CHAPTER – IV

ANALYSIS OF THE TECHNICAL PERFORMANCE OF POWER PLANTS OF THE GENARATING COMPANY

IV.1	Over view Power Sector of Gujarat.
IV.2	Installed Generation Capacity of India, Gujarat state and GSECL.
IV.3	Generation of power pre reform and post reform of GEB./GSECL
IV.4	Analysis of Technical Performance.
IV.5	New projects pre reform and post reform of GEB./GSECL.
IV.6	Renovation and Modernization of power plants

CHAPTER – IV

ANALYSIS OF THE TECHNICAL PERFORMANCE POWER PLANTS OF THE GENARATING COMPANY

IV.1 Over view Power Sector of Gujarat

IV.1.1 Power is an essential building block of economic development. In an effort to meet the demands of rapid industrialization, the power sector of Gujarat has undergone significant growth in past few years. Areas like the resource exploration, capacity additions and sectorial reforms have been revolutionized. The power sector includes generation, transmission and distribution of electricity. The power sector has grown considerably over the years and is able to support infrastructure development in the State.

Figure 1 : Gujarat Power Sector overview.

Generation.	Generation of electricity primarily takes place from coal, gas, renewable, hydro & nuclear. Current as on 31st March 2017 installed capacity is around 27057 MW.
Transmission	GETCO is responsible for strengthening the transmission network of the State with 1770 Sub-stations & 558507 ckm of transmission lines as on 31st March 2017.
Distribution.	Distribution network provides 24*7 electricity to around 1.37 Cr consumers with lowest AT&C losses of around 15.96% in the country.

(Source Annual Report of 2016-17 of SLDC. Gujarat.)

The details of the States performance & its future plans in each sector will be summarized below.

IV.1.2 Power Sector over view

Gujarat Electricity Board (GEB) was established along with the formation of Gujarat State in the year 1960 under Section 5 of the Electricity (Supply) Act 1948. Commencing with generation capacity of 315 MW and a consumer base of 1.40 million consumers, GEB today is the lifeline of over 13.70 million consumers across the State of Gujarat, with the capacity as on 31-03-2017 of 27057 MW.

During 1980s, GEB focused mostly on rural electrification, providing new connections and maintenance activities. But as it focused on the above, profitability & revenue recovery

suffered hugely, GEB resulting suffered huge losses for several years denting the image of public sector in Gujarat.

No rays of hope were seen until the year 2001, when an initiative by the Government of Gujarat led by visionary politicians, proficient administrators and diligent employees took everyone by surprise. A major reformation which included multipronged strategies and tactics including unbundling of the board, renegotiation of power purchase agreements (PPA), reduction of interest rates on loans, curbing of power theft and reduction of huge transmission and distribution (T&D) losses without compromising with the quality of fuel. (Sources : Annual *Reports of Gujarat Electricity Board.* Vadodara from 1990-2016 and Gujarat Electricity Board. Retrieved from www.gseb.com) (Board., 1990-2016)

IV.1.3 Industry structure

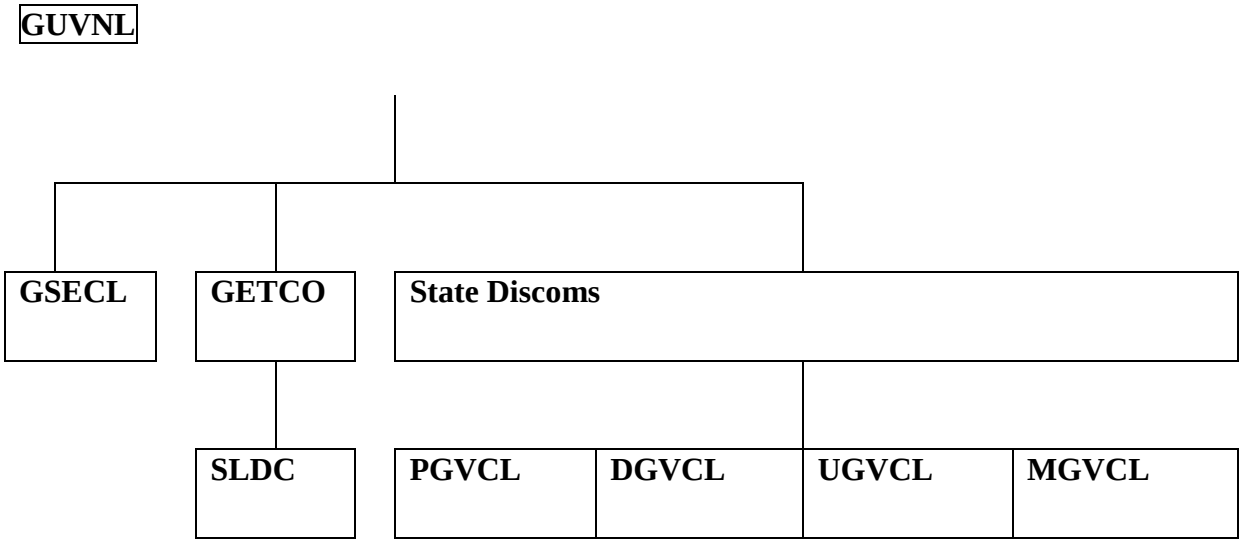
Series of reforms in the 1990s and the EA 2003 has moved the power sector towards its vision of a competitive market with multiple buyers, sellers supported by regulatory, and oversight bodies. In context to this, organizations have been formed both at the central and State Government levels to facilitate development of the power sector.

Figure 2 : Stake holder map of Power Sector

	Centre		State	
Policy	**Ministry of Power. Central Govt.**		**Energy & Petrochemical Dept. (State Govt.)**	
Appeal	**APTEL**			
Regulations	**CERC**		**SERC**	
Advisory	**CEA**			
Renewables	**MNRE, SECI**		**GEDA**	
Generation	**Central Gencos**	**IPPs**	**GSECL, GPCL**	**IPPs**
Transmission	**CTU**	**Transmission Licensee**	**GETCO**	
Distribution	**Only monitoring by ministry of power.**		**PGVCL, DGVCL, MGVCL, UGVCL, Torrent, MPSEZ, KPT**	
Trading	**Trading Licensee**		**GUVNL (State Trading Licensee)**	
System Operation	**NLDC**	**RLDC**	**SLDC/ALDC**	

The State undertook structural reforms wherein the erstwhile **Gujarat Electricity Board (GEB**) was unbundled on 1st April, 2005 into seven companies with functional responsibilities of trading, generation, transmission and distribution

Figure 3 : Gujarat State Electricity Board structure



Gujarat Electricity Regulatory Commission (GERC)

GERC, constituted in November 1998 is responsible to regulate & determine tariff, issue licenses, specify the Grid Code, specify and enforce standard for quality & reliability, etc. at intra-state level Promote cogeneration and generation of electricity from renewable sources of energy and Adjudicate upon the disputes between the licensees, and generating companies and to refer any dispute for arbitration

Gujarat UrjaVikas Nigam Ltd. (GUVNL)

GUVNL was incorporated as a Govt. of Gujarat Company. GUVNL is engaged in the business of bulk purchase and sale of electricity, supervision, Co-ordination and facilitation of the activities of its six subsidiary companies. It is the single bulk buyer of power in the State as the bulk supplier to distribution companies.

Gujarat State Electricity Corporation Limited (GSECL)

Post Electricity Act 2003, GEB was unbundled in 2005 & GSECL was given responsibility of electricity generation & to undertake new power projects in the State. It currently accounts for 31% (6132 MW) of the total installed conventional capacity of the State and has achieved highest ever PAF of around 83.65%.during F.Y.2017-18

Gujarat Energy Transmission Corporation Ltd. (GETCO)

GETCO setup in 1999 builds, operates & maintains State transmission network, company has made significant progress in network capacity addition, transmission asset management, State grid operation, smart solutions and human resource development. Currently it has transmission network of about 58507 ckm and 1,700 sub-stations with transformation capacity of around 105200 MVA.

