Analysis on Indian Power Supply Situation and Policies

National Expansion of Successful Electric Power Reform "Gujarat State Model"

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Summary

India features robust demand for the development of infrastructure including electric power and is expected to drive the world economy as a manufacturing base and a giant market. However, about 240 million people, close to one-fifth of the Indian population, live without electric power. Blackouts are frequent, indicating an unstable electric power supply environment. Narendra Modi, who was elected India's 18th prime minister in May 2014, has vowed to supply electric power 24 hours a day, seven days a week, indicating his determination to promote domestic electric power development. Cited as the largest factor behind his election as prime minister are an electric power reform and other successful policies in Gujarat state when he served as the state's chief minister from 2001 to 2014. Particularly, the electric power reform is called the Gujarat state model, gaining high ratings. In response to people's strong wish to see the expansion of the reform's fruits throughout India, Prime Minister Modi is now tackling the national expansion of the reform. Stable power supply is such an important policy challenge supporting national development.

In this paper, Chapter 1 reviews India's present situation and future outlook regarding economy, energy, electric power supply and demand, and an existing supply-demand gap. Chapter 2 summarizes India's present electric power business arrangements, power supply conditions and numerous challenges facing India. Chapter 3 analyzes the Gujarat state model cited in the subtitle, delving into the electric power reform that Modi as chief minister of Gujarat state promoted to eliminate blackouts and into the reform's fruits such as electric power quality improvements.

Finally, Chapters 4 and 5 analyze private companies' participation in power generation and distribution through the recent electric power reform, focusing on overviews and business conditions of three Indian private sector electric power companies (Tata Power, Reliance Power and Torrent Power) and the effects of their participation.

Improvement effects of these private power companies' efforts to achieve power quality improvements such as the reduction of power losses and an increase in power supply efficiency along with federal and state companies have been confirmed in various areas. These effects contribute to upgrading living standards for many Indian people still left in a disadvantageous electric power environment. Great hopes are placed on their roles and further improvements in the future.

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Introduction

The Indian population stood at 1,316.89 million as of January 2017, coming close to the 1,390.84 million in China[1]. India is expected to replace China as the most populous country in the world by 2020 at the latest. In 2050, the Indian population is projected to reach 1.7 billion. While China is transforming itself from the world's factory into a giant consumer in line with income growth in the wake of economic growth, India has robust demand for the development of infrastructure including electric power and is expected to drive the world economy as a manufacturing base and a giant market. Narendra Modi, who was elected as India's 18th prime minister in May 2014, has vowed to supply electric power 24 hours a day, seven days a week, indicating his determination to promote domestic electric power development.

Under the 12th five-year Plan (April 2012-March 2017), India invested 56 trillion rupees (about 97 trillion yen) in infrastructure development. The electric power sector accounted for 18 trillion rupees or one-third of the infrastructure development investment[2]. To electrify unelectrified regions where about 240 million people, close to one-fifth of the Indian population, live without electric power and eliminate frequent blackouts emerging from power shortages, India is tackling various electric policy power reform measures.

A factor behind the government-given priority for electric power policies is that economic growth is expected to accelerate in line with an increase in power consumption. Infrastructure development in underdeveloped or unelectrified regions would help to diffuse daily necessities such as fluorescent and light-emitting diode lamps and create new demand for electrical appliances such as washing machines and air conditioners. As these electrical products diffuse, power consumption would increase, with consumption and commercial operations being invigorated to accelerate economic growth. As electric power quality is improved with power supply stabilized, India could promote manufacturing and attract foreign companies. For these reasons, the Indian government gives priority to electric power policies.

In India, the federal government takes legislative and other procedures to pave the way for the electric power reform and leaves state governments to implement the reform, leading the degrees of progress in the reform to differ from state to state. Gujarat state, which was viewed as the most successful state in India for the electric power reform, took the initiative to implement multi-faceted institutional reform measures for the electric power sector as devised by the Ministry of Power (MOP) in line with the 2003 Electricity Act to eliminate blackouts. Gujarat state substantially reduced power losses and served as a model for preventing power theft. As a result of the 2014 federal House of Representatives election, Modi was elected as the 18th Indian prime minister thanks to his successful policies during his fourth term as chief minister of Gujarat state, including the electric power reform touted as the Gujarat state model. He served the Gujarat state post from 2001 through 2014.

Behind the birth of the Modi administration in 2014, people reportedly placed great hopes on Modi who was born in a poor family in a small town with a population of 30,000, served as a seller of chai spiced tea and a field worker, accumulated a wide range of experiences in the Bharatiya Janata Party (Indian People's Party) at state and federal levels and conducted clean political management free from corruption. In addition, people had a strong wish to see the expansion of the Gujarat electric power reform throughout India. Stable power supply is such an important policy challenge supporting national development.

This paper summarizes India's electric power supply situation and current relevant challenges and analyzes and assesses Gujarat state's forerunning electric power reform initiatives and their achievements. It also considers Indian electric power policies modeled after Gujarat state's policies, focusing on overviews and the business performances of private sector electric companies participating in the power sector and the power environment's improvements brought about through the participation.

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[1] China's population of 1,390.848 million was as of January 28, 2017, and India's population of 1,316.896 million as of January 25, 2017. Source: IMF World Economic Outlook Database
(Source) IMF World Economic Outlook Database

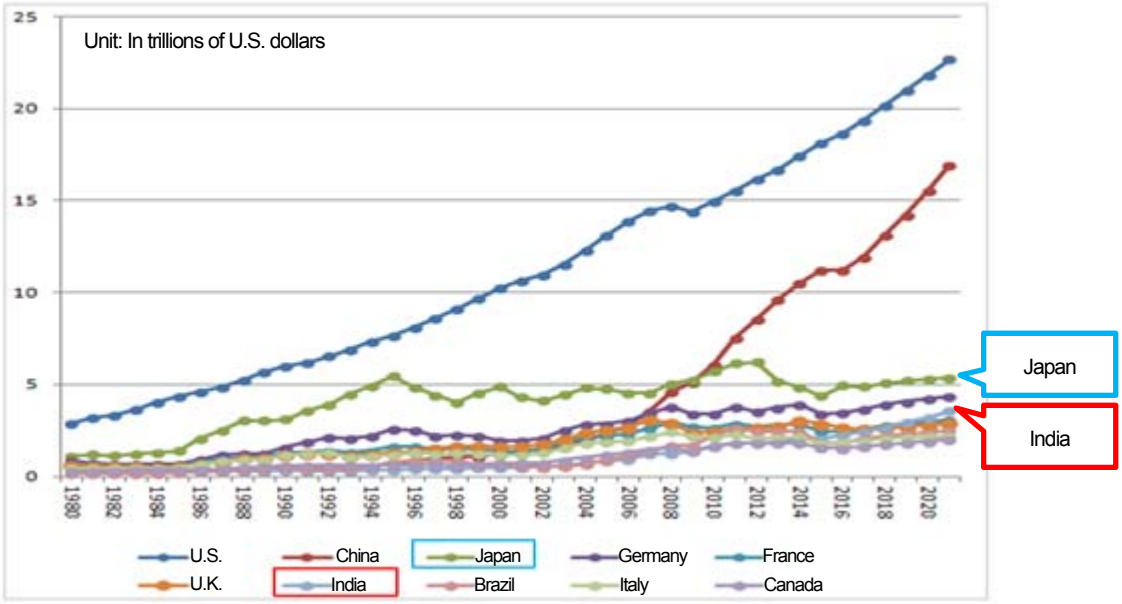
[2] Exchange rate: 1 rupee = 1.7407 yen (average in January 2018)

1. India's present situation and future outlook

1-1 Economy and energy demand

1-1-1 Comparison with other major countries

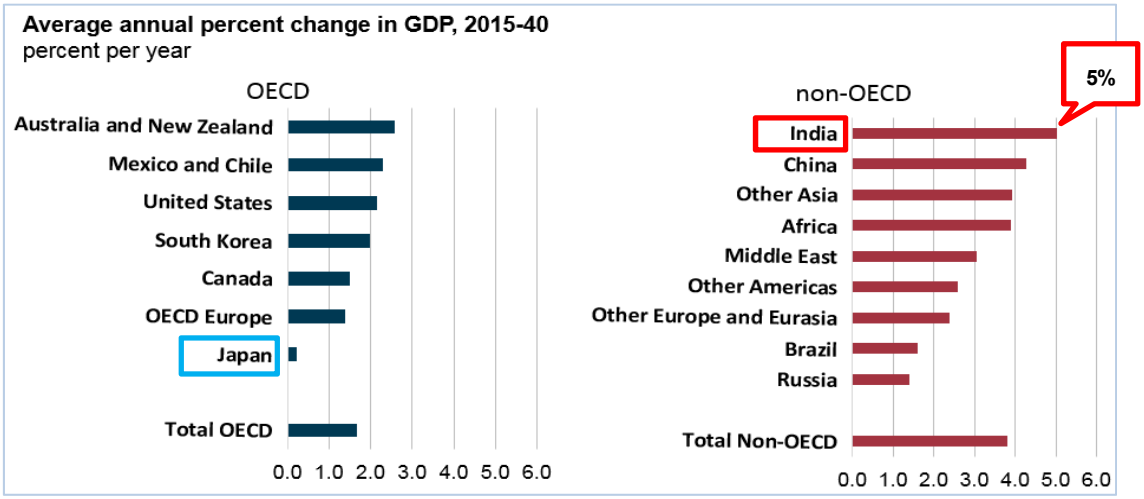
Figure 1-1 Nominal GDP trends in major countries (1980-2020) [*including IMF projections]



(Source) IMF World Economic Outlook Databases

First, we would like to check Indian economic conditions. Figure 1-1 indicates nominal gross domestic product (GDP) trends in major countries as published by the International Monetary Fund (IMF) in October 2016. India's nominal GDP[3] totaled $2.6 trillion in 2016, the seventh highest level in the world, and is predicted to surpass the U.K. and French GDP to become the fifth highest by 2020.

Figure 1-2 Projected GDP growth in major countries (2015-2040)



(Source) U.S EIA International Energy Outlook 2017

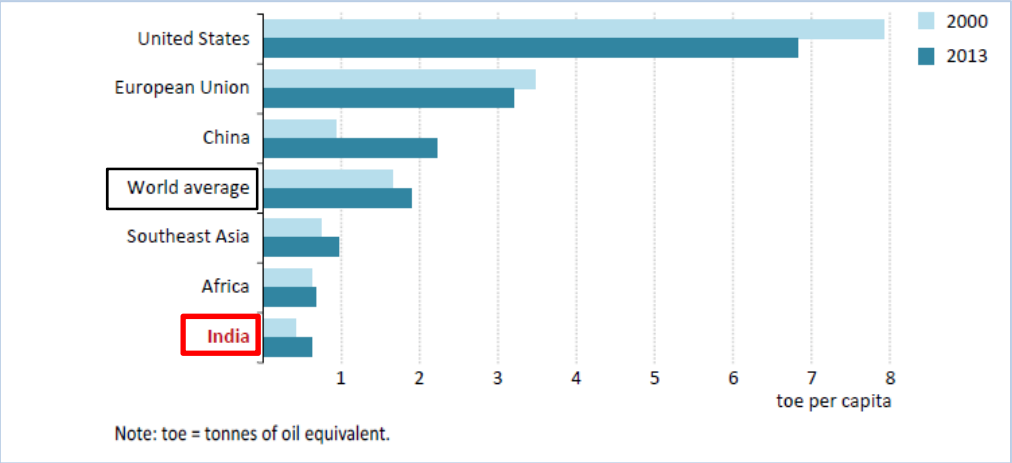
[3] Based on nominal GDP published by the IMF annually for a total of 191 countries. GDP is total value added excluding material and other intermediate input costs from output of goods and services through domestic production operations. Each year's average exchange rates are used for converting GDP into U.S. dollars.

Economic growth in India stood at 7.9% in 2015 and 6.8% in 2016. While China has been decelerating economic growth from remarkably high levels several years ago, India is expected to accelerate economic growth from 7.2% in 2017 to 7.7% in 2018. Indian GDP is projected to double in 10 years if annual growth remains at 7%.

Figure 1-2 represents data published by the U.S. Energy Information Administration, indicating average annual economic growth rates for the members of the Organization for Economic Cooperation and Development (OECD) and non-OECD countries. India among non-OECD countries is projected to record the highest average growth rate of 5% to drive global economic growth.

1-1-2 Present status of energy consumption

Figure 1-3 Comparison of per capita energy consumption between India and other economies (2000-2013)

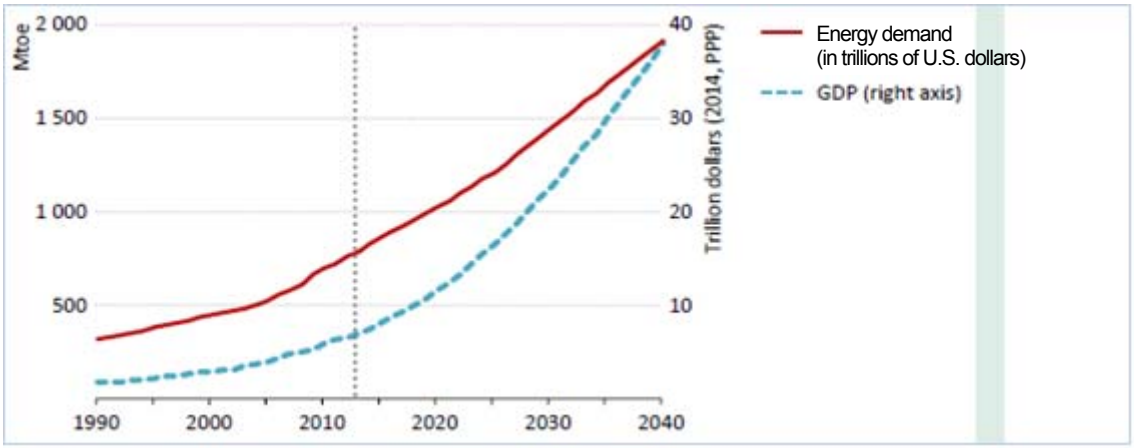


(Source) OECD/IEA India Energy Outlook 2015

While India continued remarkable economic growth, its per capita energy consumption, though increasing from 2000 to 2013, was far lower than the world average and only about one-10th of the U.S. level at the top, indicating that India is still a developing country.

1-1-3 Energy demand accompanying economic growth

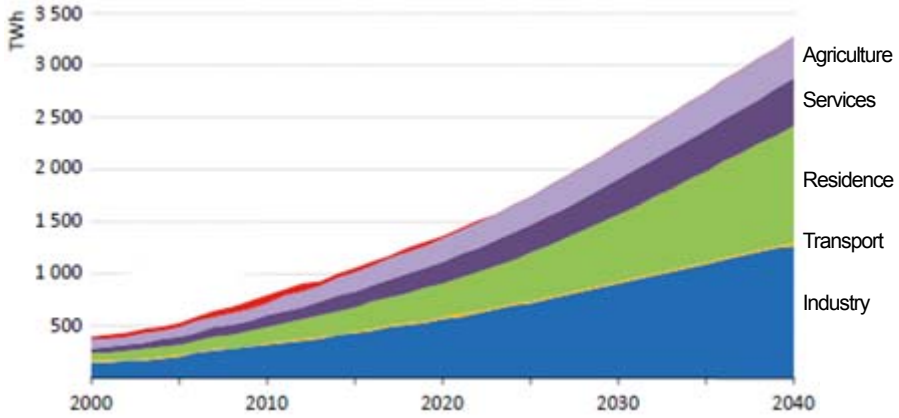
Figure 1-4 Indian GDP and energy demand trends (1990-2040) [*including IEA projections]



(Source) OECD/IEA India Energy Outlook 2015

Figure 1-4 shows actual Indian GDP and energy demand growth from 1990 to 2013 and projected growth through 2040. A long-term outlook by the International Energy Agency (IEA) predicts that India's energy demand would increase at an annual pace of 4.5% through 2040 to account for a quarter of global energy consumption.

