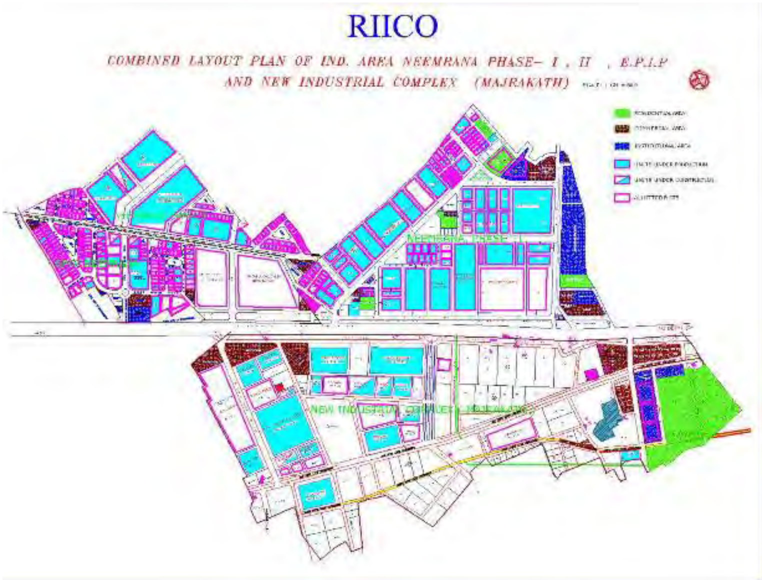


Fig. 7.4-2 Layout of Plots in the NIC

The Project sites are in the industrial area of Shajhanpur, Neemrana, Behror, Sotanala and Keswana in operation and an area of Ghilot under constructing. The expected negative social and environmental impacts caused by this Project are listed below.

1) Construction Stage

Some negative social and environmental impacts caused by the construction works are envisaged at the construction stage. The main structures constructed in the Project are underground 33 kV distribution lines and transformers. The 33 kV distribution lines are laid down below several meters from the ground surface. It is assumed that the transformers are installed on the substations at the industrial areas and near the consumers.

① Waste

As the construction wastes, earth and sands which are from excavation works, debris of asphalts and concretes and packing materials of modules and transformers are envisaged. These wastes are quantitatively limited and less dangerous. Therefore, the appropriate transportation and final disposal of wastes can mitigate the negative social and environmental impacts.

② Noise and Vibrations

The criteria for noises shown below are regulated in "The Environment (Protection) Rules, 1988" in India.

Zone Code	Zone Category	dB (A) Daytime (06:00 - 21:00)	dB (A) Night (21:00 - 06:00)
(A)	Industrial Area	75	70
(B)	Commercial Area	65	55
(C)	Residential Area	55	45
(D)	Silence Zone	50	40

The Project area is categorized as (A) Industrial Area and the noises should be less than 75dB (A) at daytime and 70dB (A) at night. The envisaged noises and vibrations of the Project are arisen from earth works of cable laying and construction vehicles. The earth works are mostly of excavations and back-fillings for cable laying, therefore the large noises and vibrations will not occur. Regarding the construction vehicles, as the frequency of the traffic of heavy vehicles are little, it is assumed that noises and vibrations of the Project will be less than the above criteria. Hence little negative social and environmental impact is envisaged on noises and vibrations.

③ Accidents

Traffic accidents due to construction vehicles are envisaged at the construction stage. Few people are seen on the road at the Project area. However there are cattle moving on the road. Cattle are worshiped as a holy animal in Hinduism and their activities are not restricted. It is reported that vehicles often collide with cattle. Therefore, appropriate mitigations such as installation of temporary fences and hiring of security guards are required to mitigate such accidents due to construction works at the construction stage.

④ **Involuntary Resettlement**

Depending on the wiring route of 33 kV distribution lines, resettlements may be required. Roads and land at the Project area are zoned in the industrial area. There are restaurants and stores along Route No.8, and also buffer zones between Route No.8 and the industrial areas. By planning the wiring route along and in the road and buffer zones, the Project can be undertaken without resettlements.

The transformers, depending on number of the unit, are expected to be installed at the public area near the consumers and inside the substations. Only manufacturers are located along the roads at the industrial areas except the small shops near the entrance of the industrial area, therefore enough space for installation of transformers are secured. Hence, the little social and environmental impact of the Project is envisaged.