Distribution Licensees in Gujarat : Undertake the electricity distribution and retail supply in the State of Gujarat.

Table no 4.1 Distribution Licensees in Gujarat

State Discoms	Other Discoms
DGVCL	Torrent Power
MGVCL	Aspen
UGVCL	Kandla Port Trust
PGVCL	Adani MPSEZ Utilities Pvt. Ltd.

(Sources :*Annual Report of 2016-17.* Vadodra: State Load Desptch Center of Gujarat. Retrieved from www.sldcguj.com) (Gujarat, 2017)

IV.1.4 Policies & Regulations in Gujarat

Power in India is a concurrent subject, implying that the onus of development of the sector lies both with the Central as well as the State Governments. State Power sector & regulatory landscape come under purview of State Government and GERC. Under the guiding principles of central level policies, Gujarat State Government & Regulatory Commission have come up

with various policies & regulations for development of power sector, providing energy access to all at affordable price and to deal with environmental issues in the State

Major Policy & Regulations issued by Gujarat

Table no 4.2 : Major Policy & Regulations issued by Gujarat

Policy / Regulation	Key Highlights
Solar Policy (2015)	• Any company or group of individuals shall be eligible for setting up a solar generating plant with capacity varying from 1KW to 1 MW. • Operative period :Upto 31st March, 2020. • Solar power developer is allowed to: 1) Use electricity for Captive consumption. 2) Sale electricity to Third party under open access. 3) Sale to Discom as per competitive bidding / preferential Tariff. 4) Sale through REC mechanism if registered. • Electricity generated will be exempted from electricity duty • Generator/developer shall retain 100% of CDM benefits/Preferential Tariff. • Exemption from Cross Subsidy Surcharge (CSS) & Additional Surcharge (AS) for Captive users & 50% exemption allowed in case of sale of power to third party under open access. • Surplus power generated can be sold to Discom at APPC if RE attributes are allowed to Discom else at 85% of APPC if RE attributes are used by consumer. *(Source Website of Government of Gujarat State Energy & Petrochemicals Department , and Specific websites as mentioned on page Table no 4.3 i.e*https://geda.gujarat.gov.in/policy

Policy / Regulation	Key Highlights
	files/Solar%20Power%20policy%202009.pdf)
Net Metering Regulations for Roof top Solar (2016)	• Allowed capacity: Up to 50% of contract demand. • Transmission loss, wheeling loss, transmission charges, wheeling charges are not applicable over electricity generated. • Cross subsidy surcharge & Electricity duty exempted on the generated solar energy. • Developer can avail subsidy of Rs.10,000/Kw provided by State Government with a ceiling of Rs.20,000 per consumer & 30% of the discovered cost from MNRE. *(Source Website of Government of Gujarat State Energy & Petrochemicals Department , and Specific websites as mentioned on page Table no 4.3 i.e*http://www.gerc.in.org/uploaded/document/adf57eac-f111-4b33-b447-b07ecaa34165.pdf)
Wind energy policy (2016)	• Operative period : 5 years. • Any individual, company will be eligible for setting up of WTG for captive use, selling to Discoms or third party. • Allowed capacity : Up to 50% (100% for MSME) of contract demand/Load. • Exemption on payment of electricity duty & exemption of 50% of wheeling charges & losses for captive consumers. • 50% exemption on Wheeling charges & losses for Captive consumers. • Exemption from Cross Subsidy Surcharge (CSS) & Additional Surcharge (AS) for Captive users & 50% exemption allowed in case of sale of power to third party under open access. • Surplus power generated can be sold to Discoms at APPC if RE attributes are allowed to Discoms else at 85% of APPC if RE attributes are used to by consumers.

Policy / Regulation	Key Highlights
	*(Source Website of Government of Gujarat State Energy & Petrochemicals Department , and Specific websites as mentioned on page Table no 4.3 i.e*https://geda.gujarat.gov.in/policyfiles/Gujarat%20Wind%20Power%20Policy-2016.pdf)
Waste to Energy Policy (2016)	• Facilitate & promote utilization of Municipal Solid Wastes for generation of electricity at affordable cost in sustainable manner. • State Govt Facilitation & Nodal Agency: Gujarat Energy Development Agency (GEDA). • Power sale options:1) Captive use, 2) Third party Sale, 3) Sale of power to Discom/obligated entities. • Land will be made available to developer at lease rental of Rs1/year without charging any tax, cess, royalty, levies. • Developer can avail Viability Gap funding based on competitive bidding process considering base tariff determined by GERC. • Exemption from Cross subsidy surcharge & Additional surcharge for captive consumption as well as third party sale. *(Source Website of Government of Gujarat State Energy & Petrochemicals Department , and Specific websites as mentioned on page Table no 4.3 i.e*https://geda.gujarat.gov.in/policyfiles/Waste%20to%20Energy%20Policy%202016.pdf)
Multi Year Tariff regulation 2016	• Gives predictability of electricity tariff over the control period minimizing risk for investor. • The regulation ensures standardization and reduces subjectivity in power procurement and to protect consumers' interest through a process of transparent and economic procurement of power. *(Source Website of Government of Gujarat State Energy &*

Policy / Regulation	Key Highlights
	*Petrochemicals Department , and Specific websites as mentioned on page Table no 4.3 i.e*http://www.gercin.org/uploaded/document/en 1307189397.pdf)
Open Access Regulation (2011)	• Provides flexibility to consumers with demand more than 1 MW to source cheaper electricity from different generators. • Consumers can avail Short term, Long term & Medium term open access depending on the duration of agreement. • Promotes competition by providing open platform for buyers & sellers of electricity. • Power can be sold or purchased from within the state or outside the state. • Distribution licensee shall have highest priority in allotment of open access capacity followed by Long term, Medium term & Short term applicants. *(Source Website of Government of Gujarat State Energy & Petrochemicals Department , and Specific websites as mentioned on page Table no 4.3 i*)
Demand Side Management (DSM) Regulations (2012)	• Implementing cost effective DSM initiatives in State to control, reduce and influence electricity demand by encouraging consumers to amend their electricity consumption pattern through increased adoption of energy efficient technologies. • Bulk consumers participating in DSM activities will get tariff benefits from Discoms which will lower their cost of electricity. • DSM cell will assist Discom in planning & implementation of DSM activity. • Strategic efforts to induce behavioural changes – adoption of energy efficient technologies.

Policy / Regulation	Key Highlights
	*(Source Website of Government of Gujarat State Energy & Petrochemicals Department , and Specific websites as mentioned on page Table no 4.3 i.e*http://www.gercin.org/uploaded/document/en 1338898507.pdt)
State Grid Code (2013)	• Lay down rules, guidelines & standards to be followed by various entities in developing, maintaining & operating states power infrastructure. • Provides standards & framework for carrying any work in State power infrastructure reducing technical & operational risk for EPC & other power companies. *(Source Website of Government of Gujarat State Energy & Petrochemicals Department , and Specific websites as mentioned on page Table no 4.3 i.e*http://www/gercin.org/uploaded/document/en 1408800596.pdf)
Gujarat Small Hydel Policy (2016)	• Operative period: 5 years. • State Govt. Facilitation & Nodal Agency : Gujarat Energy Development Agency (GEDA). • Power sale options : 1) Captive use, 2) Third party Sale, 3) Sale of power to Discom/obligated entities. • Exemption from Cross Subsidy Surcharge (CSS) & Additional Surcharge (AS) for Captive users & 50% exemption allowed in case of sale of power to third party under open access. • Surplus power generated can be sold to Discom at APPC if RE attributes are allowed to Discom else at 85% of APPC if RE attributes are used by consumer. • Obligated Entities may purchase power from Small Hydel Projects to fulfil their RPO at the tariff as determined by GERC or rate determined through competitive bidding. *(Source Website of Government of Gujarat State Energy &*