Figure 1-5 Indian electric power demand trends [by sector] (2000-2040) [*including IEA projections]

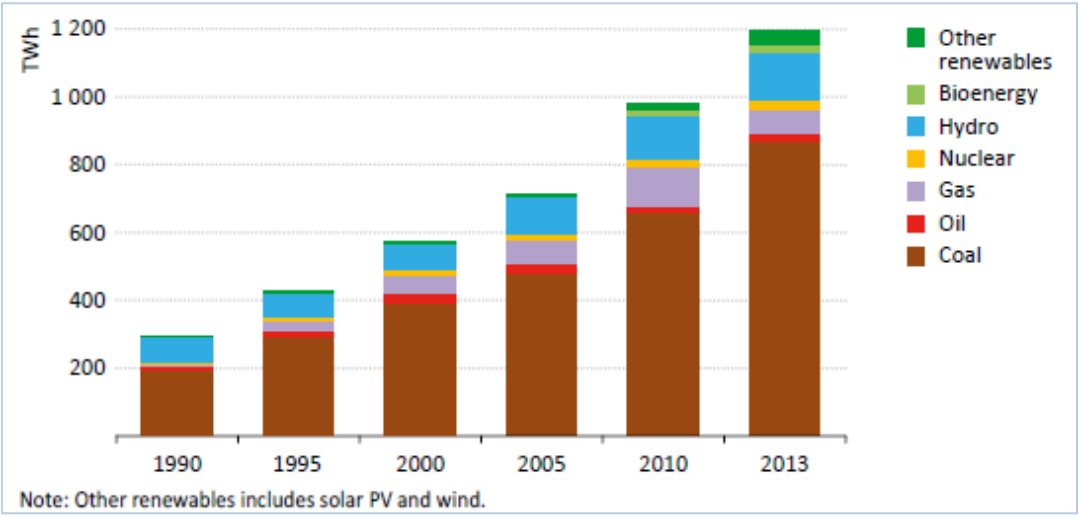


(Source) OECD/IEA India Energy Outlook 2015

Out of energy demand, electric power is projected to increase eight-fold in 40 years through 2040, as indicated by Figure 1-5. By sector, residence and industry sectors are expected to boost power demand very rapidly.

1-2 Present status of power supply and demand, and supply-demand gap

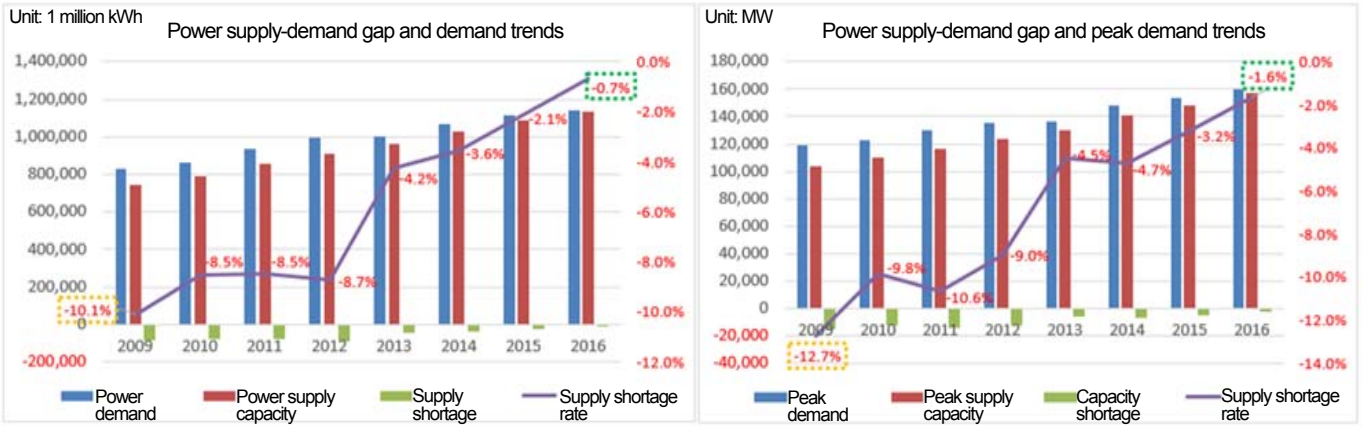
Figure 1-6 Indian electric power generation trends by source (1990-2013)



(Source) OECD/IEA India Energy Outlook 2015

While electric power demand increased substantially due to economic and population growth and urbanization from 1980, power plant construction failed to catch up with power demand growth, resulting in frequent power supply restrictions that affected economic growth. Figure 1-6 shows electric power generation trends from 1990, indicating that coal and other large power plants increased. India's power generation thus almost quadrupled in 13 years.

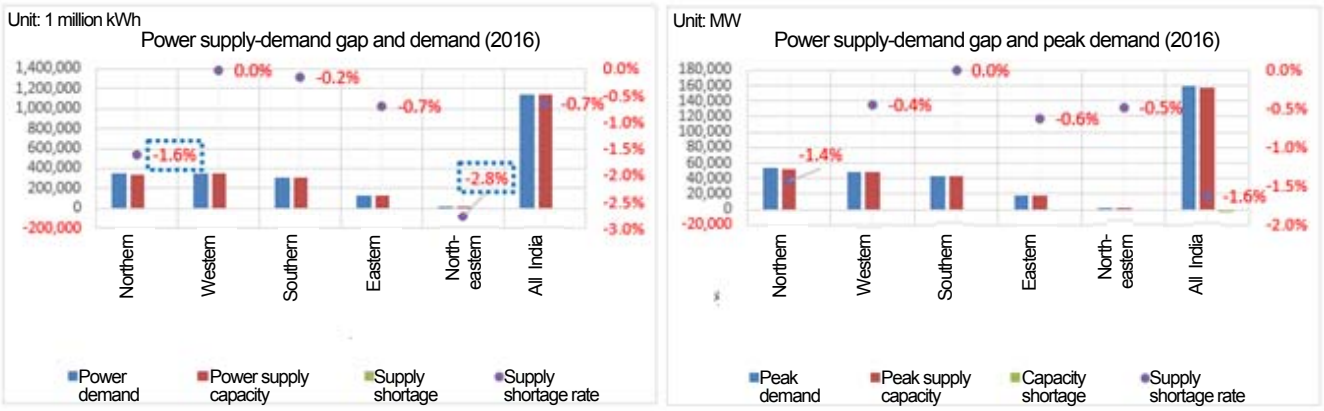
Figure 1-7 Indian power supply-demand gap (power generation capacity/peak power demand) trends (2009-2016)



(Source) Prepared by the author from the Ministry of Power of India (MOP) website

Figure 1-7 indicates power supply-demand gap trends for demand (demand and supply capacity) and peak demand (peak demand and supply capacity). As of 2009, the shortage rate stood at 10.1% for ordinary demand and 12.7% for peak demand. In 2016, however, the rates narrowed to 0.7% and 1.6%, respectively. Power plant shortages under growing demand have thus been resolved in recent years.

Figure 1-8 Power supply-demand gap (demand and peak demand) (2016)

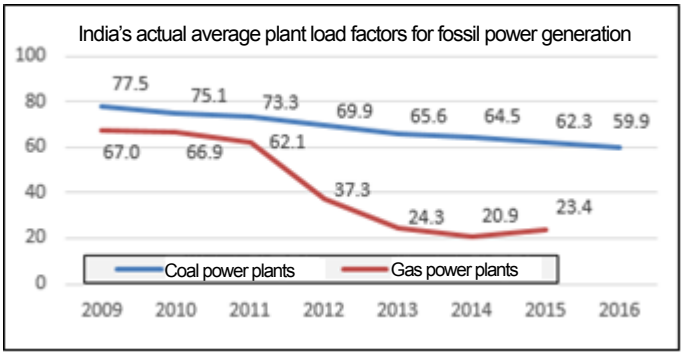


(Source) Prepared by the author from Central Electricity Authority of India (CEA) Annual Report and Hindu (http://www.thehindu.com)

By region (northern, western, southern, eastern and north-eastern regions), however, the supply-demand gap (demand/supply capacity) in 2016 stood at -1.6% for the northern region where demand was growing and at -2.8% for the north-eastern region where electric power development was lagging, indicating supply shortages. India is thus required to eliminate the gap on a region-by-region basis.

Electric power supply and demand here are for regions where power systems including transmission and distribution lines are in place to provide power to users. Attention should be paid to the point that power demand data do not cover unelectrified regions where power transmission or distribution lines do not exist.

Figure 1-9 India's average fossil power plant load factor (%) trend (2009-2016)



(Source) Prepared by the author from "Power Sector at a Glance ALL INDIA" on the Ministry of Power of India website

Figure 1-9 shows average plant load factors (PLFs)[4] for fossil power generation in India. Average PLFs have followed a downtrend. Particularly, the average PLF for coal power plants was below 60% in 2016[5]. The average PLF for gas power generation remained below 30% from 2013, indicating that gas power generation was limited[6]. While power source development has made progress with power plant shortages eliminated in India, sufficient power transmission and distribution lines have failed to be developed for power supply. This is the reason people accounting for one-fifth of India's population are forced to live without electric power mainly in rural regions. It must be recognized that some real electric power demand has failed to be statistically visible or met. India has more than 100 power transmission line construction projects[7] that have failed to make smooth progress due to delays in land expropriation and state government approval procedures. India is thus required to correct electric power environment gaps between regions.

The following chapters review India's electric power situation and policies in the past and delve into challenges facing the country.

[4] The plant load factor (PLF) is the ratio of a power plant's output to its total capacity, indicating how effectively a power plant is operated.
PLF (%) = Annual power output (kWh/year) / (annual hours (365 days x 24 hours) x capacity (kW) x 100 (%)

[5] There are two reasons for the falling PLF for coal power plants. First, there were coal supply shortages between 2013 and 2015. Second, power demand was not as high as planned. Renewable energy power generation increased amid a power demand decrease, resulting in a decline in output from coal power plants.

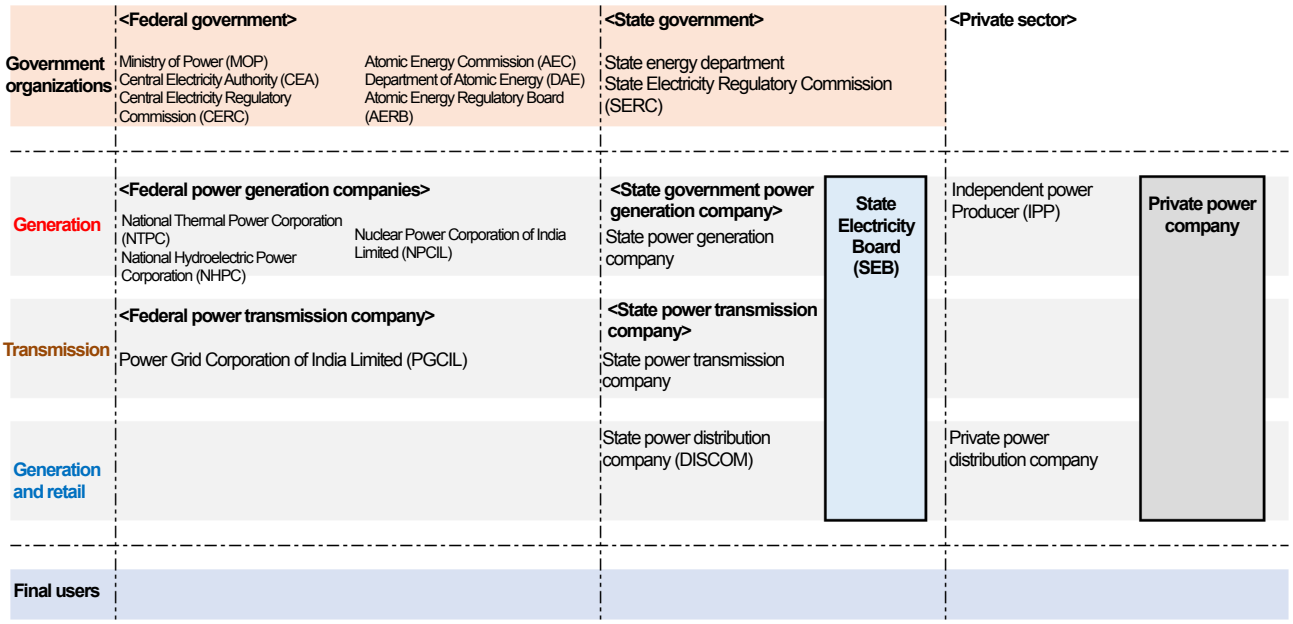
[6] Power generation companies have limited power plant operations in the absence of power procurement offers from power distribution companies since 2013. As power distributors have no interest in purchasing power from high-cost gas power plants rather than low-cost coal power plants, the PLF for gas power plants is unlikely to increase unless gas prices in India decline.

[7] (Source) CEA, National Electricity Plan (Vol-II) Transmission, 2016
7.8 EXPECTED TRANSMISSION SYSTEM ADDITION DURING 13TH PLAN (i.e. 2017 – 22)

2. India's electric power situation

2.1 India's electric power business system

Figure 2-1 India's federal/state/private electric power business system



(Source) Prepared by the author from information from the Ministry of Power of India (MOP), Government of India Department of Atomic Energy, etc.

Figure 2-1 illustrates India's electric power business system covering the federal and state governments and the private sector. At present, the federal government makes national policies and undertakes interstate power transmission and generation (nuclear, hydro and thermal) businesses. Each state government conducts state policy planning, and power generation, transmission and distribution businesses. Each state government has freedom to make and implement electric power and renewable energy policies, although its engagement in federal nuclear and coal policies is restricted. Details of the private sector are discussed in Chapter 4 and later chapters.

Since its transition to a free market economy in the 1990s, India has implemented an electric power sector reform including liberalization and deregulation, as have Western developed countries. Specific reform measures include independent power producers' (IPPs') participation in power generation, the privatization of State Electricity Boards (SEBs), the opening of power transmission and distribution networks and the development of an electricity tariff system.

The Electricity Act 2003[8], enacted in February 2003, triggered a full-blown power sector reform by separating the power transmission sector from the SEBs to promote competition and efficiency to protect consumer interests. The SEBs had monopolized the power sector covering power generation, transmission, distribution and trade. The comprehensive act called for not only the SEB breakup but also each state's obligation to establish the State Electricity Regulatory Commission (SERC), the abolition of a licensing system for non-hydro power generation, the implementation of open access and the rectification of the electricity tariff system, leaving each state to implement these measures. As the chief state minister has great influence on policies

[8] The act took effect in June 2003, combining existing laws on power generation, transmission, distribution, trade and use and providing for burden sharing between federal and state governments, the promotion of separation between power generation and transmission and the expansion of renewable energy use.
It provides for the federal government to determine and verify national electricity measures and a power rate policy in cooperation with state governments and the CEA, to establish regulatory organizations (State Electricity Regulatory Commissions) under its umbrella, and to set up national and regional load dispatch centers and a special court for power theft. The act cites the reorganization of the State Electricity Boards (SEBs) for power distribution into state power transmission, generation and distribution companies as a key role of state governments.

in each state, some states have proactively implemented the SEB breakup and privatization, with some other states leaving their SEBs effectively untouched. Degrees of progress in the power sector reform thus differ from state to state[9].