2) After Commissioning

After commissioning of the Project, negative environmental and social impacts including the periodical maintenance is expected as shown below.

Accidents
Accidents of electric shocks with transformers which is installed near the consumers are expected after energization of the facilities. As mentioned above, there are few people on the road at the Project area, but cattle moving on the road are seen. Therefore, countermeasures such as installation of fences are required.

(2) Classification of the Category

As the results of the above scoping, envisaged negative social and environmental impacts of the Project mainly occur at the construction stage. The appropriate countermeasures at the construction stage can mitigate the social and environmental impacts.

In addition, the projects on power sector which require the application of the EC in the act concerning the EIA mentioned in Chapter 3 are only river valley projects, thermal power plant projects and nuclear power projects and processing of nuclear fuel as shown in Table 3.3-1. The environmental expert of JVVN expressed the comments that the EC will not be required in the Project, because the Project is new construction of distribution line at the industrial complexes and little negative environmental and social impact is envisaged.

As a conclusion, it is reasonable that the project is classified as Category C in the JICA Guidelines.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

This Study took about five (5) months from the late June in 2011 to the middle of November in 2011 to form the Project in order to improve the electricity infrastructure objected in the Shahjahanpur Development Area including the NIC in Rajasthan and performed the evaluation and analysis on the possibility of application of the Japanese technologies for the solution.

The 12th five-year plan (2012-2017) of Rajasthan State assumes that the installed capacity (75% of total capacity) will exceed the expected electricity demand and the current shortage of power supply will be resolved after FY 2013. MOP and the power companies (generation, transmission and distribution companies) in Rajasthan recognize that the insufficiency of distribution network arrangement is the biggest problem among problems in the generation, transmission and distribution of the electricity.

Currently, power failures due to accidents and schedule have occurred in the transmission and distribution system (11 kV, 33 kV, 132 kV, 220 kV) in the Shahjahanpur Development Area. One record from a Japanese firm shows that the longest electric interruption in the day was 15 hours (total of 3 times on June 1, 2011 and 5 times on June 15, 2011) and the frequency had fluctuation in the range of 49 - 52 Hz and also the voltage in the range of 5 - 6 % based on the record between March 15, 2011 and July 12, 2011 (Refer to Fig 5.2-3).

In consideration of the current problem and the future plan, the improvement of the 33 kV Distribution Network Project in the Shahjahanpur Development Area is proposed as the valuable project. This Project aims to supply highly reliable electricity by new construction and expansion of the 33 kV distribution network. The Japanese technologies such as an Automatic fault detector, a Transformer with automatic voltage regulation, etc. can be applicable for the Project.

As an additional option to the above Project, an automatic distribution operating system including a automatic fault detector is introduced to improve power quality and smart meters are to be installed to secure the accuracy of metering and fairness of billing. They help, as well to reduce the commercial losses of the electricity by identifying the amount and place of leakage and theft of electrical energy. Also, DSM by using the smart meters helps to improve the efficiency of electric utilization. The Japanese technologies such as an operation technology of the automatic distribution operating system, automatic fault detector, and installation and operation technology of smart meter, etc. can be applicable for this Project.

It is recommended that the Project be implemented in 4 phases taking into account of the priority of the development in the Shahjahanpur Development Area (6 industrial areas) for the 33 kV Distribution Network Project. It is recommended that the NIC, where is the highest priority area in the Shahjahanpur Development Area, be developed in the 1st phase and construction cost and schedule for the Project in 1st phase are estimated as follows. On the other hand, construction cost and schedule for the additional option are for the whole Shahjahanpur Development Area.

Table 8.1-1 Approximate Construction Cost and Schedule of the Project

No.	Project Name	Construction Cost (100 million Japanese Yen)	Term (Year)
1	33 kV Distribution System Installation Project	95	5
2	Automatic Distribution Line Operating System Project	20	5

Economical benefits of this Project would be of reducing the losses from economic damage by electric interruption. Each consumer generates the electricity utilizing diesel generator to avoid this damage (averaged duration of power failure in a day is 133 minutes). The operation cost of diesel power generation (including operation and maintenance cost) is about 14 INR/kWh and the Project will bring the economical benefit to reduce the cost down to 5 INR/kWh, which is electricity tariff of JVVN.