Policy / Regulation	Key Highlights
	*Petrochemicals Department , and Specific websites as mentioned on page Table no 4.3 i.e*http://geda.gujarat.gov.in/policy files/GUJARAT SMALL HYDEL POLICY 2016.pdf)

(Source Website of Government of Gujarat State Energy & Petrochemicals Department , and various websites as mentioned on page Table no 4.3 . 2017, December . *All*. Retrieved from https://guj-epd.gujarat.gov.in/)

Table no 4.3: Web links of major Policy & Regulations issued by Gujarat

State Policies Regulations	**Links**
Solar Policy (2015)	https://geda.gujarat.gov.in/policy files/Solar%20Power%20policy%202009.pdf
Net Metering Regulation (2016)	http://www.gerc.in.org/uploaded/document/adf57eac-f111-4b33-b447-b07ecaa34165.pdf
Wind Policy (2016)	https://geda.gujarat.gov.in/policy files/Gujarat%20Wind%20Power%20Policy-2016.pdf
Waste to Energy Policy (2016)	https://geda.gujarat.gov.in/policy files/Waste%20to%20Energy%20Policy%202016.pdf
MYT Regulation (2016)	http://www.gercin.org/uploaded/document/en 1307189397.pdf
DSM Regulation (2012)	http://www.gercin.org/uploaded/document/en 1338898507.pdt
State Grid Code (2013)	http://www/gercin.org/uploaded/document/en 1408800596.pdf
Gujarat Small Hydel Policy (2016)	http://geda.gujarat.gov.in/policy files/GUJARAT SMALL HYDEL POLICY 2016.pdf

(sources .*All*. Retrieved from https://guj epd.gujarat.gov.in/:)

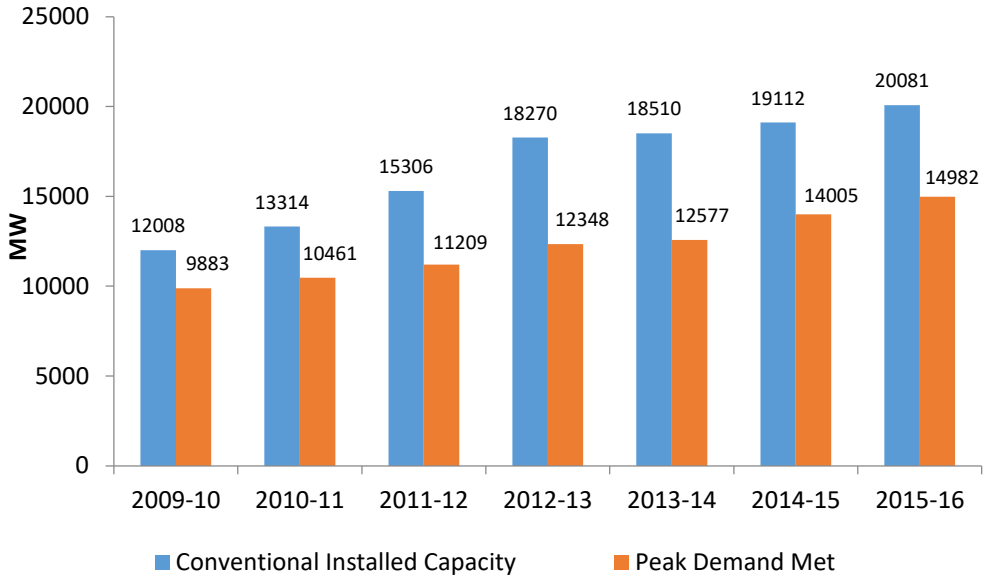
IV.1.5 Historical Demand & Supply Situation

In the last decade, State of Gujarat has remained the pioneer of the progress. The power sector utilities have driven the social economic growth, progress and prosperity.

<table>
<tr><td>• The State of Gujarat accounts for around 9% of total energy requirement in India.</td><td rowspan="2">Gujarat has been power surplus since 2009. Currently Gujarat's peak demand is 15,142 MW during F.Y. 2016-17.</td></tr>
<tr><td>• Owing to significant capacity additions in the past few years and steady reduction in T&D losses, there has been a significant improvement in the power supply position of the State.</td></tr>
<tr><td colspan="2">• State's installed capacity through conventional resources has increased at CAGR of around 8.9% in past few years.</td></tr>
<tr><td colspan="2">• Even though state's peak demand has been increasing at CAGR of 7.2%, it has been successful in mitigating increase in power demand without any load shedding.</td></tr>
<tr><td colspan="2">• Due to uninterrupted, quality and reliable power the growth is apparent and visible in all the fields viz industries, agriculture, education, health, judiciary and security system.</td></tr>
<tr><td colspan="2">• For agricultural consumers 8 hours 3 phase supply is given. Extended hours of supply is also provided to farmers to safeguard the standing crops as per the farm requirement. "</td></tr>
</table>

(Sources :*Annual Report of 2016-17.* Vadodra: State Load Desptch Center of Gujarat. Retrieved from www.sldcguj.com and Bussines plan of Gujarat Urjavikas Nigam submited to GERC.)

Figure 4 : Historic installed capacity & peak met conditions in Gujarat



(Peak demand observed is 15142 MW in FY 2016-17 (upto Dec)

(Source : GUVNL Annual Reports of (2008-2017) *as well as* (2008-2017). *Annual Reports of State Load Desptch Center*. VAdodra: State Load Desptch Center. Retrieved from www. sldcguj.com *)*

IV.1. 6 Power Generation

Gujarat has an installed capacity as on 31-03-2017 of 270574 MW. 23% of this is contributed by Renewable Energy Source

Power Generation Sector

"The State has planned augmentation of generation capacity considering current demand supply situations as well as demand from upcoming consumers.

- Current installed capacity as **on 31-03-2017 of** 27054 MW – Conventional 20459 MW, Renewable 6598 MW.
- Gujarat contributes to nearly 9% of total installed capacity of the country.
- Gujarat has remained front runner in climate efficient initiatives by adapting various renewable Energy Sources are ;

- Wind 5318 MW
- Solar 1230 MW
- Biomass 41 MW
- Mini Hydel 9 MW

- Another significant fact that contributes to excellent power conditions in State is the dominance of private players in the generation sector. Private sector contributes to around 48% of total power generation followed by State Utilities with 36% and Central Plants having contribution of 16.%
- (Sources: **Reports of 2005 to 2017 of *Managment Information Sysytem of Gujarat State*** *Electricity Corporatin* . Vadodara: Gujarat State Electricity Corporatin.) (Corporatin, 2005-2017) "

Table No.4.4 Sector wise installed Capacity (in MW).in Gujarat.

Installed Capacity (MW)	AS on 31-03-2017	% of total Installed Capacity
State Sector	5996.67	22.16
Private Sector	8411.86	31.09
Central Sector	6051.44	22.37
Wind Farm	5318.38	19.66
Solar	1229.6	4.54
Bio mass	41.10	0.15
Mini Hydro	8.56	0.03
Total	27057.61	100.00

(Sources: **Reports of 2005 to 2017 of *Managment Information Sysytem of Gujarat State*** *Electricity Corporatin* . Vadodara: Gujarat State Electricity Corporatin.) (Corporatin, 2005-2017)

Figure No.5 Sector wise installed Capacity (in MW).in Gujarat.