The act also provides for the Central Electricity Authority (CEA) under the umbrella of the Ministry of Power (MOP) to give power policy advice to the federal government and serve as a technical power grid coordinator to work out power grid development plans and play coordination roles. Specifically, the CEA is designed 1) to set technological standards for constructing power plants, building power grids and connecting grids, 2) to determine safety requirements for the construction, operation and maintenance of power plants and grids, 3) to establish grid standards for the operation and maintenance of power transmission networks, 4) to fix conditions for the installation of power transmission and distribution meters, 5) to collect and record data regarding power generation, transmission, trade, distribution and consumption, and 6) to survey costs, efficiency and competitiveness.

The National Electricity Policy[10], published in 2005, called for promoting 1) the electrification of rural areas, 2) the expansion of power generation capacity by 100,000 MW, 3) competition through international bidding and the private sector's participation in power businesses, 4) the recovery of supply costs and the payment of subsidies to poorest people, 5) the expansion of national and state grids through cooperation between the Central Electricity Regulatory Commission (CERC) and the State Electricity Regulatory Commissions (SERCs) and 6) the improvement of power distribution projects disregarding profitability.

In 2010, Power System Operation Corporation Limited (POSOCO) [11] was set up as a subsidiary of Power Grid Corporation of India Limited (PGCIL) to operate the central power supply command for coordination between regional grids on a nationwide basis.

[9] While the State Energy Regulatory Commission is designed to determine an electricity tariff system, its determination has no legal binding power and fails to be implemented thoroughly. Effectively, chief state ministers give political considerations to electricity tariff systems. As about 70% of Indian people live in rural areas, any hike in tariffs for agricultural power consumption has the potential to bring about massive vote losses in rural areas in future elections. Therefore, chief state ministers tend to cut or eliminate agricultural electricity tariffs in consideration of elections.

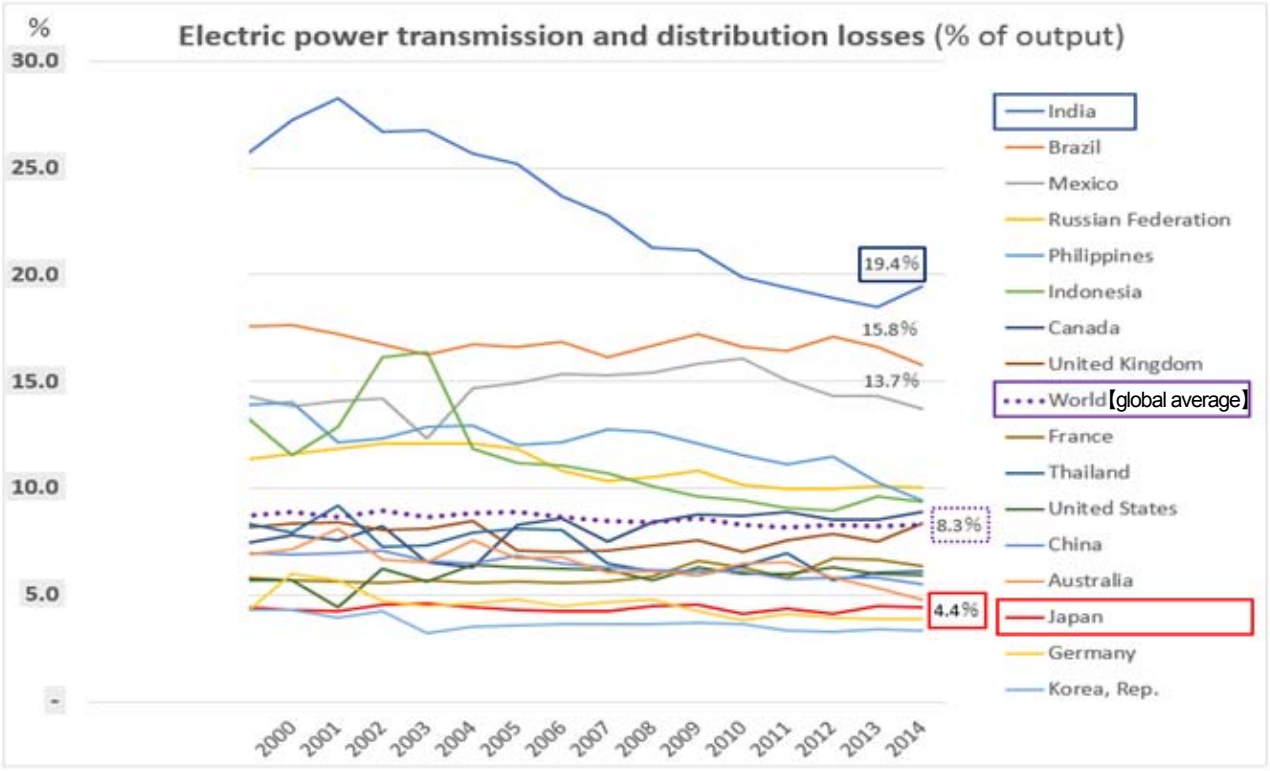
[10] In the National Electricity Policy implemented from February 2005, the federal government clarified the following objectives of the policy:
(1) Access to electricity available for all households in the next five years.
(2) Availability of power demand to be fully met by 2012. Energy and peaking shortages to be overcome and spinning reserve to be available.
(3) Supply of reliable and quality power of specified standards in an efficient manner and at reasonable tariffs.
(4) Financial turnaround and commercial viability of electricity sector.

[11] POSOCO has jurisdiction over central and regional power supply commands, with state power supply commands controlled by state governments. Power system operation is put under a three-layer hierarchy, in which the central power supply command controls five regional commands that lead 33 state commands.

2.2 India's electric power situation and challenges

2-2-1 Reduction of power losses

Figure 2-2 Power T&D loss trends in major countries (2000-2040)

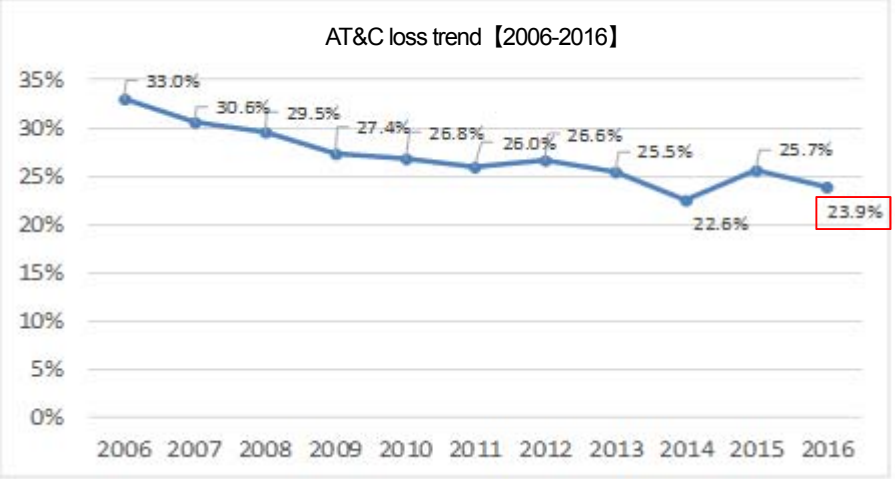


(Source) Prepared by the author, based on IEA Statistics © OECD/IEA 2014 Electric power transmission and distribution losses

Figure 2-2 indicates power transmission and distribution (T&D) loss[12] rate trends in India and other major countries as picked up from IEA statistics. While the global average T&D loss rate remained around 8% from 1996, the rate in India stayed far higher than in other countries. The Indian T&D loss rate rose close to 28% in the first half of 2000 and followed a downtrend after the 2003 electric power reform. In 2014, however, it stood at 19.4%, the highest in the world. Behind the high T&D loss rate in India is the fact that India has more technical and commercial problems than other countries. Technical problems include heat losses in the power supply process. Among commercial problems are wrong metering and power theft.

[12] T& D Losses (Transmission & Distribution losses) = { 1- (Total energy Billed / Total energy Input in the system)} x 100

Figure 2-3 AT&C loss trend in India (2006-2016)



(Source) REPORT ON "The Performance of State Power Utilities for the years"
Power Finance Corporation Ltd. (A Govt. of India Undertaking)

In addition to the T&D loss, India uses the aggregate technical and commercial (AT&C) loss[13] combining the billing efficiency regarding power theft, metering errors, falsified meter values, the absence of meters and meter readers' wrong records with the electricity rate collection efficiency involving unpaid power bills. As shown in Figure 2-3, the AT&C loss rate in 2015-16 stood at 23.9%. Behind the high AT&C loss rate are poor management and inefficient business operations at state power distribution companies (DISCOMs). India is thus required to introduce billing through metering using information technology and a prepaid billing system to improve electricity rate collection.

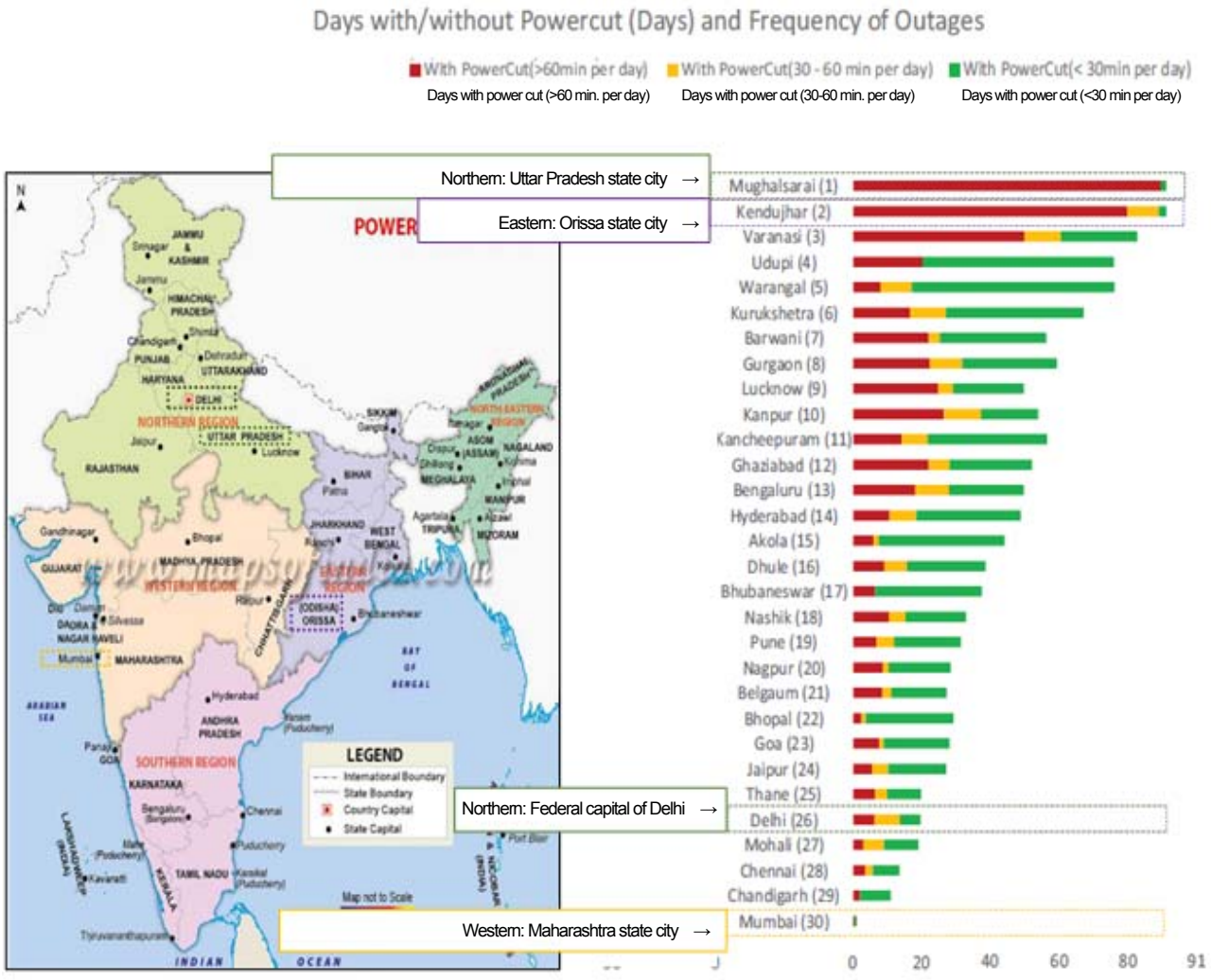
The biggest reason India still sees a power supply-demand gap despite a steady increase in installed power generation capacity over recent years is that the AT&C loss problem has yet to be resolved as noted in the previous chapter.

Priority measures cited in the 12th Five-year Plan (April 2012-March 2017) for power transmission and distribution sectors included the enhancement of power transmission and distribution network development, the resolution of the AT&C loss problem attributable primarily to the distribution sector and the reconstruction of DISCOMs. As electricity tariffs controlled at low levels have failed to cover power supply costs, losses have been accumulated at DISCOMs. Therefore, DISCOMs have remained unable to maintain distribution networks or replace outdated equipment, leading to blackouts and a fall in power frequency.

[13] AT&C Losses (Aggregate technical and commercial losses) = { 1- (Billing Efficiency x Collection Efficiency) } x 100
- Billing efficiency = Total unit Billed/ Total unit Inputs
  The billing efficiency is the ratio of billing to total power supply costs, affected by power theft, metering errors, falsified meter values, the absence of meters, meter readers' wrong records, etc.
- Collection efficiency = Revenue collected / Amount Billed
  The collection efficiency is the ratio of users' payments to billing.

2-2-2 Improvement of outages and frequency

Figure 2-4 Frequency and durations of outages by region in India (December 2015 - February 2016)

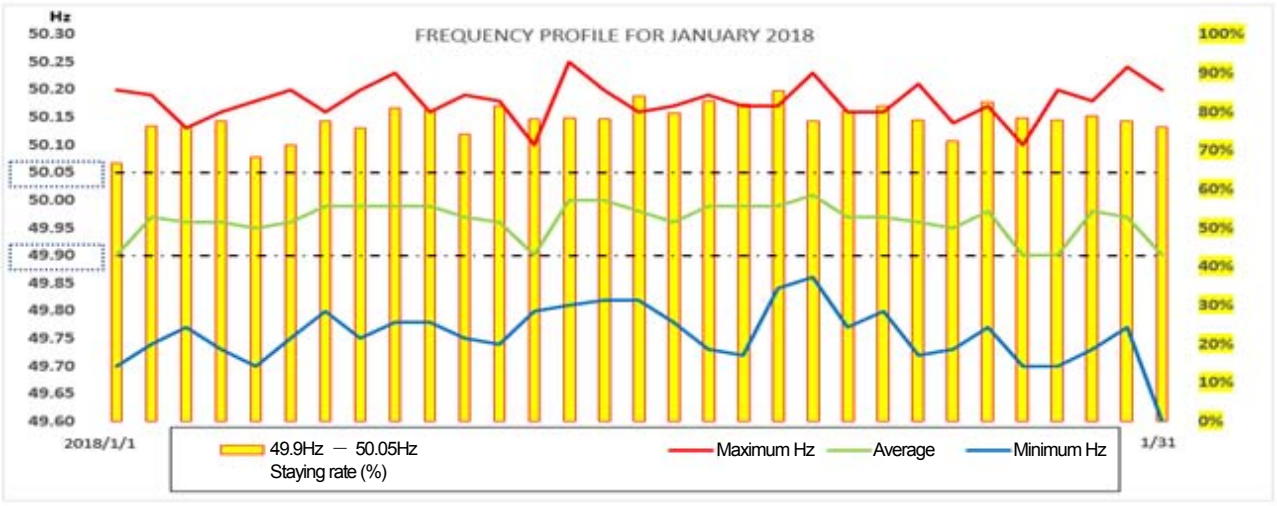


(Source) Energy Storage in India Applications in the Renewable Energy Segment 2016
(Council on Energy, Environment and Water (CEEW))

The left graph of Figure 2-4 shows the results of a fact-finding survey on the number of days with outages and outage durations at 30 major cities in three months (a total of 91 days) between December 1, 2015, and February 29, 2016. Posting the most frequent outages was Mughal Sarai in the northern state of Uttar Pradesh, where an outage lasting for 60 minutes or longer came almost every day. In 15 cities representing a half of the surveyed cities, an outage occurred every two days. However, the capital city of Delhi and Mumbai, the largest economic city in India, featured less outages than the other cities. Particularly, Mumbai had an excellent electric power environment seeing few outages.