The result of economic analysis shows that the IRR is 1.8% and it means the economic value of the Project is low. In order to ensure the JVVN's targeted discount rate of 12%, the following conditions should be satisfied.

♦ The Project scale should be equivalent to the construction cost of about 3.7 billion Japanese Yen (about 39% against 9.5 billion Japanese Yen of total cost).

or

♦ The power generating cost by alternative power source should be around 28 INR/kWh or more (roughly twice as much as 14 INR/kWh).

Financial benefit in this Project for the executing agency (distribution company) will be the increased revenue by sales of additional electricity. The result of financial analysis shows the IRR will be 4.0 and B/C will be 0.28 if the current electricity charge of 5 INR/kWh will go up by 5% every year. It is smaller than JVVN's targeted IRR of 12% and financial efficiency is low. The Project scale shall be equivalent to the construction cost of about 2.74 billion Japanese Yen (about 29% against 9.5 billion Japanese Yen) in order to satisfy the IRR of 12%.

This Project intends to install the new construction and expansion of distribution network in the industrial area, so the anticipated negative impacts to natural and social environments are small. The personnel of JVVN, who is in charge of the environment, said that the Project will not be required to obtain the approval of the EC stipulated in the environmental Acts and Laws in India. It is considered reasonable that this Project is classified into Category C in JICA Guidelines.

In order to facilitate the Project further, it is necessary to implement a feasibility study next. The scopes of the study are shown in the following Section 8.2 Recommendations.

8.2 Recommendations

(1) Follow-up Study for Implementation

F/S is required to implement the Project for the next step. The objective area for the study is the Shahjahanpur Development Area. The scopes of the F/S are described as below.

1) Demand estimate and power development plan in Rajasthan State and the objective area

The 12th five-year plan (2012-2017) of Rajasthan assumes that the installed capacity will exceed the expected electricity demand after FY 2013. The details of power development and transmission plan and the developing status should be evaluated. Also, demand and supply plan of the electricity and its adequacy in the objective areas should be evaluated. Demand and supply of the electricity, demand forecast (kW and kWh), power losses and electrical energy losses in the last 5 years in the objective area should be surveyed.

2) Current situations and problems of distribution system (low-voltage of 415 V, medium-voltage of 33 kV / 11 kV) including sub-stations (11 kV / 415 V and 33 kV / 11 kV) in the objective area

It is necessary to elaborately study the current situations and the plan of the sub-stations and the distribution system (supply capacity, voltage, current, frequency, harmonic, duration and frequency of power failure) in the objective area for more than 1 year, and then identify problems. In addition, it is necessary to collect and evaluate information on problems in consumer's power facilities and capacity shortage.

3) Capacity expansion plan of sub-stations

It is necessary to examine the capacity expansion or new construction of the sub-stations in order to refurbish/strengthen the existing distribution networks. Shortage of future power supply and appropriate distribution network arrangements should be also analyzed, and the reinforcement plan for the sub-stations should be established.

4) Installation plan of distribution line

The situations and locations of existing distribution networks should be studied, and then the installation plan of distribution line to be newly constructed or expanded should be developed.

Introduction of the automatic distribution operating system and installation of smart meter as the additional option will require the following study.

1) Replacement of existing electricity meter

The current situations and problems of the WHmeter should be analyzed, and the evaluation of adequacy and necessity of smart meter should be studied.

2) Formulation of automatic distribution operating system

In order to expand IT (Information Technology) networks in the objective area, software development and hardware installation and operation are required. Those function and system configuration should be specified, and the viability of the introduction should be evaluated.

(2) Considerations for the Distribution Project

1) Prevent repeated construction (or efficient investment)

Future plan is quite unclear because the objective area of this Project is currently developing areas where the ultimate power demand in the area and supply point and power demand of end users are not identified. For such areas, additional power supply equipment works will be necessary in every occasion of individual demand. When the electricity is supplied by the all underground distribution system, the underground system cannot be flexibly adopted to changes encountered. Therefore, if the demand forecast is not appropriate, the construction cost for individual demands will be increased and the frequent construction works will give adverse impacts to environment and/or traffic of the neighboring areas. In order to avoid these kinds of anticipated adverse impacts, a long-term demand forecast and prediction of supply to each user as precise as possible should be essential. In particular, a plan taking into account of the following points should be developed.