(Gujarat, 2017)

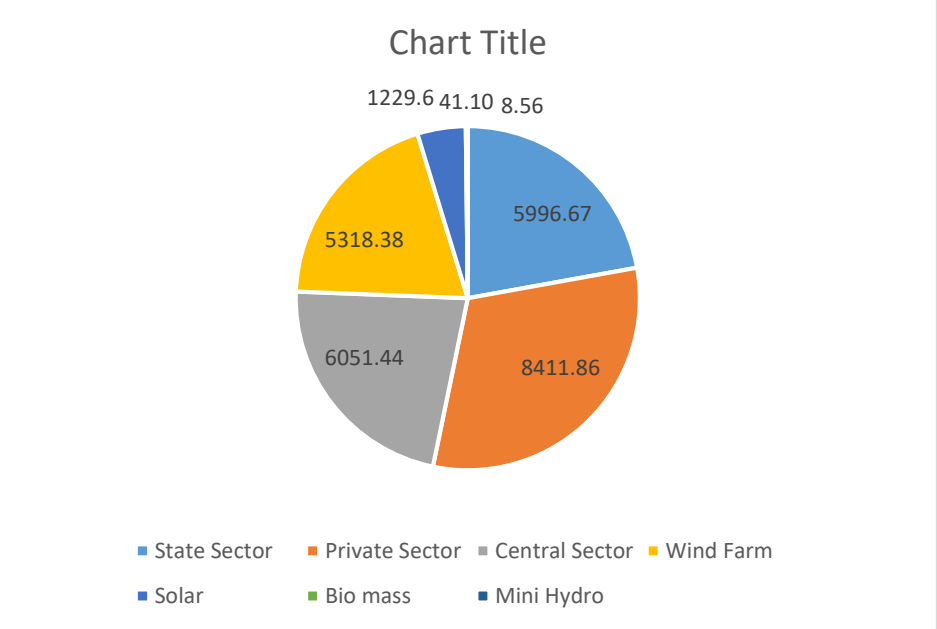
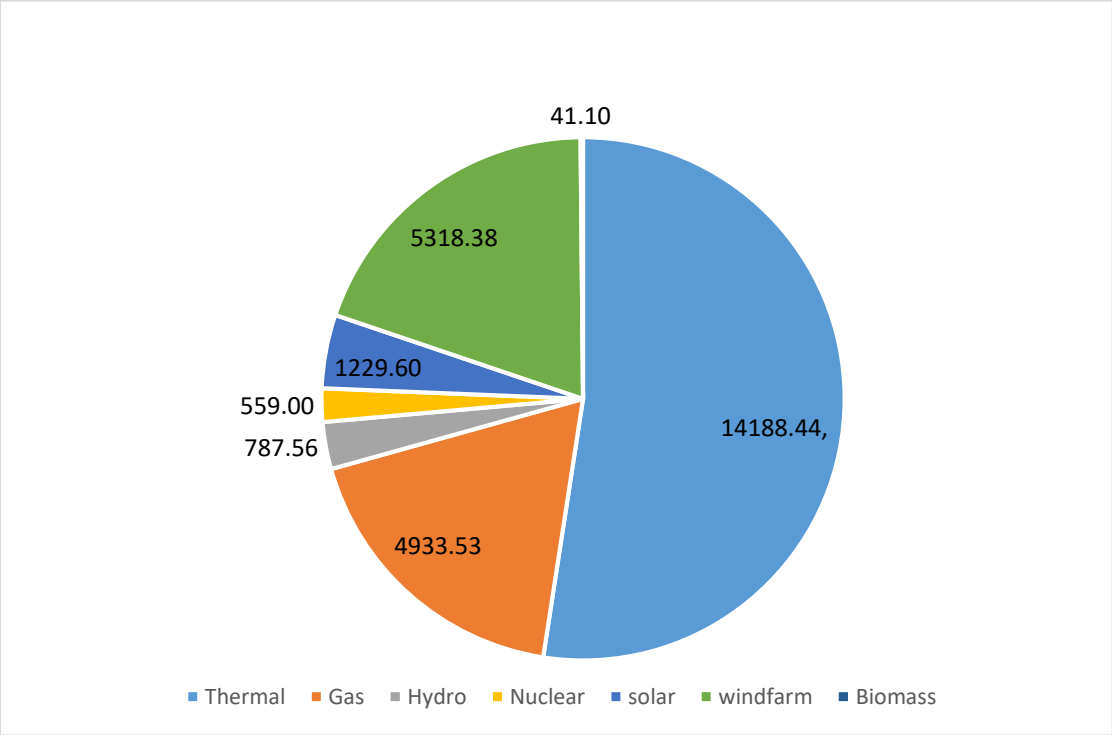


Table No.4.5 Fuel wise Installed Capacity as on 31-03-2017

Installed Capacity fuelwise Period as on 31-03-2017	MW	% of fuelwise Installed Capacity
Thermal	14188.44	52.44
Gas	4933.53	18.23
Hydro	787.56	2.91
Nuclear	559.00	2.07
solar	1229.60	4.54
windfarm	5318.38	19.66
Biomass	41.10	0.15
Total	27057.61	100.00

(Sources: **Reports of 2005 to 2017 of *Managment Information Sysytem of Gujarat State Electricity Corporatin*** . Vadodara: Gujarat State Electricity Corporatin.) (Corporatin, 2005-2017)

Figure 6 : Fuel wise installed capacity (MW) in Gujarat



(Source : Annual Report of SLDC Gujarat for the year 2016-17.) (Board., 1990-2016)

IV.1.7 Conventional Capacity addition

The regulations and new policies have given a positive momentum to capacity addition in past years. Generation capacity addition in Coal based thermal plants has been significant along with solar & wind.

- Two of the largest Power Projects in the country i.e. 4620 MW (AdaniMundra Project) and 4000 MW (Mundra UMPP of Tata Power) is located in the Gujarat.
- Torrent Power is operating 3139 MW of conventional power projects in different parts of the State.
- In last six years State utilities has added capacity of 7214 MW in coal, 1429 MW in gas, 2424 MW in wind and 1127 MW in Solar projects.
- By 2022 state utilities has planned to add 3540 MW from conventional sources.
- During the same time it is expected that around 8000 MW from renewable sources will be available in the State. “

- (Sources :Govt of Gujarat Eergy & petrochemicals Department . its websitte https://guj-epd.gujarat.gov.in/: www.https://guj-epd.gujarat.gov.in/ refer in moth of December 2017.)

Table no 4.6: Fuel wise cumulative conventional capacity addition plan of State utilities till 2022 (MW)

Fuel	Conventional Capacity as on 31-03-2016	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Coal	12313	12600	13107	13907	14127	14127	15127
Gas	4850	4850	4850	4850	4850	4850	4850
Lignite	1290	1540	1540	1540	1540	1540	1540
Hydro	779	779	779	779	779	779	779
Nuclear	559	559	797	1035	1035	1035	1035
Total	19791	20238	21073	22111	22331	22331	23331

(Sources :Govt of Gujarat Eergy & petrochemicals Department . its websitte https://guj-epd.gujarat.gov.in/: www.https://guj-epd.gujarat.gov.in/ refer in moth of December 2017.)

IV.1. 8 Comfortable Power Scenario – Advantage Gujarat

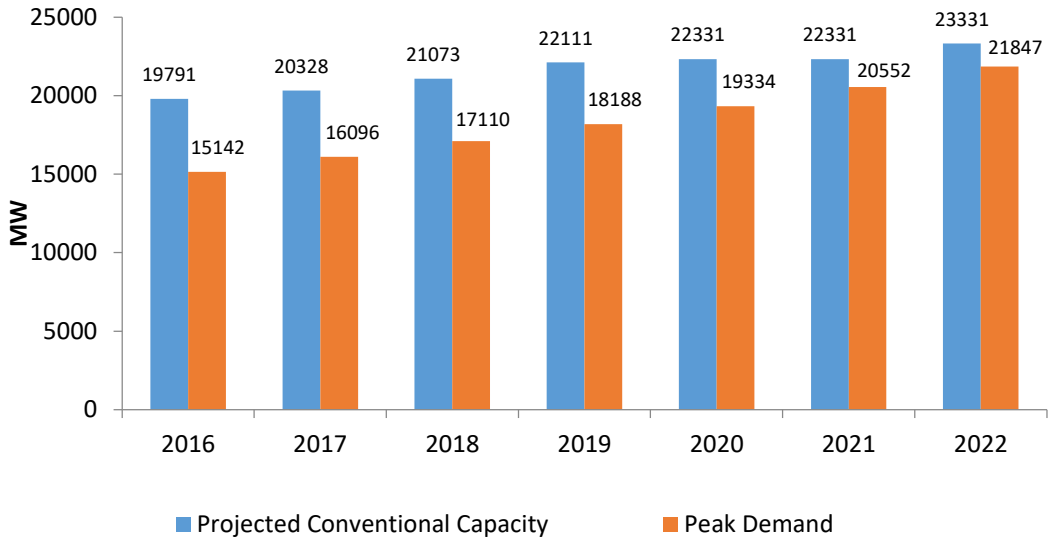
"Gujarat is on the verge of infrastructure revolution.