As indicated by the survey results, a power quality gap exists between central and rural cities.

Figure 2-5 India's grid frequency profile (January 2018)

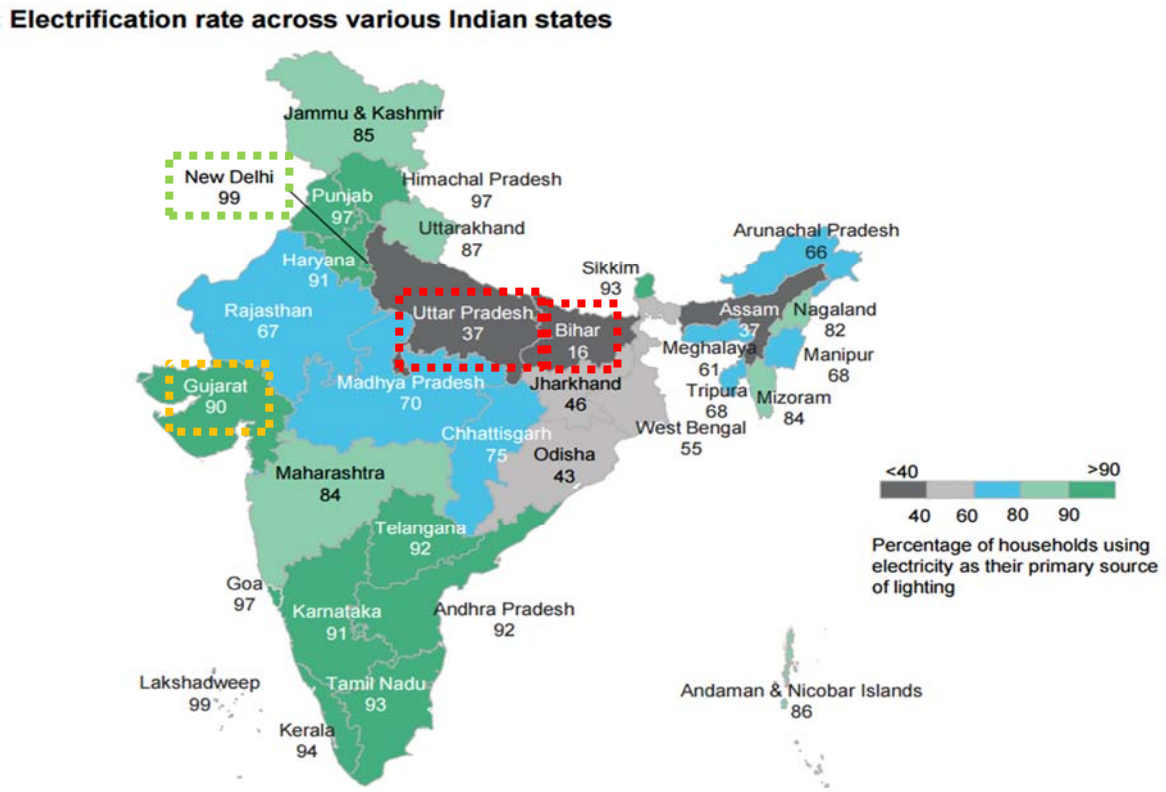


(Source) Prepared by the author from Power System Operation Corporation Limited (POSOCO) Monthly report (January 2018)

Figure 2-5 shows India's grid frequency profile in January 2018. The average frequency fell within the POSOCO-set target control range of 49.09-50.05Hz. However, the minimum and maximum frequencies on each day deviated from the range. The staying rate, or the number of frequencies staying within the range as a percentage of the total number of frequencies, reached close to 80% on some days while failing to exceed 95% as seen in Japan and other developed countries, indicating that more grid stabilization efforts are required in India.

2-2-3 Electrification of unelectrified regions

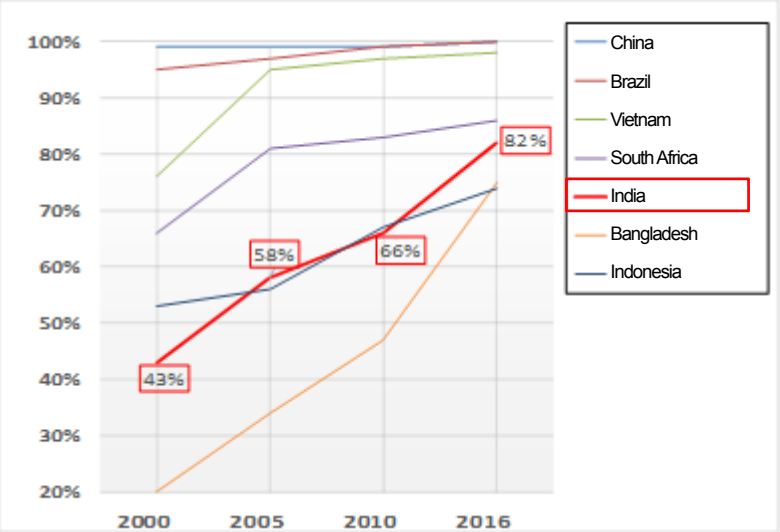
Figure 2-6 Electrification rate by state in India (percentage of population with access to electricity) (2011)



(Source) National Commission on Population, 2011 and Bloomberg New Energy Finance

Figure 2-6 shows the percentage of population with access to electricity in each Indian state as of 2011. In the northern state of Uttar Pradesh where an outage lasting for 60 minutes or longer occurs almost every day as noted earlier regarding Figure 2-14, population with access to electricity was limited to 37% of the total population. The percentage was only 16% in the eastern state of Bihar. In contrast, the percentage comes to 99% in the capital city of New Delhi and other central cities and stood at 90% in the western state of Gujarat that took the initiative in electric power reform. Generally, southern and western states are more electrified than northern and eastern states.

Figure 2-7 Electrification rate trends in major developing countries (percentage of population with access to electricity) (2000-2016)



(Source) Energy Access Outlook 2017

Figure 2-7 compares electrification rate trends in India and other major developing countries from 2000. While China and Brazil achieved an electrification rate of 100% in 2016, the rate was still limited to 82% in India and around 75% in Bangladesh and Indonesia. In the three countries, 20-30% of people still live without electric power.

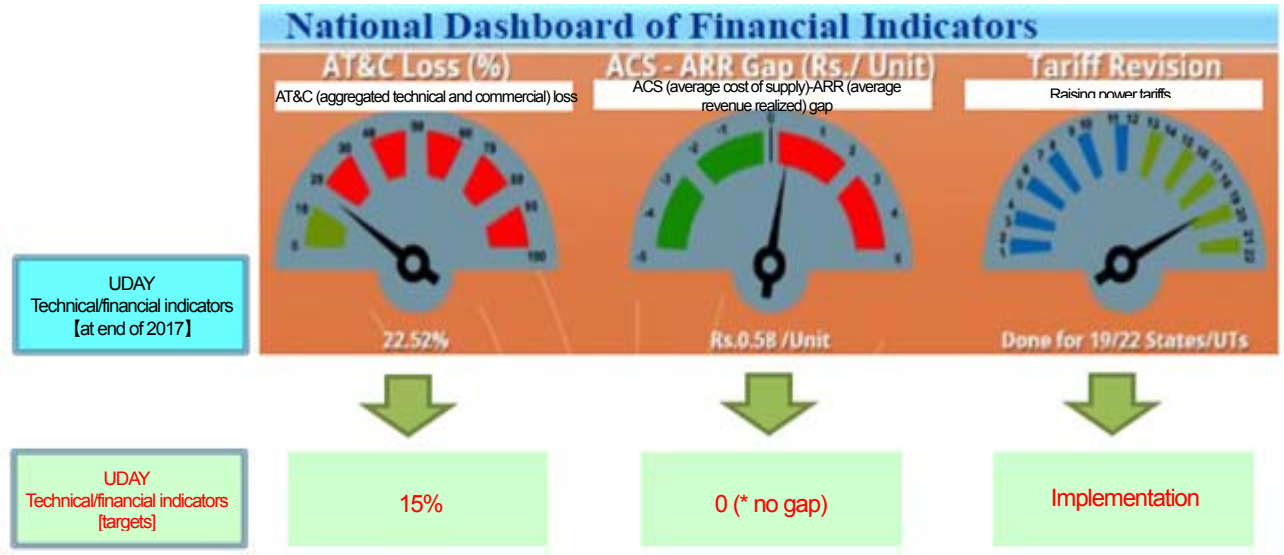
In India, Prime Minister Narendra Modi launched the Saubhagya scheme in September 2017 to electrify more than 40 million households in rural and urban areas[14] to overcome the unfavorable situation.

2-2-4 State power distribution companies' debt resolution

State power distribution companies, though tackling financial consolidation to resolve debt, have failed to make smooth progress in fund management and financial consolidation due to interest payments on massive loans. They are failing to raise funds for procuring electricity for retail supply from power generation companies, plunging into chronic arrears of payments to power generators. Retail electricity prices are mostly set at levels that do not exceed power generation costs, leading state governments to provide subsidies covering power distributors' revenue shortfall. Even with such subsidies provided, power distributors tend to be several months in arrears of payments to power generators. Under such situation, power generators stop power supply to state power distribution companies, which easily reject supply to users deciding that stopping power procurement or supply would be better than accumulating losses on power procurement and supply. They have thus plunged into a serious situation.

[14] Under the Saubhagya scheme launched in September 2017, Prime Minister Modi plans to invest a total of 160 billion rupees (about 278 billion yen) mainly in solar photovoltaic and wind power microgrids or minigrids. Off-grid renewable energy systems (independent lighting systems combining solar PV and lamps), which are not connected to power grid networks, are expected to become a solution to promptly improve electrification rates in rural areas where power transmission and distribution networks have not been developed.

Figure 2-8 Target financial indicators for UDAY debt resolution program for state power distribution companies



To break through the serious situation, the federal government in November 2015 approved the UDAY DISCOM debt resolution program[15] to fundamentally reform the Indian electric power sector. Under the relief program, each state government was authorized to take over 75% of debt as of the end of September 2015 from a state power distribution company and securitize the debt for sales in two years. The remaining 25% was made available for each company's debt securitization and sales.

As state power distribution companies tried to improve the technical indicator (AT&T loss) and the financial indicator (ACS-ARR gap) under such government support as indicated in Figure 2-8, their debt decreased from $515.9 billion at the end of 2016 to $388.3 billion at the end of 2017.

[15] The UDAY (Ujwal Discom Assurance Yojana) program is implemented upon the signing of a memorandum by the Ministry of Power, a state government and a state power distribution company. At the end of 2017, 25 states had selected and participated in the UDAY program, under which a state government provides a state power distribution company with financial consolidation solutions, prompts the company to reach a break-even point by a target year and takes over a big portion of the company's debt in exchange for business performance improvements. (Source) Ministry of Power website (https://www.uday.gov.in/Salient-Features.php)

3. Gujarat electric power reform

The previous chapter reviewed India's electric power business system, national power supply conditions and challenges, confirming that the country excluding some states and urban regions is not in a stable power supply environment. To overcome the unstable power supply environment, the federal government has promoted an initiative to expand the model electric power reform of Gujarat state throughout the country. Gujarat state had been plagued with frequent outages and massive electricity losses. Its State Electricity Board had seen chronically tight finances that made it difficult for the board to invest in power generation, transmission or distribution facilities.

Figure 3-1 Basic profile of Gujarat state

Item	Data	Note
Area	196,000 ㎢	About 6.0% of total national land
Population	About 60 million	
Chief minister	Vijay Rupani	From August 2016
Agricultural products	Raw cotton, tobacco, peanuts, sugar canes, rice	
Manufacturing products	Cotton fabrics, petrochemicals, drugs, vehicles, machines	
State capital	Gandhinagar	Birthplace of independence movement leader Mahatma Gandhi
Largest city	Ahmedabad	Population at 5.58 million (2011)
Religion	Hinduism share at about 90% and Muslim share at about 10%	
Others	Gujarat is the only Indian state that bans alcohol under a state law. Strict vegetarians are abundant.	

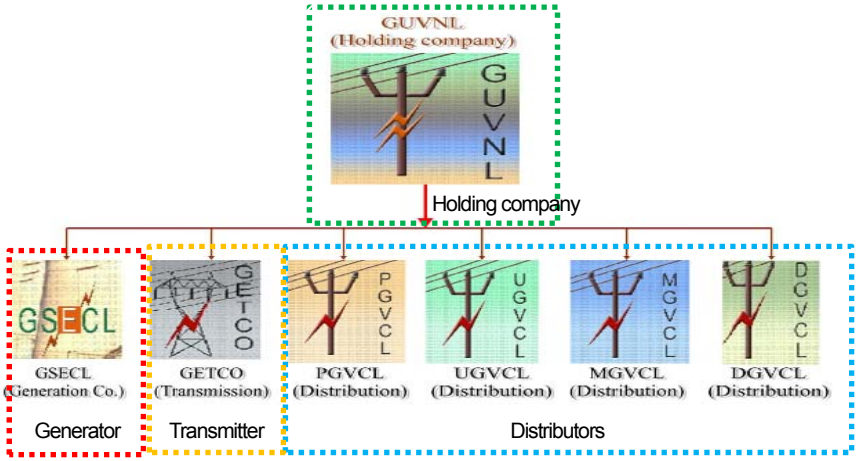
(Source) Prepared by the author from various documents

Figure 3-1 indicates the basic profile of Gujarat state. Though being one of the states in India, Gujarat has a population totaling about 60 million, about five times more than Tokyo's. The following provides key points of the electric power policy that then Gujarat Chief Minister Modi (now India's prime minister) promoted from 2001.

3-1 Details of electric power reform

After India's independence in 1947, its government decided to create a State Electricity Board (SEB) in each state and commission each state government to develop the electric power sector, based on the Electricity Supply Act of 1948. Later, however, inefficient and loss-making equipment operations and business management led state finances to deteriorate, making it difficult to regularly maintain or replace electric power equipment. Contending that SEB management should be enhanced to stabilize electricity supply for promoting citizens' livelihood and the economy, the Gujarat state government launched reorganization to separate power transmission from power generation, distribution and trade at its SEB, based on the Electricity Act of 2003 enacted by the federal government in 2003. The reorganization was designed to promote competition and increase efficiency to cut costs and streamline business management.