a. Figure out a long-term demand forecast and decide the number of outlet holes of conduit from the sub-stations, trunk cabling route and the number of cabling holes.

b. For works in maintenance and recovery from accidents of underground distribution line, installation of manholes is necessary. For the works, it is necessary to secure an installation space for easy entry at proper location. Also, it should try not to install it on traffic road in consideration of the impacts to traffic disturbance.

c. Trunk conduit must be installed cross over main road. This conduit crossing the main road requires high cost for drilling, when installed on the existing road. If the road is still under construction, it enables to install at low cost by excavation works. Therefore, it is important to ensure the number of necessary manholes based on a long-term demand estimate and implement advanced works.

2) Communication disturbance

a. Neutral earthing of the 33 kV system is thought to be direct grounding or low-resistance grounding. When the communication cable is jointly installed in this system, there is a possibility that the communication disturbance will happen due to constant electrostatic induction by power line or electromagnetic induction in case of accident. Thus, it is necessary to design the facility with enough space between power line and communication cable in order to prevent the communication disturbance.

b. In case of underground line, the constant induction such as an overhead distribution lines has never happened. Even in case of accident, the problem is thought to be very few because almost all accidental current flows back through shielding layer. However, when the fault resistance is low and the cable length is short, it is necessary to secure enough space from the communication cable because earth return circuit current will be bigger.

c. Higher harmonics wave will occur because most of loads are from factories in the objective area. And zero-phase-sequence impedance will decline because of long underground lines. For these reasons, the increase of zero-phase voltage by increase of 3n higher harmonics wave is possibly considered. When overhead distribution lines and underground system exist in the same bank, there is a possibility that the induced voltage to communication cable will increase by the 3n higher harmonics wave as mentioned above.

3) Maintenance efficiency

a. Accident detection and restoration for all underground distribution system require lots of efforts. If the equipment is a direct burying system, it is difficult to investigate the location and cause of incident. And in some cases, excavating works will take a process of trial and error. This will have a big social impact, so it would be desirable to adopt a conduit system at least for the main trunk in order to correspond the accident.

b. Manholes (or pits) will be necessary for maintenance under normal operation other than the case of accident. In this case, manholes (or pits) should be designed on the place where the entrance into the manhole will not disturb the traffic.

c. If a direct burying system is applied for the installation of cables, excavation works will be necessary to implement the above maintenance works. In this instance, to prevent any meaningless works, equipment has to be installed at the precise location and the accurate administrative information (layout drawing, etc.) should be prepared and stored. Also, this is important for the power utilities to avoid the effect from other infrastructure works.

4) Public security

a. When 33 kV overhead distribution line is installed in urban areas, enough installation space shall be secured between the structure such as house building and the charger part. And the cable such as electrical insulated wire, etc. must be utilized to prevent potential electrical shock at contact with the other things.

b. Rising in electrical potential itself and rising in electrical potential of surrounding lands would become a problem at equipment failure when ground-based equipment will be installed in the 33 kV underground distribution system. Rising in electrical potential of the outer casing of the equipment and step voltage must be controlled to safety level in order to prevent public from any potential electrical shock around the equipment. Rising in electrical potential of the outer casing of the equipment by coordinating should be controlled to be within the range between the neutral grounding resistance and the equipment grounding resistance.

c. Arcing due to cable accidents may occur and burst to the ground, if 33 kV cable is installed into the trough. The depth to install the trough and the protective measure against arcing must be carefully designed in order to prevent any effects to the public in urban area. And the influence of arcing to the other facilities closely arranged near the line must also be paid attention. Therefore, when the underground line is installed nearby the other underground line or the weak electric current line, the following measurements should be taken; put the underground line into a secure inflammable pipe, ensure enough space from those cable or line, or install a firewall in between.

(3) Recommendation for Project Implementation

Two (2) kinds of technology such as Automatic fault detection system and Transformer with automatic voltage regulation, etc. have a highly potential to be applied as Japanese technologies for the distribution arrangement project. Especially, the automatic fault detection system in the distribution system is effective to establish an automatic distribution line operating system and be expected as a Japanese technology to improve the quality of power.