- State's gross domestic product has been rising at growth rate of 9.3% over the decade.
- State is involving integrated developments of large areas like SIRs, PCPIR and DMIC to transform the industrial scenario in the State. India's first SEZ for global financial services GIFT emerges as a fore runner of new opportunities in Gujarat.
- Owing to the high pace of development peak demand of State is expected to reach 21,847 MW by 2022 at a CAGR of 6.3%.
- State has made adequate planning to meet the upcoming demand.
- Considering the focus of Government of India on promoting renewable energy sources State would be required to add 8000 MW of renewable energy by 2022.

- (Sources : researcher on collected information from the website of Govt of Gujarat Eergy & petrochemicals Department . its websitte https://guj-epd.gujarat.gov.in/: www.https://guj-epd.gujarat.gov.in/ , GUVNL www.gseb.com.)

"Owing to adequate generation capacity tie up and planning Gujarat will remain power surplus till FY 2022.''

Figure No 7 Projected Conventional Capacity and Peak demand.



(Sources :Govt of Gujarat Eergy & petrochemicals Department . its websitte https://guj-epd.gujarat.gov.in/: www.https://guj-epd.gujarat.gov.in/ refer in moth of December 2017 .)

State has identified capacity addition requirements in generation, transmission & distribution segments to meet its power needs.

IV.1. 9 Gujarat State Electricity Corporation Ltd.

The generation company surfaces noteworthy contests and prospects in wake of numerous forces that have been presented in the commercial setting since the enactment of the Electricity Act, 2003. These forces range from change in foundation and movement for guideline to overview of rivalry in extensive as well as trade power marketplaces.Under the

Financial Restructuring Plan (FRP) formulated for the power sector in the state, financial projections have been developed for each unbundled entity keeping in mind various measures to be undertaken by the entity. The FRP has also provided opening balance sheets to each entity. As a part of the reform process, the Government of Gujarat has unbundled the various functions of GEB. As a result of this unbundling, electricity generation has been entrusted to the already existing company - Gujarat State Electricity Corporation Limited (GSECL).

Residual Life Assessment

GSECL plant portfolio is of considerable vintage. Life extension projects yield positive cost benefit analysis only if executed well in time. Therefore, to identify the current status and the corresponding need for R&M in terms of timeframe & capital expenditure and the resultant efficiency improvement, residual life assessment and related studies need to be conducted. The same should be completed for all the units that are past more than 50% of their life.

1. Government Support

Government Support is critical for GSECL to achieve the capacity addition and R&M targets for the business plan period. Government Support is envisaged to be in the form of equity contribution. The same has been determined after assuming reinvestment of cash generated from GSECL operations assuming an a debt equity ratio of 70:30. The equity contribution of Government will, therefore, be dependent on the revenues of GSECL.

Prominent Players in Generation Sector

Following are some prominent players with significant generation capacity in the State.

Gujarat State Electricity Corporation Ltd.	Gujarat Industries Power Co. Ltd.	GSEG	Gujarat Pipaval Power Company Ltd.
Adani Power Co. Ltd.	Reliance Power	LANCO	Tata Power
GMR Group	Torrent Power	Moserbeer Clean Energy Limited	Essar
IPCL	Acme Solar	Azure Power	AES Solar
SUN EDISION	WELSPUM	SUZZLON	BECL
CLP ENERGY	KIRAN ENERGY	HIRCO	

(Source : Annual Report of SLDC Gujarat for the year 2016-17.)

IV.1.10 Overview of Power Transmission

With System Availability of 99.6% GETCO operates a network of 55468 ckt KM and capacity of 105200 MVA

The peak power demand of Gujarat is 15142 MW, this demand is expected to grow significantly due to increasing commercial and industrial activities. State Transmission utility GETCO has provided a robust & reliable Inter-state & Inter-state transmission network with system availability of 99.6% at average transmission losses of 3.68% ensuring 24*7 quality power supply. It also provides non discriminatory open access to eligible consumers as pre GERC guidelines.

The transmission infrastructure of State in FY 16 is as follows :

Table no.4. 7: Transmission asset of GETCO

Voltage Class	Sub-station (Nos)	Transmission Line (ckm)	Transformation Capacity (MVA)
400 KV	13	4301	13505
220 KV	99	17847	28690
132 KV	55	5333	8275
66KV / 33 KV	1504	27987	41074
Total	1671	55468	91544

(Sources: *Annual Report of 2016-17.* Vadodra: State Load Desptch Center of Gujarat. Retrieved from www.sldcguj.com(Gujarat S. L., 2017)

GETCO is the STU for the State of Gujarat whereas PGCIL is handling the Inter-State transmission of Power. Inter-State EHV transmission system consists of 418 ckt km of 765 kv, 4740 ckt of 400 kv and 1000 ckt km of 220 kv with transformation capacity of 6965 MVA.

Table no 4.8 : Existing Interstate Transmission System in Gujarat

Sub-Station type	Category	No. of Sub-stations	Transformer Capacity (MVA)
765 KV Grid Sub-Station (PGCIL)	Inter-state	1	3000
400 KV Grid Sub-station (PGCIL)	Inter-state	5	3965

(Source : Annual Reports of Gujarat Energy Transmission Corporation Ltd. Of 2015 to 2017.)

Historical Growth in transmission sector

Considering the ever increasing demand of electricity across State and capacity addition at the generation side, transmission network has strengthened leading to total investment of around 12103 Cr over last five years.

Table no 4. 9: Historic capacity addition

Sr.No.	Particulars	FY 2012	FY 2013	FY 2014	FY 2015
1	Number of Sub-stations added	80	80	120	100
2	Transmission Line addition (ckt Km)	3251	3027	2160	2400

(Source : GETCO Tariff orders (2017, April 24). *Gujarat Electricity Regulatory Commission*. Retrieved from www.gercin.org: www.gercin.org)

Capacity addition in transmission sector

Expected electricity requirement of Gujarat by FY 2021-22 would be around 1,29,549 MU. In order to match above capacity addition, GETCO has planned to increase its number of sub stations & interstate transmission line with investment of around 15,234 Cr in next five years. By FY 2022 GETCO will have transmission asset of total 2166 sub stations & 68168 ckm of transmission line details of which have been given in the following table :

Table no.4. 10 : Transmission asset by 2022

Year	Sub-station (Nos)	Transmission Line (ckm)
FY 2016-17	100	2400
FY 2017-18	100	2200
FY 2018-19	80	2100
FY 2019-20	75	2000
FY 2020-21	70	2000
FY 2021-22	70	2000

(Source : GETCO ‘s MYT petition and its order of *Gujarat Electricity Regulatory Commission*. Retrieved from www.gercin.org: www.gercin.org , (2017, April 24))

IV.1.11 Over view of Power Distribution Sector

" Gujarat is the first State in the Country to achieve 100% Electrification. The Discoms are among the Best Performers in the Country."