Figure 3-1 Organizational chart of Gujarat Urja Vikas Nigam Ltd. (GUVNL)



(Source) Gujarat Urja Vikas Nigam Ltd.(GUVNL) website

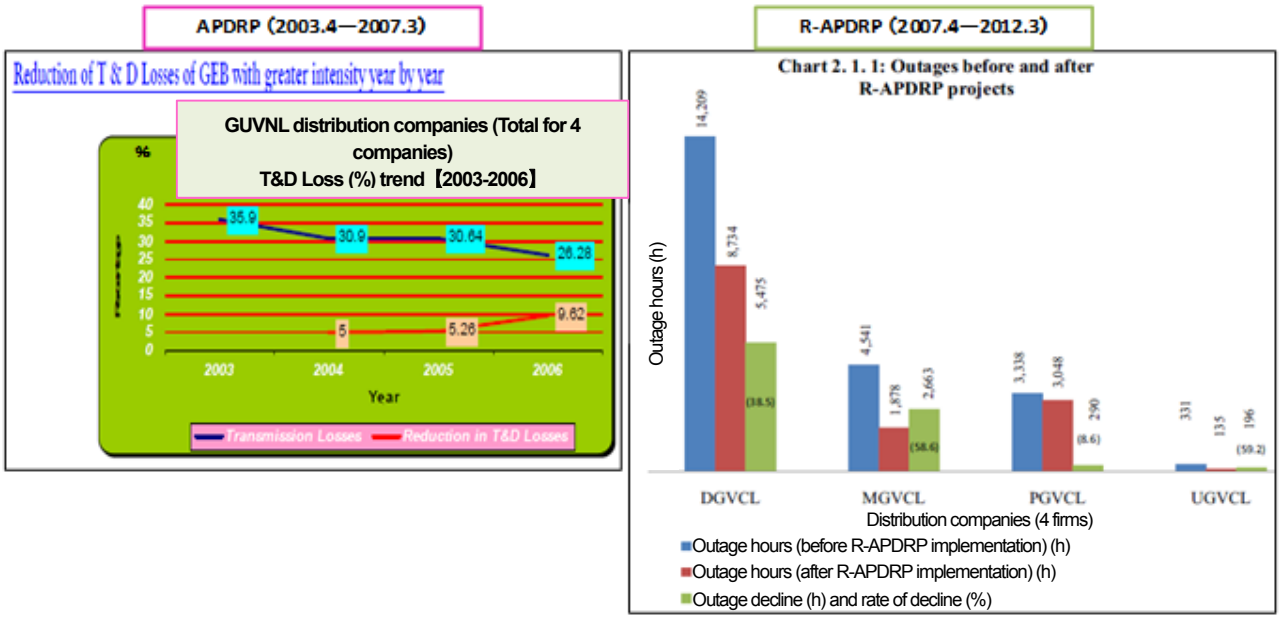
The Gujarat state government first launched the reform of the Gujarat State Electricity Board (GSEB) that was bloated and bankrupt. As shown in Figure 3-2, GSEB-controlled power generation, transmission and distribution operations were divided into seven different companies (one generation company, one transmission company, four distribution companies and a holding company for planning and coordination (Gujarat Urja Vikas Nigam Ltd. or GUVNL)). To increase business efficiency, these companies were given greater discretion to manage business operations to compete with each other. The state government also liberalized private sector entities' entry into electric power business operations. As the GSEB was plagued with massive debt, the state government tried to increase business efficiency by improving the financial profile through refinancing, enhancing inventory control and cutting management expenses. As a result, power generation and transmission companies improved their financial conditions, using their profits for investment in the construction of infrastructure including power plants and transmission equipment.

Particularly, the state government gave priority to measures against power theft that was seriously affecting business performance. In a bid to enhance crackdown on power theft, the state government revised relevant law to strengthen police authorities[16]. It also installed meters invulnerable to the manipulation of power consumption data and prohibited meter readers from receiving bribes.

[16] The power distribution companies set up about 70 observation posts, employing 500 retired military veterans as observers, who closely cooperate with police in observation.

3-1-1 Improving electricity quality

Figure 3-3 4 GUVNL power distribution companies' improvements under ARDRP and R-ARDRP programs



(Source) Gujarat Electricity Board – A Benchmark in the progress of SEB reforms 2006
/ Audit Report (PSUs) for the year ended 31 March 2016 - Report No. 1 of 2017

The state government also developed and improved an efficient system for supplying electric power for the agriculture sector accounting for about one-third of state power demand. It also proactively implemented the Accelerated Power Development and Reform Program (ARDRP) prepared by the federal government for improving the power distribution sector and the Restructured ARDRP (R-ARDRP) for developing high-voltage power distribution networks in rural areas under the 10th Five-year Plan (April 2002-March 2007) and the 11th Five-year Plan (April 2007-March 2012) [17].

Electricity is used to power millions of irrigation pumps in the state. Electricity supply to irrigation pumps through high-capacity transformers and low-voltage naked wires had been vulnerable to power theft. Those low-voltage wires had been losing more power than high-voltage power distribution lines and featured wild voltage fluctuations that had frequently triggered outages and pump breakdowns. Farmers had had to suspend work frequently and pay massive money for repairing pumps.

Under such situation, the state government developed high-voltage power distribution lines in rural areas and divided power transmission lines for users into two systems – one for agriculture and another for households and other non-agriculture purposes. The agricultural power transmission system transmits electricity for eight hours per day with a three-phase 440-volt power line, while the non-agriculture system uses a single-phase 220-volt line. This measure contributed to preventing electricity for agriculture from being used for other purposes, avoiding power theft and securing adequate management including the secure collection of electricity tariffs.

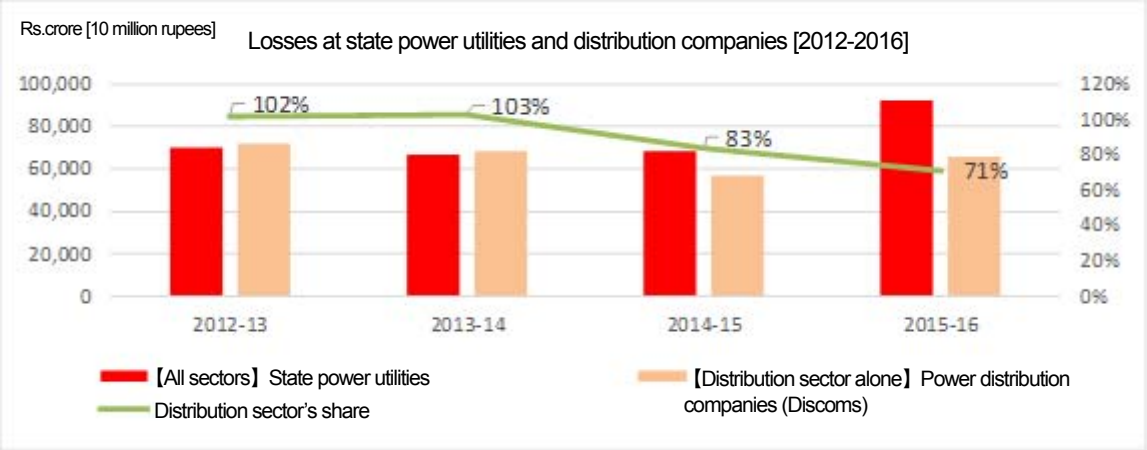
[17] After the Ninth and earlier Five-year Plans had given priority to power generation in the electric power sector, the 10th Five-year Plan switched investment priority to power transmission and distribution for the first time. Specific measures included the requirement for users to install accumulation meters and the promotion of adequate electricity tariff collection. The World Bank and the Asian Development Bank concluded that India was urgently required to improve the power transmission and distribution sector, providing relevant financial assistance. The 11th Five-year Plan called for the following four measures:

(1) Additional power generation capacity of 78,600 MW
(2) Continuing the Accelerated Power Development & Reform Program (APDRP) to develop distribution equipment and lower the power transmission and distribution loss rate (from about 35% in FY2005 to 15% within the five-year period)
(3) Improving power generation efficiency
(4) Promoting users' energy conservation (about 10,000 MW)

As shown in Figure 3-3, the transmission loss declined from 35.9% in 2003 to 26.2% in 2006. Outage hours for the four power distribution companies declined substantially from 2007 to 2012. Particularly, DGVCL and MGVCL nearly halved outage hours.

3-1-2 Improving business performance and collecting electricity tariffs of state power distribution companies

Figure 3-4 Losses at state power utilities and distribution companies [2012-2016]

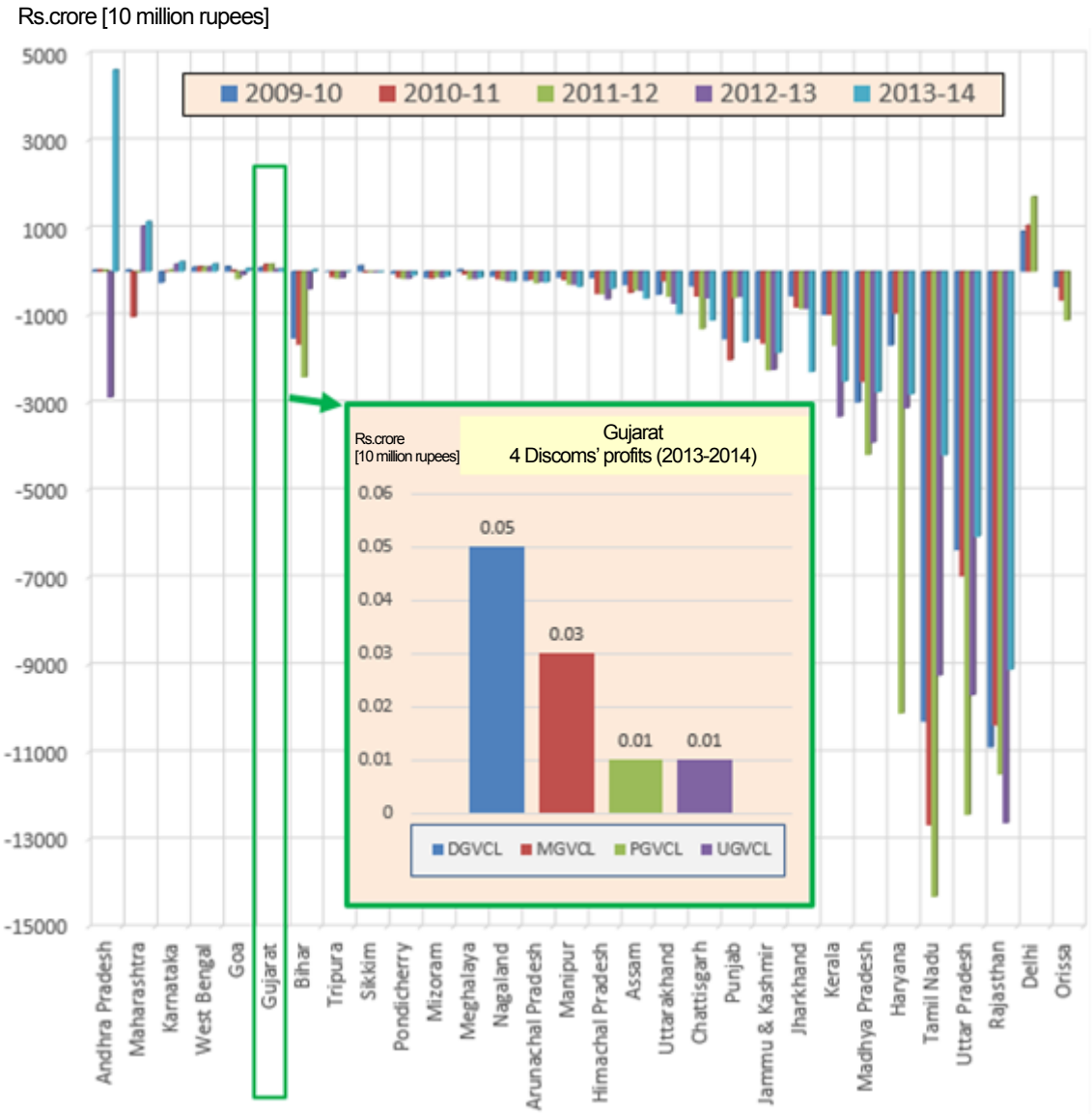


(Source) REPORT ON "The Performance of State Power Utilities for the years 2012-13 to 2015-16"
Power Finance Corporation Ltd. (A Govt. of India Undertaking)

Figure 3-4 shows recent losses at state power utilities [all sectors] (red bars) and at state power distribution companies (Discoms) [distribution sector alone] (orange bars) in all Indian states. The line graph indicates Discoms' percentage share of total losses at state power utilities. State power utilities have had an unfavorable financial profile, generating losses and accumulating debt chronically. Particularly, Discoms account for 70-100% of losses for all state power utilities[18]. Loss coverage and subsidies for state power utilities have become a great financial burden on state governments. Particularly, the business performance improvement for the distribution sector (Discoms) accounting for most of the total losses for state power utilities holds the key to state fiscal consolidation and the redress of the state electric power environment.

[18] As shown by the green line graph, the power distribution sector's (Discoms') percentage share of losses at all state power utilities indicates a downward trend. This is because the power generation sector's (state power generation companies') losses have expanded due to rising power generation costs amid a decline in the load factor for fossil power plants, as noted above.

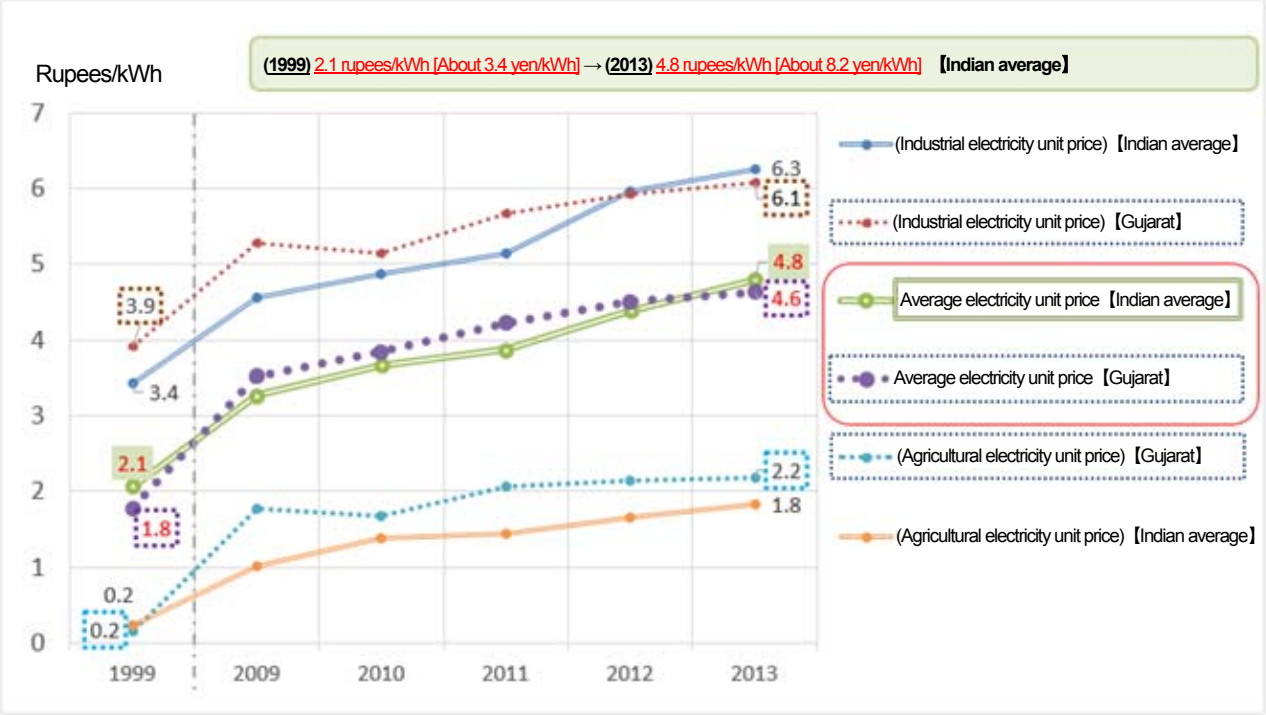
Figure 3-5 Business performance of state power utilities [2009-2014] and 4 Gujarat state power distribution companies [2013-2014]



(Source) Prepared by the author from REPORT ON "The Performance of State Power Utilities for the years 2012-13 to 2015-16," Power Finance Corporation Ltd. (A Govt. of India Undertaking)

Direct factors behind chronic losses at state power utilities include not only technical power losses but also great commercial losses on power theft during the distribution process, as noted above. Gujarat addressed these power losses faster than other states. As shown by Figure 3-5, therefore, the four Gujarat Discoms secured small profits while power utilities in other states chronically generated losses.