In order to apply Japanese technologies for the distribution arrangement project, it is necessary that the advantages and effects of Japanese technologies must be understood by the Indian government and related organization such as JVVN, RVPN and RIICO. The training specializing in Japanese technologies would be effective. Visiting the distribution facilities of Japanese power companies and taking a look at their operation system will help to enhance their understanding. If participants can see the automatic recovering process visually by a computer simulation, they can deeply understand the advantages and worth of Japanese technologies.

Moreover, it is recommended that, by dispatching technical advisors to JVVN, the further study for 33 kV distribution arrangement project in the Shahjahanpur Development Area be instructed and Japanese technologies be positively introduced. In addition, investigations to expand 33 kV distribution arrangement project and Japanese technologies to the other industrial complex are also in the charge of the advisors.

Installation of the automatic distribution operating system as well as smart meter is an additional option to 33 kV distribution arrangement project. The Project, which is expected to control electrical supply and demand, will be effective when a photovoltaic power generation system will be installed into this area and connected the grid in the future. However, it should be considered to explore the applicability to India upon the evaluation of the results of demonstrative tests currently being implemented in four areas in Japan. The technical cooperation for the additional option should be also required for the purpose accordingly.

In India, high rate of distribution losses of approximately 30% in the urban area becomes a problem. Reducing the distribution losses by improving the operation system of the distribution network would be a big challenge for the Indian government. To facilitate the Project, it is desirable to develop a business model which can enjoy the benefit with JVVN utilizing technologies and fund from private sector by using PPP scheme. If succeeded, this model can be applied to the other area.

Appendix

Appendix 1　List of Parties Concerned

Appendix 2　List of Collected Data

APPENDIX 1

LIST OF PARTIES CONCERNED

Appendix1: List of Parties Concerned

Ministry of Energy

Mr. Shri Alok	Director

Energy Department Government of Rajasthan

Mr. Naresh Pal GANGWAR	Secretary of Power

JAIPUR VIDYUT VITRAN NIGAM LTD (JVVN)

Mr. Sudhansh Pant	Chairman of JVVN
Mr. A.K.Gupta	Director Technical
Mr. C. S. Chandalia	MBA Director (Power Trading)
Mr. Anand Joshi	Director Finance
Mr. S.K. Gupta	Superintending Engineer (Plan)
Mr. Sanjay Lad	Engineer
Mr. R.K. Dixit	Superintending Engineer, Alwar Office

Rajasthan Rajya Vidyut Prasaran Nigam Ltd.(RVPN)

Mr. Y. K. Raizada	Director of Technical
Mr. T. S. Sharma	Senior Engineer
Mr. L.N. Nimawat	Superintending Engineer (P&P)
Mr. D. K. Sharma	Executive Engineer of Neemrana 220kv GSS
Mr. B. B. Sharma	Assistant Engineer of Neemrana 220kv GSS

Rajasthan Rajya Vidyut Utpadan Nigam Ltd.(RVUN)

Mr. Devesh Gupta	Assistant Engineer, Project Planning
Mr. Shin Prapash Sharma	Assistant Engineer, Project Planning

Rajasthan State Industrial Development & Investment Corporation Ltd. (RIICO)

Mr. ANIL SHARMA	General Manager (Marketing)
Mr. D. P. Gupta	Superintending Engineer (power)
Mr. R. C. Jain	Neemrana Regional Office Manager
Mr. S.C. Garg	Regional Manager

Embassy of Japan

Mr. Yasujiro MIYAKE	First Secretary

JETRO	
Hiroshi DAIKOKU	BSC Advisor
NEDO	
Mr. Iwao MIYAMOTO	Chief Representative
JICA	
Mr. Kazuyoshi OHNUMA	Representative
Ms. Shashi Khanna	Senior Development Specialist

APPENDIX 2

LIST OF COLLECTED DATA

Appendix 2 : List of Collected Data and Documents

(Project Formulation Guidance for Improvement of Power Infrastructure in Urban Area of Rajasthan)