State topography has been distributed in four regions and each region has been allotted to a State distribution company.

- It is responsibility of State distribution Company to supply electricity to consumers in that particular region.
- State took major step in allowing private participation in the distribution business.
- Torrent power has been appointed as distribution licensee for supplying electricity in Surat, Ahmedabad &Gandhinagar and Dahej.
- Total energy available to State in FY 2015-16 is around 94,025 MUs. (SLDC)
- Around 78,147 MU's of electricity is being supplied by State Discoms& Torrent power to their consumers. "

Table no.4.11: Key Highlights of State Discoms in FY 2016

Sr. No.	Data	Unit	PGVCL	DGVCL	MGVCL	UGVCL
1	Divisions	Nos.	45	19	18	21
2	Sub-stations	Nos.	240	121	113	133
3	HT/LT ratio	Nos.				
4	Number of distribution transformers	Nos.	563381	115076	111736	222666
5	Number of Consumers	Nos.	4718113	2942674	2913548	3194710
6	Number of Employees	Nos.	13657	6793	7340	7940
7	SAIFI	Nos.	86.36	94.73	53.34	35.74
8	SAIDI	Hr:Min	146:29	132:48	63:48	69:25
9	Reliability Index	%	98.32	98.48	99.96	99.21
10	Distribution Transformer failure rate	%	11.97%	4.29%	3.91%	4.87%

(Source : Annual Reports of GUVNL and Subsidiaries Companies related to F.y 2015-16 & 2016-2017.)

V.1.12 Rural Electrification: Gujarat is the first State in India to achieve 100% electrification.

In Gujarat around 57% of total population live in rural areas. Access to electricity is one of the prime needs for their development. Government has given impetus to rural electrification through various State level policies. Presently all rural households have been electrified by State Discoms.

IV.2 Installed Generation Capacity of Power .

IV.2.1 Installed Generation Capacity of India , Gujarat state and GSECL

Table No. 4.12 Installed Generation Capacity of India ,Guajarat state and GSECL.

At the end of March	INDIA	GUJARAT	GEB/GSECL
1961(End of the 2nd Plan)	4653	331	143
1966(End of the 3rd Plan)	9027	666	293
1974(End of the 4th Plan)	16664	662	730
1979(End of the 5th Plan)	26680	1763	1355
1985(End of the 6th Plan)	42585	3314	2490
1990(End of the 7th Plan)	63636	4696	3402
1997 (End of the 8th Plan)	85795	6630	4375
2002 (End of the 9th Plan)	105046	8621	4888
2007 (End of 10th Plan)	132329	9561	4968
2012 (End of 11th Plan	199877	18093	5006
2017(End of 12th Plan	319606	27057	6021

(Sources : *Growth of Electricity Sector in India from 1947-2017.* Delhi**:** Central Eletricity Authority of India. Retrieved from www.cea.nic.in/reports and Govt of Gujarat Eergy & petrochemicals Department . its websitte https://guj-epd.gujarat.gov.in/: www.https://guj-epd.gujarat.gov.in/ refer in moth of December 2017.)

1. Government of India was able to increase installed capacity of power only by 2941MW during First thirteen years from independent. it menace 226 MW annually. ,which is equivalent to 172 %. In spite of this 172% increase in installed capacity was very low as per the planning of GoI. This was mainly , Due to financial and physical constrain after independent .

2. Government of India was able to increase installed capacity of power only by 58963 MW between the III rd Five year plan to VI five year plan (1st April ,1961 to 31st March,1990) . Goi able to expand 1965 MW annually. Addition of installed capacity is a about more than 13 times of 4653 MW as on end of March 1961. However increaseof installed capacity more than 13 time against requirement increase about more than 22 times (21754 village was electrified in 1961 as against 470838 village electrified) over and above Per capita consumption also increase from 46 KWH to 329KWH.
3. During the period from seventh Five year i.e 1st April 1990 to end of the ninth Five year plan i.e 31st March 2018 I.e 28 years of reform of power sector capacity reach to 344002 MW. From 63616MW. (net increase by 280386 MW.i.e 10013MW Average Annually MW) as a consequence We had electrified more 490399 villages as well as Per capita Consumption up to 559 KWH.as against 46 KWH of 1990.
4. Thus Government able to achieve the advantages of Reform of Power sector.
5. Government of Gujarat established w.e.f 1st May, 1960.with installed capacity of 331 MW on bifurcation of State of Mumbai. In spite of shortages of Physical as well as financial limitation ,GoG was able to increase installed capacity of 4365 MW during first thirty years i.e. 1961 to 1990. Annually increase installed capacity about 146 MW.
6. After reform of power sector process initiated , Gujarat achieved the additional capacity of 22361 MW during the period from 1991 to 2017. i.e 828MW P.A. Considering the installed capacity Gujarat capacity was 7.11% of total installed capacity of India. However , Gujarat installed capacity achieve 8.74% of total installed capacity of India.
7. GEB. establishedw.e.f 1st May, 1960.with installed capacity of 143 MW on bifurcation of State of Mumbai. In spitof newly bifurcated state with acute shortages of Physical as well as financial resources.GEB was able to increase installed capacity of 3259 MW during first thirty years i.e. 1961 to 1990. Annually increase installed capacity about 109 MW. Originally GEB share in Gujarat capacity was 43.20% but end of the march 1990 share of installed capacity increase to the level of 74.66%.Gog was generally dependent on GEB.

8. After reform of power sector process initiated, GEB was unbundling into Generation Transmission and Distribution separate company. GSECL is Generating Company . GSECL able to expand additional capacity of 2619 MW during the period from 1991 to 2017. i.e 97 MW P.A. Considering the installed capacity GSECL capacity is 22.25% of total installed capacity of Gujarat. As a result of reform private share increase in power sector.

9. GEB. establishedw.e.f 1st May, 1960.with installed capacity of 143 MW on bifurcation of State of Mumbai. In spitof newly bifurcated state with acute shortages of Physical as well as financial resources.GEB was able to increase installed capacity of 3259 MW during first thirty years i.e. 1961 to 1990. Annually increase installed capacity about 109 MW. Originally GEB share in Gujarat capacity was 43.20% but end of the march 1990 share of installed capacity increase to the level of 74.66%.Gog was generally dependent on GEB.

10. After reform of power sector process initiated, GEB was unbundling into Generation Transmission and Distribution separate company. GSECL is Generating Company . GSECL able to expand additional capacity of 2619 MW during the period from 1991 to 2017. i.e 97 MW P.A. Considering the installed capacity GSECL capacity is 22.25% of total installed capacity of Gujarat. As a result of reform private share increase in power sector.

Table no 4.13 Installed Generation Capacity of GEB/GSECL in MW.