Figure 3-6 Electricity price trends (average/industrial/agricultural) [1999-2013]



(Source) Prepared by the author from Annual Report (2013-14) (Power & Energy Division) PLANNING COMMISSION on the working of State Power Utilities & Electric Departments GOVERNMENT OF INDIA FEBRUARY 2014

Another factor behind the tight finances at state power utilities is state government control on electricity prices. Considering people's low solvency, state governments set electricity prices at levels far less than supply costs. Particularly, they set agricultural and ordinary household electricity prices at far lower levels and industrial and commercial electricity prices at higher levels. As electricity bill collection rates are low with many users refusing to pay, however, most power distribution companies fail to cover supply costs with electricity bill revenue.

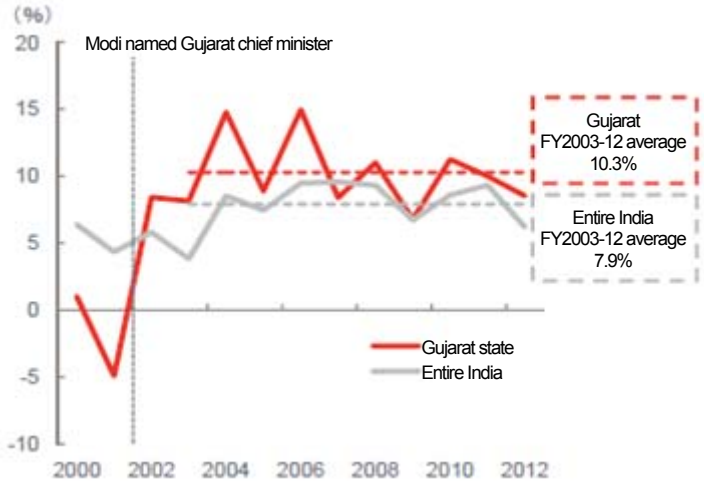
The dotted line graphs in Figure 3-6 indicate that while Indian electricity prices have generally followed an uptrend in recent years, Gujarat has attempted to raise agricultural and industrial electricity prices to adequate levels faster than other states since the 2003 electric power reform. The state has had no choice but to raise electricity prices to help cover various measures for and investment in the improvement of electricity quality. As the improvement has substantially reduced outages and stabilized voltage and frequency, however, rural and ordinary households as well as the industrial world have accepted and praised such hikes[19]. Electricity bill revenue growth has allowed the Discoms to positively invest in the further improvement of distribution equipment and power meters and the introduction of rational systems through bill issuance and increase their supply cost recovery rates.

[19] Farmers had been provided with irregular, unreliable electricity supply for 13 to 14 hours per day. Under a new parallel electricity supply system to set up an independent agricultural electricity supply network, however, secure voltage and electricity has been guaranteed for eight hours per day for farmers, contributing to increasing agriculture productivity.

3-2 Achievements of electric power reform

Gujarat state was devastated by the magnitude 7.7 Western India Earthquake in January 2001[20]. Narendra Modi (now Indian prime minister) took up the post of Gujarat chief minister just after the disaster and worked hard to restore devastated infrastructure. While proceeding with urban development including the construction of electric power facilities, roads, ports and other infrastructure, Modi simplified development investment procedures and successfully attracted domestic and foreign companies, paving the way for the state's economic growth. By attracting not only India's largest automaker Tata Motors Ltd. but also multinational automakers such as Ford Motor Co. of the United States and Suzuki Motor Corp. of Japan to the state, Modi promoted the state's industry successfully. Behind the successful achievement, the Gujarat state government promoted a prompt, open process to attract enterprises by removing bureaucratic procedures and Chief Minister Modi reportedly made aggressive efforts to lead domestic and foreign companies to invest in the state.

Figure 3-7 Economic growth trends for India (national average) and Gujarat state [2000-2012]



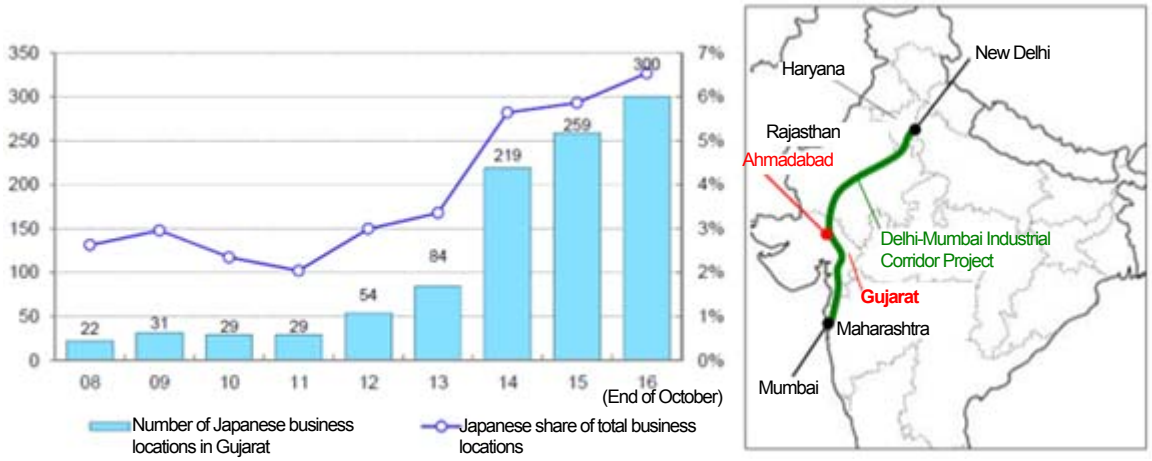
(Source) East Spring Investments (Singapore) Limited.

In vast India, state governments with great influence on political and economic management tend to give priority to local residents and industries to the disadvantage of investment from the outside. However, Gujarat state promoted investment more proactively than other states. Its state government established and planned numerous industrial complexes in the state, with its investment attraction leader, Industrial Extension Bureau, serving as a bridge between outside investors and relevant state organizations.

As indicated by economic growth trends for the past eight years in Figure 3-7, Gujarat state took advantage of these initiatives to achieve average economic growth of 10.3% against 7.9% for the whole of India.

[20] The giant earthquake hit Kutch District in the western Indian state of Gujarat on January 26, 2001. The inland earthquake had a magnitude of 7.7, with the epicenter at a depth of about 16 kilometers. The large-scale disaster killed 20,000 people and injured 166,000 others, according to the Indian government.

Figure 3-8 Number of Japanese companies expanding into Gujarat state [2008-2016] and Delhi-Mumbai Industrial Corridor Project



(Source) Embassy of Japan in India, "List of Japanese Companies Expanding into India (January 2017)"

When considering expanding into India, Japanese and other foreign companies pay attention to the electric power environment exerting direct influence on manufacturing operations as well as distribution and road infrastructure. Gujarat has sufficient power generation capacity (29 GW as of 2015) to even export electricity to other states and features less outages at plants and residential zones. It is endowed with a remarkably excellent electric power environment. As indicated by the left side of Figure 3-8, a large number of Japanese companies are considering Gujarat as a production or sales base for India as a promising market[21].

The right side of Figure 3-8 indicates the Delhi-Mumbai Industrial Corridor (DMIC) Project on which the Japanese and Indian governments agreed as a joint project. It calls for the construction of a freight railway linking Mumbai, the largest city in India, to the Indian capital of New Delhi and for private sector-led investment in industrial complexes, distribution bases, power plants, roads, ports and harbors, residences, commercial facilities and other infrastructure along the railway. About 37% of the DMIC Project area belongs to Gujarat. There is also a plan to construct a 500-kilometer high-speed railway adopting Japan's Shinkansen bullet train line technology between the state's largest city of Ahmadabad and Mumbai[22]. Therefore, Gujarat is expected to have new business chances and continue economic growth.

There are moves to take advantage of vigorous private sector investment in India for the electric power sector. As noted above, state power utilities in India have chronically generated losses and accumulated debt, failing to make progress in investment in plant and equipment. Given this point, the next chapters focus on private companies' participation in the electric power sector and the effects of such participation and delve into such participation while comparing private companies with federal and state-run corporations.

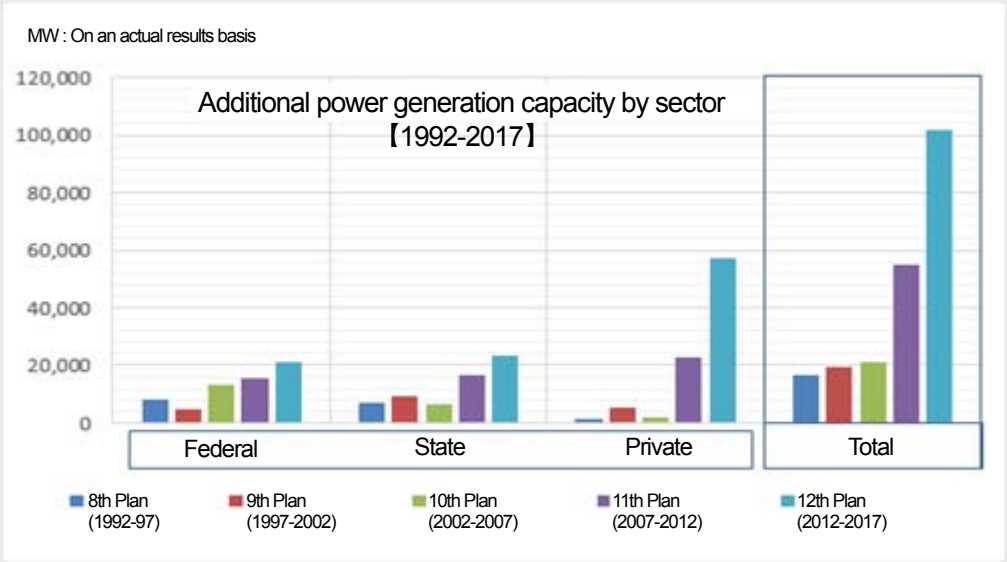
[21] As of January 2017, 29 Japanese companies had 300 business locations in Gujarat. Japan's Suzuki Motor Corp., which has the largest share exceeding 40% of India's passenger car market, has independently expanded into Gujarat, launching its wholly owned subsidiary Suzuki Motor Gujarat running a large-scale production plant. Japan's Honda Motor Co. and the United States' Ford Motor Co. have also expanded into the state. In the future, relevant suppliers are expected to expand into the vicinity of the state.

[22] The construction of the high-speed railway will be launched in 2018 for completion in 2023, costing a total of about 980 billion rupees (about 1.7 trillion yen). Japan plans to provide a 0.1% yen loan covering some 80% of the construction costs other than land acquisition expenses.

4. Private sector companies' participation in electric power industry

4-1 Private sector companies' participation in electric power industry in India

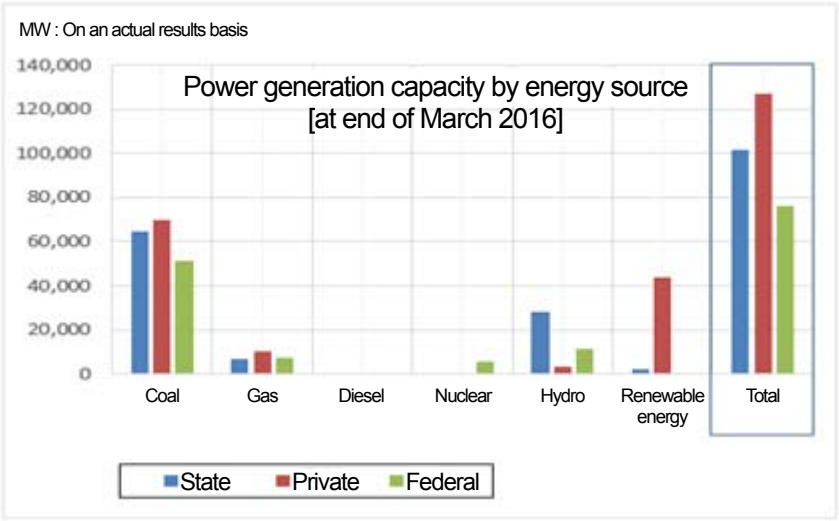
Figure 4-1 Additional power generation capacity by sector (federal, state or private sector) [1992-2017]



(Source) Prepared by the author from National Electricity Plan 2016, Central Electricity Authority of India (CEA)

Figure 4-1 shows new power generation capacity added between the eighth Five-year Plan (1992-1997) and the 12th Five-year Plan (2012-2017) by sector (federal, state or private sector). Under the eighth-10th plans (1992-2007), federal or state sector companies were dominant in power plant construction. Under the 11th-12th plans (2007-2017), however, private sector companies rapidly increased their new power plants.

Figure 4-2 Power generation capacity by sector (federal, state or private sector) and by energy source [at end of March 2016]



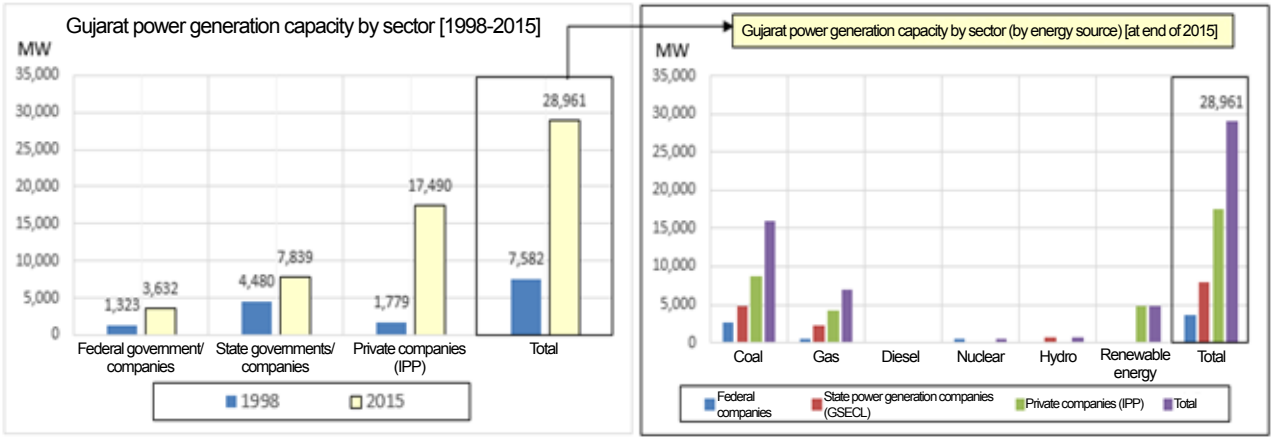
(Source) Prepared by the author from National Electricity Plan 2016, Central Electricity Authority of India (CEA)

Figure 4-2 shows power generation capacity by energy source and by sector (federal, state or private sector) at the end of March 2016 in India. Among energy sources, coal accounts for a dominant share of about 60%. By sector, state power

companies had most hydropower plants, while private sector companies had most renewable energy power plants. The federal sector took charge of nuclear power generation.