Power Sector

No.	Title （URL: Uniform Resource Locator）	Form	Original/ Copy	Released by	Published Year
1	National Electricity Policy (http://www.powermin.nic.in/whats_new/national_electricity_policy.htm)	Electronic Data	Copy	MOP	2005
2	National Tariff Policy (http://www.powermin.nic.in/whats_new/pdf/Tariff_Policy.pdf)	Electronic Data	Copy	MOP	2006
3	Electricity Act 2003 in India	Booklet	Copy	MOP	2003
4	Rajasthan Power Sector reforms policy statement 1999 http://www.rajenergy.com/polstat99.htm	Electronic Data	Copy	DOE	1999
5	Power map of Rajasthan http://www.rajenergy.com/	Electronic Data	Copy	DOE	2011
6	Power Map of NCR Area	Print A3	Copy	RVPN	2011
7	Power Map of Alwar District	Print A3	Copy	JVVN	2011
8	List of MIP Consumers in Industrial Area	Print A4	Copy	JVVN	2011
9	Unit cost of JVVN facilities	Print A4	Copy	JVVN	2011
10	Installed Capacity of Generating Projects Connected to the RVPN Grid Including Allocation of Central Sector Projects as on 30 June-11	Print A4	Copy	RVUN	2011
11	Status of Power Projects likely to be Commissioned during XII-Plan（2012-2013 to 2016-2017)	Print A4	Copy	RVUN	2011

Appendix 2 : List of Collected Data and Documents

(Project Formulation Guidance for Improvement of Power Infrastructure in Urban Area of Rajasthan)

No.	Title （URL: Uniform Resource Locator）	Form	Original/ Copy	Released by	Published Year
12	11th Plan state sector & private sector Power Projects	Print A4	Copy	RVUN	2011
13	12th Plan state sector & private sector Power Projects	Print A4	Copy	RVUN	2011
14	Installed Capacity at the end of IX-Plan, X-Plan, XI-Plan (MW)	Print A4	Copy	RVUN	2011
15	Progress of the Loss Reduction Program	Print A4	Copy	JVVN	2011
16	Power Distribution Reforms in Rajasthan	Print A4	Copy	JVVN	2011
17	Tarrif for Supply of Electricity 2004	Booklet	Copy	JVVN	2011
18	Terms and Conditions for Supply of Electricity-2004	Booklet	Copy	JVVN	2011
19	JVVN Annual Report	Booklet	Copy	JVVN	2011

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(Project Formulation Guidance for Improvement of Power Infrastructure in Urban Area of Rajasthan)

Industrial Sector

No.	Title （URL: Uniform Resource Locator）	Form	Original/ Copy	Released by	Published Year
1	Investment Policy 2010 (http://www.riico.co.in/investment_policy_2010.pdf)	Electronic Data	Copy	RIICO	2010
2	SEZ Policy 2003 (http://www.riico.co.in/SEZ%20Policy%202003.PDF)	Electronic Data	Copy	RIICO	2003
3	REVISED LAYOUT PLAN OF VIGYAN NAGAR INDUATRIAL COMPLEX SHAHJAHANPUR DISTRICT	Print A3	Copy	RIICO	2011
4	LAYOUT PLAN OF INDUSTRIAL AREA NEEMRANA	Print A2	Copy	RIICO	2011
5	SNB Proposed Land Use Plan	Print A2	Copy	RIICO	2011
6	LAYOUT PLAN OF INDUSTRIAL AREA SOTA NALA VILLAGE	Print A1	Copy	RIICO	2011
7	Map of KESWANA	Print A1	Copy	RIICO	2011
8	Map of Ghilot	Print A4	Copy	RIICO	2011
9	Neemrana General Information and Infrastructural Facilities	Print A4	Copy	RIICO	2011
10	Industrial Land in Rajasthan	Booklet	Copy	RIICO	2011

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(Project Formulation Guidance for Improvement of Power Infrastructure in Urban Area of Rajasthan)

No.	Title （URL: Uniform Resource Locator）	Form	Original/ Copy	Released by	Published Year
11	Statistical Abstract 2011 in Rajasthan	Booklet	Copy	Rajasthan State Government	2011

Enviromental Sector

No.	Title （URL: Uniform Resource Locator）	Form	Original/ Copy	Released by	Published Year
1	The Environmental Protection Act	Booklet	Copy	MOEF	2007
2	EIA-Notification so1533 http://moef.nic.in/legis/eia/so1533.pdf	Electronic Data	Copy	Department of Environment	2006
3	Rajasthan State Environment Policy 2010 http://environment.rajasthan.gov.in/Utilites/Upload/Environment_policy/environment_policy.pdf	Electronic Data	Copy	Department of Environment	2010

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