SL.No	Year	Thermal			Total	Hydro	RES	Total
		Coal/Lignite	Oil	Gas				
1	1995-96	3150	534	189	3873	427	0	**4300**
2	1996-97	3225	534	189	3948	427	0	**4375**
3	1997-98	3435	534	189	4158	427	0	**4585**
4	1998-99	3645	534	189	4368	547	0	**4915**
5	1999-00	3645	534	189	4368	547	0	**4915**
6	2000-01	3645	534	189	4368	547	0	**4915**
7	2001-02	3645	534	162	4341	547	0	**4888**
8	2002-03	3645	534	162	4341	547	0	**4888**
9	2003-04	3645	534	269	4448	547	0	**4995**
10	2004-05	3645	534	269	4448	547	0	**4995**
11	2005-06	3645	534	242	4421	547	0	**4968**
12	2006-07	3645	534	242	4421	547	0	**4968**
13	2007-08	3645	220	354	4219	547	0	**4766**
14	2008-09	3645	220	354	4219	547	10	**4776**
15	2009-10	3720	220	729	4669	547	10	**5226**
16	2010-11	3720	0	729	4449	547	10	**5006**
17	2011-12	3720	0	729	4449	547	10	**5006**
18	2012-13	4220	0	729	4949	547	10	**5506**
19	2013-14	4220	0	729	4949	547	12	**5508**
20	2014-15	4220	0	729	4949	547	12	**5508**
21	2015-16	4720	0	729	5449	547	12	6018

SL.No	Year	Thermal			Total	Hydro	RES	Total
		Coal/Lignite	Oil	Gas				
22	2016-17	4480	0	970	5450	547	12	6021

(SourcesGovt of Gujarat Eergy & petrochemicals Department . its websitte https://guj-epd.gujarat.gov.in/: www.https://guj-epd.gujarat.gov.in/ and MIS reports of GEB/GSECL)

GSECL is generating company of GUVNL /GoG as a process of reform of power sector. after unbundling GSECL has installed capacity of 6021MW as on 31/03/2017 against 4995MW .During period additional installed capacity of 1788 MW including 1075MW of coal, 701 MW of Gas and 12MW of RES.(10MW of Wind and 20MW of Solar.) . Simultaneously 774MW (534MW of Oil & 240 MW of Coal) decommissioned. Considering the total addition 36% increase in installed capacity post reform period. (net increase 31%).

IV. 3 Generation of power before and after unbundling of GEB./GSECL

Table no 4.14 Generation of power before unbundling of GEB.

Year end march	Over all Generation of Gujarat	Generation of GEB	%Share of GEB/GSECL of Gujarat power sector
1995	32909	21984	66.8
1996	36730	23042	62.73
1997	37964	22905	60.33
1998	41494	4.14	57.38
1999	45103	23151	51.33
2000	49378	23179	46.94
2001	50507	23327	46.19
2002	50069	22920	45.78
2003	55127	22822	41.4
2004	54727	21363	39.04
2005	58211	27989	48.08

(Sources: Researcher on collection and calculation from various reports refer of Power sector and MIS of GEB/ GSECL and GoG .during study.)

Table no. 4.14 Generation of power before reform was more than70% ,However after initiating unbundling of GEB share of generation is going down . the Main reason of decreasing share in generation due more and more IPP. Private players come forward for power plants .

Table No 4.15Generation of power after unbundling of GEB. i.e GSECL

Year end march	Over all Generation of Gujarat	Generation of GEB	%Share of GEB/GSECL of Gujarat power sector
2006	58724	27130	39.39
2007	61539	27534	44.74
2008	66545	29241	43.94
2009	68963	28406	41.19
2010	69883	28507	40.79
2011	71255	27762	38.96
2012	78650	28837	36.66
2013	87723	23631	26.94
2014	86221	15850	18.38
2015	96637	21415	22.16
2016	103137	19225	18.64
2017	103705	16254	15.67

(Sources: Researcher on collection and calculation from various reports refer of Power sector and MIS of GEB/ GSECL and GoG .during study.)

Table No 4.15Generation of power after unbundling of GEB. i.e GSECL clearly indicate the impact of liberation of power sector and implementation of Merit Order Operations. Due to considering all effect share in generation is going reduce progressively. i.e from 69% to 16%.

IV.4 Analysis of Technical Performance.

IV.4.1 The performance of parameters of power plant can be expressed through some common performance factors viz;

(1) Plant Availibilty Factor (in %)
(2) Plant load Factor.
(3) Heat Rate.(Energy efficency)
(4) Thermal Efficency
(5) Auxiliary Consumption.

ELECTRICAL OUTPUT.

Power plant electrical output is one of the most important and critical parameters of an overall performance evaluation. Once power plant electrical output has been determined, it can be corrected to reference condition to provide a comparison of current plant power output to rated output. This is very important so that contract guarantees can be confirmed and /or changed in performance can be tracked over time.

To determine the combined cycle performance of several operational parameters need to be considered to estimate properly the corrected combined cycle performance in terms of electrical output.

Since these parameters are intimately tied to the revenue generated by the plant, high precision measurements are required in order to ensure the highest accuracy value for this parameter.

IV.4.2 Plant Availability Factor (in %)

The availability factor of a power plant is the amount of time that it is able to produce electricity over a certain period , divided by the amount of the time in the period.

IV.4.3 Plant load Factor (in %).

Plant Load Factor is the ratio between the actual energy generated by the plant to the Maximum possible energy that can be generated with the plant working at its rated power and for a duration of an entire year.

$$PLF\ \% = \frac{\text{Total Generation}}{\text{Installed Quantity./Capacity}}$$

Table No.4.16 Plant Load Factor (%)

Year	Central	State	Private	Over	GEB/GSECL
1997-98	64.7	70.4	60.9	71.2	65.36
1998-99	64.6	64.6	60.7	68.0	63.50
1999-00	67.3	67.3	63.7	68.9	64.34
2000-01	74.3	65.6	73.1	69.0	67.85
2001-02	74.3	67.0	74.7	69.9	68.14
2002-03	77.1	68.7	78.9	72.1	69.69
2003-04	78.7	68.4	80.5	72.7	64.72
2004-05	81.7	69.6	85.1	74.8	70.01
2005-06	82.1	67.1	85.4	73.6	68.01
2006-07	84.8	70.6	86.3	76.8	67.53
2007-08	86.7	71.9	90.8	78.6	76.19
2008-09	84.3	71.2	91.0	77.2	75.32
2009-10	85.5	70.9	82.4	77.5	72.48
2010-11	85.1	66.7	76.7	75.1	67.48
2011-12	82.1	68.0	76.2	73.3	71.35
2012-13	79.2	65.6	64.1	69.9	58.28
2013-14	76.1	59.1	62.1	65.5	34.20
2014-15	74.0	59.8	60.6	64.5	47.05
2015-16	73.1	59.7	61.5	64.4	40.14
2016-17	71.8	55.2	59.4	61.6	31.80

(Sourcess**.** Various Reports on *Managment Information Sysytem of Gujarat State Electricity Corporatin during relevent period. Of study* Vadodara:)

IV.4. 4 STATION HEAT RATE (Energy efficiency)

Heat Rate is defined as the Gross input heat required to produce one unit. As in simple terms it indicates the amount of fuel required to generate one unit of electricity, the station heat rate of a power plant directly indicates its performance. Performance parameters tracked for any thermal power plant like efficiency, fuel costs, plant load factor, emissions level, etc

are a function of the Station heat rate and can be linked directly. It accounts for all generation requirements including the core BTG as well as the auxiliary consumption and is typically represented in Btu/kWh or kJ/kWh or kcal/kWh. Gross heat rate is a function of the turbine heat rate and boiler efficiency. The net heat rate would further bring the APC% or the auxiliary power consumption to the defining loop.

COMPUTATION OF HEAT RATE (Ratio of Heat input to gross Generation)

$$\text{HEAT RATE} = \frac{\text{COAL CONSUMPTION MULTYPLY BY COAL GCV}}{\text{GROSS GENERATION.}} \text{ -=KCL/KWH}$$

Table No.4.17 HEAT RATE (KCAL/KWH)

YEAR	HEAT RATE (KCAL/KWH)				
	UKAI TPS	GTPS	WTPS	STPS	KLTPS
1997-98	2644	2511	2509	2516	3787
1998-99	2760	2455	2501	2480	3329
1999-2000	2536	2456	2528	2501	3349
2000-01	2595	2489	2472	2506	3404
2001-02	2608	2513	2464	2665	3250
2002-03	2590	2505	2459	2725	3662
2003-04	2675	2534	2515	2835	3521
2004-05	2680	2535	2534	2909	3802
2005-06	2721	2677	2658	2925	3355
2006-07	2745	2919	2562	2826	3197
2007-08	2769	2662	2599	3064	3583
2008-09	2731	2655	2616	3044	3397
2009-10	2717	2793	2625	3049	3520
2010-11	2850	2820	2624	2971	3507
2011-12	2764	2647	2597	3014	3509
2012-13	2741	2637	2609	3002	3239
2013-14	2739	2538	2631	3009	3185
2014-15	2673	2617	2639	2996	2951
2015-16.	2636	2548	2661	3116	3049
2016-17	2576	2525	2621	2763	3169

(Sourcess**.** Various Reports on *Managment Information Sysytem of Gujarat State Electricity Corporatin during relevent period. Of study* Vadodara:)

IV.4.6 AUXILIARY CONSUMPTION OF POWER PLANT.