4-2 Private sector companies' participation in electric power industry in Gujarat state

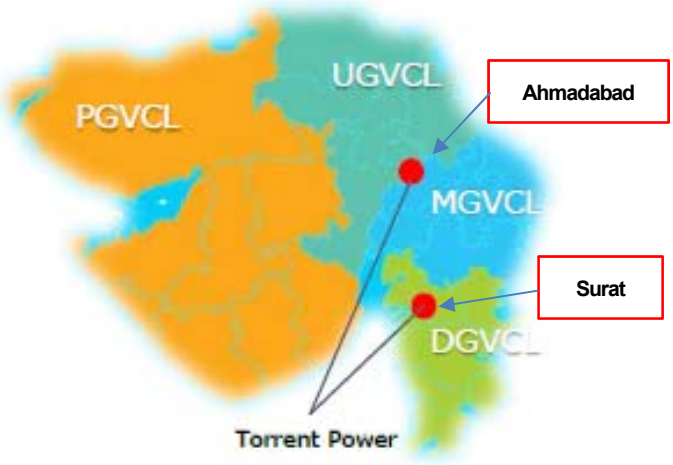
Figure 4-3 Power generation capacity by sector (federal, state or private sector) [1998-2015] and by energy source [2015]



(Source) Prepared by the author from Central Electricity Authority of India (CEA) Annual Report, etc.

In Gujarat state, meanwhile, private sector companies' power generation capacity increased more than 10-fold from 1998 to 2015, as indicated by the left side of Figure 4-3 that shows a breakdown of power generation capacity by sector in 1998 and 2015 in Gujarat state. The right side of Figure 4-3 shows power generation capacity by sector at the end of 2015 in the state and indicates that private electric power companies owned mainly coal, gas and renewable energy power plants. Particularly, all renewable energy power plants were held by private sector companies.

Figure 4-4 State power distribution companies and private electric power companies in Gujarat state

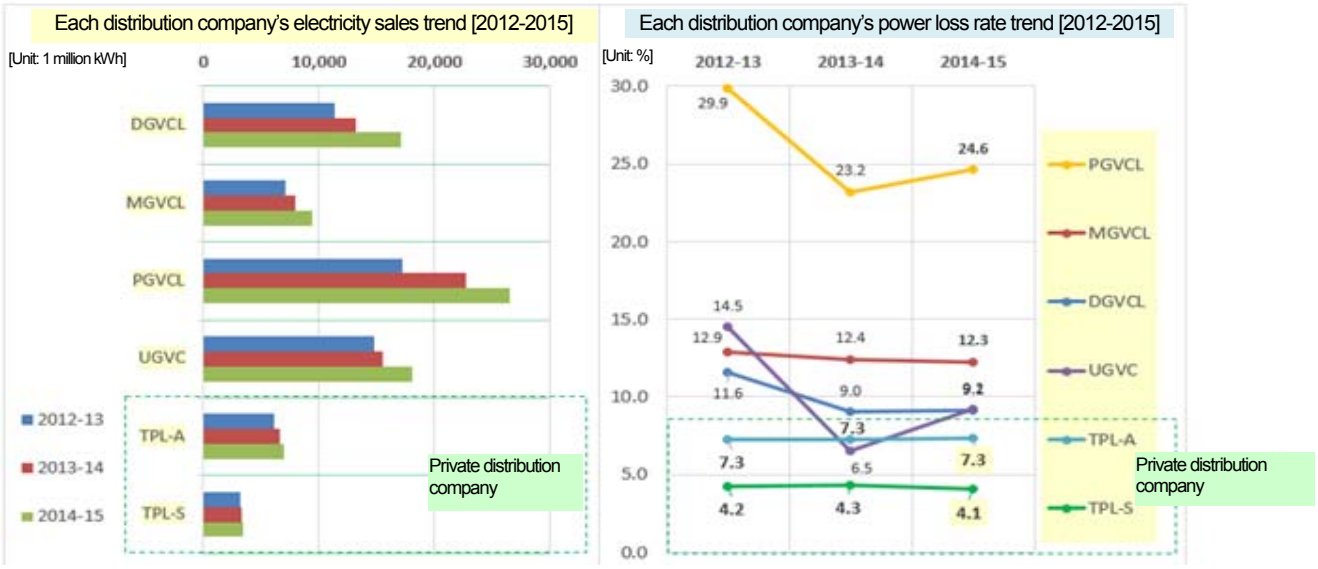


(Source) Gujarat Urja Vikas Nigam Ltd. (GUVNL) website

While four state power distribution companies (DGVCL, MGVCL, PGVCL, UGVC) have supplied electricity since April 2003 in Gujarat state as described above, private sector company Torrent Power has acquired a power distribution license and entered into power sales in Ahmadabad and Surat[23].

[23] Torrent Power's power distribution license is set to expire in 2025 in Ahmadabad and in 2028 in Surat.

Figure 4-5 Business performance comparison between state power distribution companies and private electric power companies (electricity sales and power loss rate) [2012-2015]



(Source) Gujarat Power Sector A Statistical Profile, GUJARAT ELECTRICITY REGULATORY COMMISSION (GERC)

In Figure 4-5, TPL-A represents sales in Ahmadabad and TPL-S those in Surat. While Torrent Power's electricity sales were less than those of the four state distribution companies as indicated by the left side of the figure, the line graph of the right side shows that the power loss rate stood at 7.3% for TPL-A and 4.1% for TPL-S, lower than for the state distribution companies. This means that the private sector company features higher electricity quality.

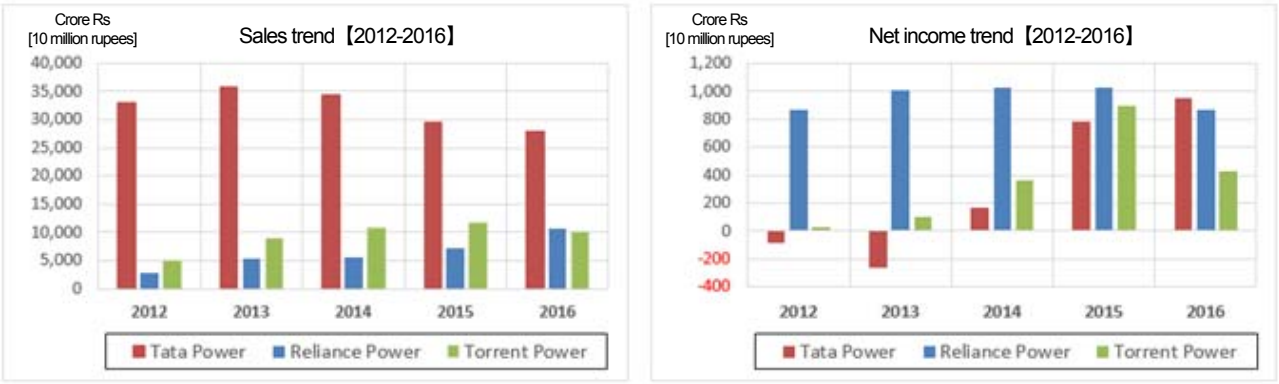
The previous chapter explained that Gujarat state has proactively implemented various measures since its 2003 electric power reform and now features a better electricity environment than other states. In recent years, however, the private sector company's participation in the electric power industry has contributed to improving electricity environment in Gujarat state further[24].

[24] While the average distribution loss rate in Gujarat in 2014-15 stood at 14.2%, a sector-by-sector breakdown indicated that the average stood at 15.3% for the state distribution companies against only 6.3% for the private company. Source: Gujarat Power Sector A Statistical Profile
(Source) Gujarat Power Sector A Statistical Profile

5. Indian private sector electric power companies

As noted above, numerous private sector companies have participated in power generation, transmission and distribution operations in India, although they are smaller than National Thermal Power Corporation (NTPC)[25], a federal power generator, or Power Grid Corporation of India Limited (PGCIL)[26], a federal power transmitter. Among them are Tata Power and Reliance Power affiliated with financially strong conglomerates, as well as Torrent Power affiliated with a leading pharmaceutical company in India.

Figure 5-1 Business performance comparison between 3 private sector electric power companies (sales/net income) [2012-2016]



(Sources) Prepared by the author from these companies' annual reports

Figure 5-1 compares the three major Indian private sector electric power companies' financial profile trends in the recent years.

Tata Power, affiliated with the Tata conglomerate, is India's largest private sector electric power company that has a long history since its founding in 1910 and has developed and operated fossil and hydro power plants. After mergers and acquisitions from 2000, Tata Power now handles a wide range of operations from power generation, transmission, distribution to retail and trading. It owns and operates coal, gas, hydro and wind power generation capacity totaling about 10 GW. Tata Power has taken advantage of a public-private partnership to enter into power transmission and distribution. Its sales are two times more than those at each of the other two. Tata power secured net income in recent years after incurring losses on rising gas prices from 2011. It has constructed numerous supercritical coal power plants featuring high efficiency. Tata Power is considering participating in nuclear power plant construction projects of Nuclear Power Corporation of India Limited, planning to proactively expand business operations in the future.

Reliance Power, a core company of the Reliance conglomerate, launched electric power business in Delhi in 1995. The private sector electric power company based in Mumbai owns and operates coal power generation capacity totaling about 6 GW. It produces some 50 million tons of coal annually for use at its coal power plants. It plans to construct new coal, gas and hydro power plants to further expand power generation. Its power generation capacity under construction or planning totals about 12 GW. As indicated by Figure 5-1, Reliance Power has steadily expanded sales since 2012, securing stable net income.

Torrent Power is an electric power company of the Torrent Pharmaceuticals group founded in 1959. It entered into electric power business by acquiring Ahmedabad Power shares from the Gujarat state government in 1997. While generating power with capacity totaling 3.3 GW including 2.7 GW for gas power plants, Torrent Power conducts power distribution in Agra, Bhiwandi and Gandhinagar, as well as Ahmedabad and Surat as mentioned above. In Gujarat, Torrent Power also produces

[25] NTPC is India's largest power generation company, having 49 power stations with total capacity of 52 GW at the end of 2017. Its annual sales total 830 billion rupees.

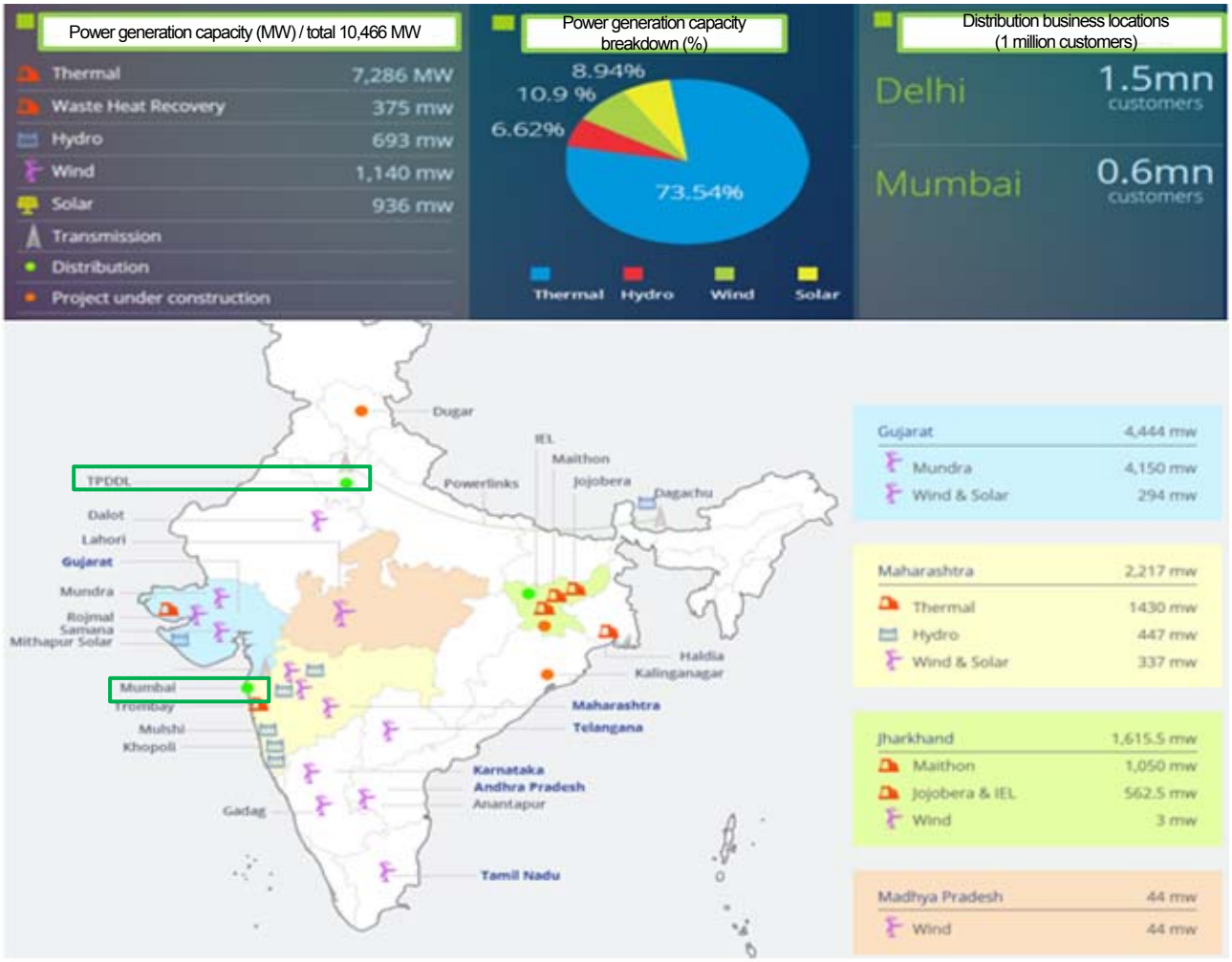
[26] PGCIL is India's largest power transmission company, having transmission lines totaling 145,735 ckm and 230 transformer stations at the end of 2017. Its annual sales total 262.8 billion rupees.

cables related to its power transmission and distribution. In recent years, it has smoothly expanded sales and net income.

Regarding the three companies' overviews and recent conditions, the following delves mainly into the power distribution sector plagued with electricity quality problems to be overcome in the future and into the power generation sector where additional capacity is under construction.