In any thermal power generation cycle components will always require auxiliary equipment to operate efficiently and safely. It can measure and analyse the auxiliary systems and troublesome equipment to ensure optimisation of the plant net electrical output. This is a critical measurement to include as one of the power plant performance parameters to evaluate.

The auxiliary consumption is a real challenge to improve. It is has a direct impact in the power plant Heat rate.

Table No.4.18 % of Auxiliary Consumption

Year end 31st March	% of Auxiliary Consumption	Year end 31st March	% of Auxiliary Consumption
1995	8.79	2006	9.24
1996	8.88	2007	9.48
1997	10.06	2008	9.30
1998	9.18	2009	9.04
1999	10.09	2010	8.84
2000	9.75	2011	9.17
2001	9.65	2012	8.96
2002	9.37	2013	9.62
2003	9.38	2014	10.60
2004	9.79	2015	9.87
2005	9.66	2016	9.27
		2017	9.31

(Source**s.** Various Reports on *Management Information Sysytem of Gujarat State Electricity Corporatin during relevent period. Of study* Vadodara:)

IV.4.7 SPECIFIOC OIL CONSUMPTION

Table No.4.19 SPECIFIOC OIL CONSUMPTION (in kl/Kwh)

YEAR	UKAI TPS	GTPS	WTPS	STPS	KLTPS
1997-98	11.53	9.41	1.47	2.12	18.77
1998-99	4.82	7.58	0.62	6.21	10.75
1999-2000	3.90	8.14	0.70	2.47	7.30
2000-01	1.76	4.52	0.57	2.50	6.75
2001-02	0.86	1.52	0.38	2.36	4.37
2002-03	0.94	0.99	0.58	1.44	3.68
2003-04	1.73	3.83	0.92	3.01	3.45
2004-05	1.52	5.76	0.42	0.88	4.18
2005-06	1.11	3.64	0.61	1.41	2.97
2006-07	2.87	2.87	0.71	2.94	5.10
2007-08	2.16	2.16	0.72	3.05	3.58
2008-09	5.92	5.92	0.49	5.36	3.68
2009-10	3.68	3.68	0.70	4.49	3.52
2010-11	3.77	3.77	0.74	3.48	4.69
2011-12	1.55	1.55	0.79	5.28	7.04
2012-13	1.08	1.08	0.70	2.43	4.54
2013-14	1.92	1.92	1.25	3.22	2.64
2014-15	1.54	1.54	0.87	1.52	2.73
2015-16.	0.80	0.77	0.92	6.72	4.00

CHAPTER IV ANALYSIS OF THE TECHNICAL PERFORMANCE OF POWER PLANTS OF THE GENERATING COMPANY.

(Sourcess**.** Various Reports on *Managment Information Sysytem of Gujarat State Electricity Corporatin during relevent period. Of study* Vadodara:)

(6) Coal Factor

Table No.4. 20 COAL FACTOR (in Kg

YEAR	UKAI TPS	GTPS	WTPS	STPS	KLTPS
1997-98	0.830	0.657	0.701	0.666	1.43
1998-99	0.737	0.745	0.710	0.726	1.22
1999-2000	0.708	0.700	0.718	0.625	1.16
2000-01	0.690	0.620	0.690	0.640	1.18
2001-02	0.719	0.583	0.653	0.662	1.13
2002-03	0.676	0.610	0.678	0.638	1.18
2003-04	0.693	0.644	0.681	0.681	1.16
2004-05	0.676	0.641	0.688	0.713	1.23
2005-06	0.663	0.589	0.675	0.673	1.10
2006-07	0.674	0.665	0.674	0.629	1.09
2007-08	0.702	0.700	0.699	0.726	1.26
2008-09	0.713	0.679	0.700	0.813	1.36
2009-10	0.697	0.656	0.691	0.812	1.38
2010-11	0.739	0.696	0.715	0.817	1.20
2011-12	0.719	0.679	0.711	0.856	1.21
2012-13	0.713	0.661	0.704	0.759	1.14
2013-14	0.710	0.653	0.687	0.721	1.09
2014-15	0.681	0.645	0.699	0.724	1.02
2015-16.	0.673	0.641	0.687	0.647	1.07

(Sourcess**.** Various Reports on *Managment Information Sysytem of Gujarat State Electricity Corporatin during relevent period. Of study* Vadodara:)

IV 5 New projects PRE & POST Reform of GEB.

Pre and Post reform periods.

Pre reform periods means period before reforms of power sector starts. Reform starts from 1990 onwards so period before 1990 i.e 1948 to 1990 is pre reforms period. Post Reforms period after 1990 onwards. 1990 to continue upto date

Addition of Power Plants in Gujarat Electricity Board (GEB)

Table No.5.2 Addition of Power Plants in Gujarat Electricity Board (GEB)

Pre reform period, erstwhile Gujarat Electricity Board had added power generating capacity of 4767 MW and spent Rs. 4591.52 crores. It means per year 159 MW generating capacity is added and Rs. 153 crores is spent for Project Cost. While after post reform period, there was a total addition by GSECL (Govt. Own Company) 2489 MW, which means 226 MW addition per year with a project cost of Rs.834 crores per year .It shows that during the reform period as also due to liberalization, power generating capacity is increased substantially. Annually increase by 159 MW during Pre reform period while post reform period annually increase 226 MW. i.e 42% higher p.a Further, the addition of 800 MW at wankbori Thermal and 150 MW of Solar capacity is under construction stage.Up to pre reform period, there was no initiative of renewable energy. However, after reform period, Govt. has initiated to generate renewable energy, and during this period 6597 MW (1258MW of Solar +5339MW of Wind) of renewable energy is installed in Gujarat, out of which, GSECL has installed 24 MW of renewable energy and addition of 150 MW of Solar is under process. So after reform period, addition of renewable energy is increasing day by day.

(Sourcess**.** Various Reports on *Managment Information Sysytem of Gujarat State Electricity Corporatin during relevent period. Of study* Vadodara:)

IV.6 Renovation and Modernization of Thermal Power Plant

1. Introduction

Renovation and Modernization of Thermal Power Plants

Renovation and Modernization (R&M) means a set activities to improved or maintain original efficiency of Plant and machinery. There are two types Renovation and Modernization (R&M) i.e

1) Complete Renovation and Modernization (Major R&M) and
2) Need base Renovation and Modernization . (Minor R&M)

Complete Renovation and Modernization is carried out when full main plant i.eBoiler,Turbine or Rotor etc. to improve to original capacity. Under this long time about one year is requiredand cost per MW about Rs.1.00 to Rs. 1.50 Crs while Need base Renovation and Modernization for particulars parts improvement required less time and cost depends how much works undertaking.

Table No.4. 21 Year-wise PLF

Year	PLF
1976-77	55.9%
1977-78	51.4%
1978-79	48.3%
1979-80	44.7%
1980-81	46.%

As a result, thermal generation fell short of the targets, leading to a power shortage of about 11%, as compared to the requirement at that time.

(Sources :Central Electricity Authority of India www.cea.nic.in/. Retrieved August 12, 2017, from Central Electricity Authority of India www.cea.nic.in/: www.cea.nic.in)

CHAPTER IV ANALYSIS OF THE TECHNICAL PERFORMANCE OF POWER PLANTS OF THE GENERATING COMPANY.