5-1 Tata Power

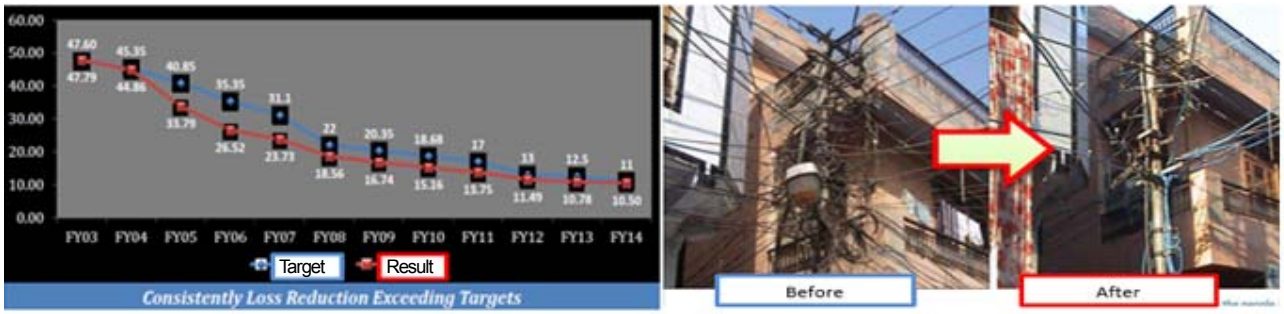
Figure 5-2 Overview of Tata Power



(Source) Tata Power website

Figure 5-2 shows that Tata Power has large coal power plants in coal-producing eastern India and many hydro and wind power plants in western and southern India. Particularly, it has wind power generation capacity totaling 4.4 GW in the western state of Gujarat. The state has proactively attracted private sector companies' investment in renewable energy, leading not only Tata Power but also other private sector companies in various business fields to take part in renewable energy power generation.

Figure 5-3 Tata Power's AT&C loss reduction [2003-2014]



(Sources) Delhi Distribution Limited TPDDL Excellence Journey

In a bid to enter into power distribution, Tata Power founded Tata Power Delhi Distribution Limited, a joint venture with Delhi Vidyut Board for Distribution under direct control by the federal government in Delhi, in July 2002. Although Tata Power's aggregate technical and commercial (AT&C) loss rate in 2003 was as high as 47.79%, meaning that nearly half of electricity was lost, the company implemented various power theft countermeasures such as the improvement of distribution equipment and power meters and the change from low-voltage distribution lines to high-voltage distribution lines, lowering the AT&C loss rate to 10.5% in 2014, as shown in Figure 5-3. These countermeasures have been given high ratings as savings on the AT&C loss reduction in the past 12 years totaled about $1.9 billion, allowing Tata Power to invest in the development of other infrastructure and repay about $100 million in borrowings from state governments. Tata Power conducts power distribution in the central economic city of Mumbai as well.

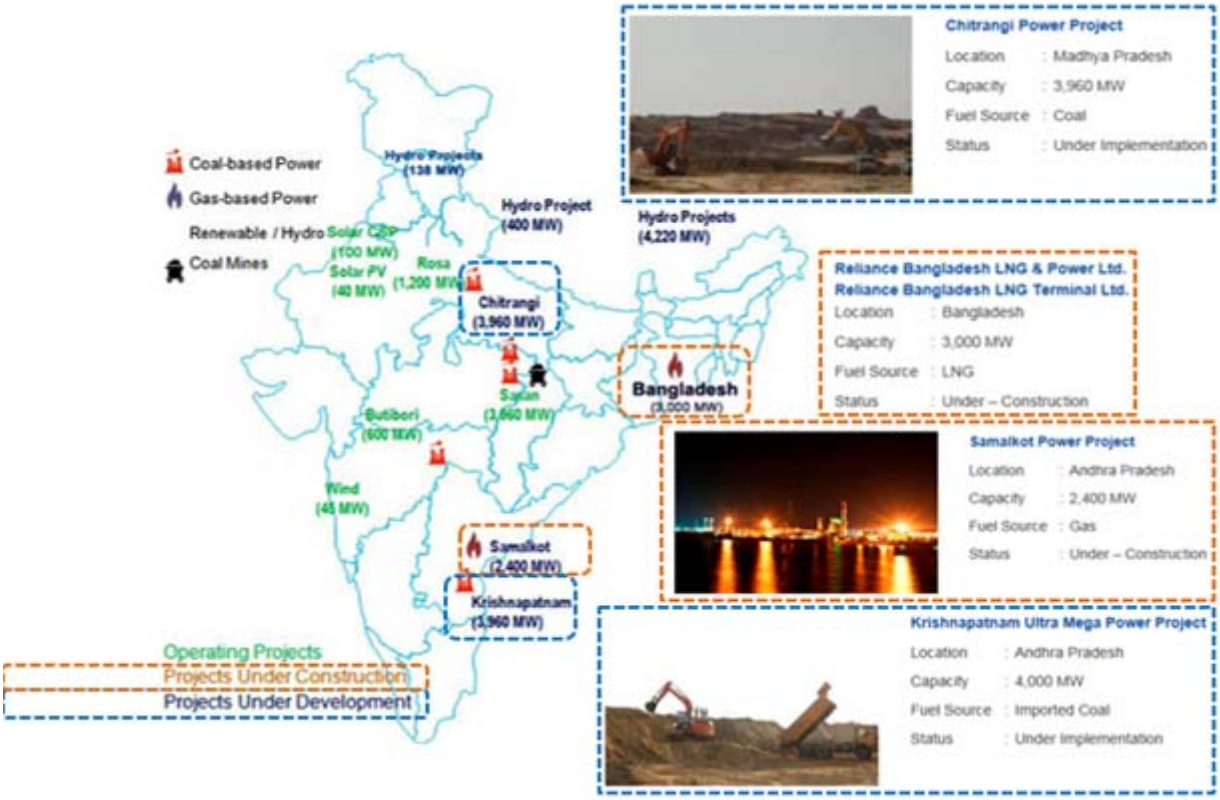
In Ajmir of Rajasthan state, Tata Power has signed a franchise agreement with public power distribution company Ajmer Vidyut Vitran Nigam Limited (AVVNL) to enter into power distribution in a manner to commission TP Ajmer Distribution Limited (TPADL), a special purpose company, to undertake management and maintenance. Tata Power has been given high ratings for excellent power loss reduction achievements in the city as well[27].

Tata Power and PGCIL have jointly founded Power Links Transmission Ltd. to transmit 126 MW of electricity generated at the Dagachhu hydroelectric power plant constructed in Bhutan to Delhi.

[27] For the purpose of utilizing private sector knowhow and money for state power distribution companies' efficient management, power distribution franchise agreements have begun to be introduced for private sector companies to undertake management and maintenance.

5-2 Reliance Power

Figure 5-4 Overview of Reliance Power



(Source) Reliance Power HP

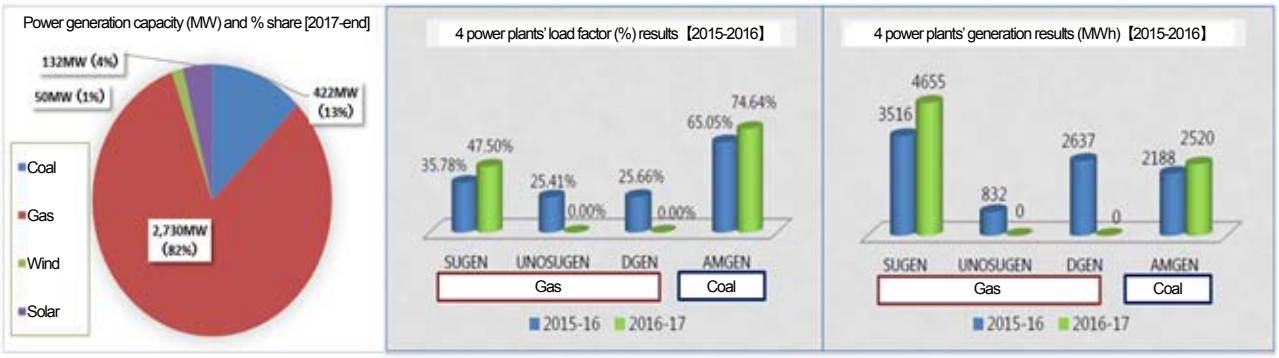
As shown in Figure 5-4, Reliance Power implements three large-scale power plant construction projects in India – a 3.9 GW coal power plant in Chitrangi of Madhya Pradesh state in eastern India, a 4 GW coal power plant in Krishnapatnam of Andhra Pradesh state in southern India and a 2.4 GW gas power plant in Samalkot of Andhra Pradesh state. In Bangladesh neighboring India, Reliance Power is constructing a 300 MW liquefied natural gas power plant and a floating LNG storage facility.

Reliance Power's major power plants now in operation include the 1.2 GW Rosa and 3.9 GW Sasan coal power plants in Uttar Pradesh state, and the 600 MW Butibori coal power plant in Maharashtra state. The Sasan plant built under an ultra-mega power project is accompanied by a coal mine that has reserves of 575 MT (million tons) and production capacity at 20 MTPA (million tons per annum). The company also owns a coal mine with production capacity at 30 MTPA in Indonesia. It has taken advantage of its cost competitiveness and stable coal procurement to achieve a high plant load factor of 85% or more for coal power plants.

In Rajasthan state, Reliance Power has a 40 MW mega-solar plant, the largest one in India. In Maharashtra state, it has 45 MW in wind generation capacity. Reliance Power has thus proactively invested in renewable energy power generation.

5-3 Torrent Power

Figure 5-5 Overview of Torrent Power



(Source) Torrent Power website

As indicated in the left side of Figure 5-5, Torrent Power owns three gas power plants with capacity totaling 2.7 GW and one 400 MW coal power plant, and renewable energy power generation capacity including a 50 MW wind power plant and two mega-solar plants with capacity totaling 132 MW in Gujarat state. The mega-solar plants are viewed as one of Asia's largest solar parks. As indicated in the right side of Figure 5-5, the load factor in 2016 was as high as 74.6% for the AMGEN coal power plant and 47.5% for the SUGEN gas power plant. However, the other two gas plants (UNOSUGEN and DGEN) did not operate in 2016 as gas price hikes boosted generation costs, with no offer made by power distribution companies to procure electricity from these plants, as noted above.

For power transmission services, Torrent Power has a 400 kV transmission line connected to the 1.5 GW SUGEN gas power plant. As noted above, the company also provides power distribution services in Ahmadabad and Surat. In Gujarat state, Torrent Power thus provides integrated services using its own power plants, and transmission and distribution cable networks for power supply to final users. In addition, its group runs a cable manufacturing company[28]. Torrent Power thus tackles initiatives to resolve composite challenges including the improvement of electricity quality to reduce transmission and distribution losses, the reduction of power supply costs through efficient business management and the expansion of power grids into unelectrified regions. As a private-sector power company in Gujarat that took the initiative in electric power reform, Torrent Power should be a model for other states and other power companies.

[28] Torrent Cables, which the Torrent Power group acquired in 2015, manufactures high-quality power and telecommunications cables including the 132 kV XLPE power cable (consisting of cross-linked polyethylene insulation material and a copper or aluminum conductor).

6. Conclusion

Many developing countries are plagued with common challenges including massive unelectrified populations and low electricity quality. The United Nations' Sustainable Development Goals (SDGs) [29] include " energy to everyone and clean" to provide electricity to unfortunate poor people. Energy is a sector in which Japan as a developed country must proactively support efforts to achieve the SDG.

India launched the privatization of the SEBs in the 1990s and enacted the Electricity Act 2003 requiring the SEBs to separate power transmission from other operations such as power generation, transmission, distribution and trade to promote competition and efficiency. In 2010, POSOCO was founded as a subsidiary of PGCIL to operate the central power supply command for coordination between regional grids on a nationwide basis.

Despite such reform, India's electric power sector has had a business environment in which it has been difficult for private sector companies to launch business operations as the government controls electricity tariffs in consideration of people's living standards. It is presumed that it was not necessarily easy for Tata Power, Reliance Power and Torrent Power, private electric power companies taken up in this study, to enter into the unknown electric power sector after specializing in other business sectors due to uncertainties about profitability and various risks. Even in such business environment, these private sector companies have competed and cooperated with federal and state power companies to reduce AT&C loss rates to improve electricity quality and increase power supply efficiency, bringing about improvement effects as identified in this study. These improvements contribute to upgrading living standards for many Indian people still in an unfortunate electricity environment. In this sense, great hopes continue to be placed on the role of private sector electric power companies.

India, though featuring largest sizes in various areas and remarkable economic growth, is still presumed as a developing country where stable electricity supply must be given top priority, with electricity policies being a key pillar supporting infrastructure for future national development. From various perspectives, this study analyzed India's unique power supply conditions, various relevant challenges facing the country and its electric power policies such as the utilization of private sector resources to resolve these challenges.

[29] On September 25, 2015, a United Nations summit adopted the 2030 Agenda for Sustainable Development setting 17 sustainable development goals known as SDGs. The SDGs cover 17 areas including poverty, hunger and food, clean water and sanitation, education, gender quality, consumption and production, climate change and biodiversity.

Reference

IMF World Economic Outlook Databases

U.S. EIA (Energy Information Administration) International Energy Outlook 2017

OECD/IEA India Energy Outlook 2015

Ministry of Power of India (MOP) website

Central Electricity Authority of India (CEA) Annual Report 2017

Government of India Department of Atomic Energy website

The Hindu http://www.thehindu.com

IEA Statistics © OECD/IEA 2014 Electric power transmission and distribution losses

REPORT ON "The Performance of State Power Utilities for the years 2013-14 to 2015-16"
Power Finance Corporation Ltd. (A Govt. of India Undertaking)

Energy Storage in India Applications in the Renewable Energy Segment 2016
Council on Energy, Environment and Water (CEEW)

Power System Operation Corporation Limited (POSOCO), Monthly report (2018.1)

National Commission on Population, 2011 and Bloomberg New Energy Finance

Energy Access Outlook 2017

Journey of Ujwal Discom Assurance Yojana (UDAY) March 2017

Gujarat Urja Vikas Nigam Ltd. (GUVNL) website

Gujarat Electricity Board – A Benchmark in the progress of SEB reforms 2006 / Audit Report (PSUs) for the year ended 31 March 2016 - Report No. 1 of 2017

REPORT ON "The Performance of State Power Utilities for the years 2012-13 to 2015-16"
Power Finance Corporation Ltd. (A Govt. of India Undertaking)

Annual Report (2013-14) (Power & Energy Division) PLANNING COMMISSION on the working of State Power Utilities & Electric Departments GOVERNMENT OF INDIA, FEBRUARY 2014

East spring Investments (Singapore) Limited.

Embassy of Japan in India, List of Japanese Companies Expanding into India (January 2017)

Nomura Research Institute, FY2016 Project for Promoting Overseas Expansion of High-quality Energy Infrastructure Systems: Survey on Indian Electric Power Business Environment

IBT, FY2016 Survey on Comprehensive Energy and Environment Strategies: Fact-finding Survey on Energy Supply Conditions and Policy Trends in Giant Energy-consuming Countries

National Electricity Plan 2016, Central Electricity Authority of India (CEA)

Central Electricity Authority of India (CEA) Annual Report

Gujarat Power Sector A Statistical Profile, GUJARAT ELECTRICITY REGULATORY COMMISSION (GERC)

Tata Power website

Tata Power Annual Report

Delhi Distribution Limited TPDDL Excellence Journey

Reliance Power website

Reliance Power Annual Report

Torrent Power website

Torrent Power Annual Report

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