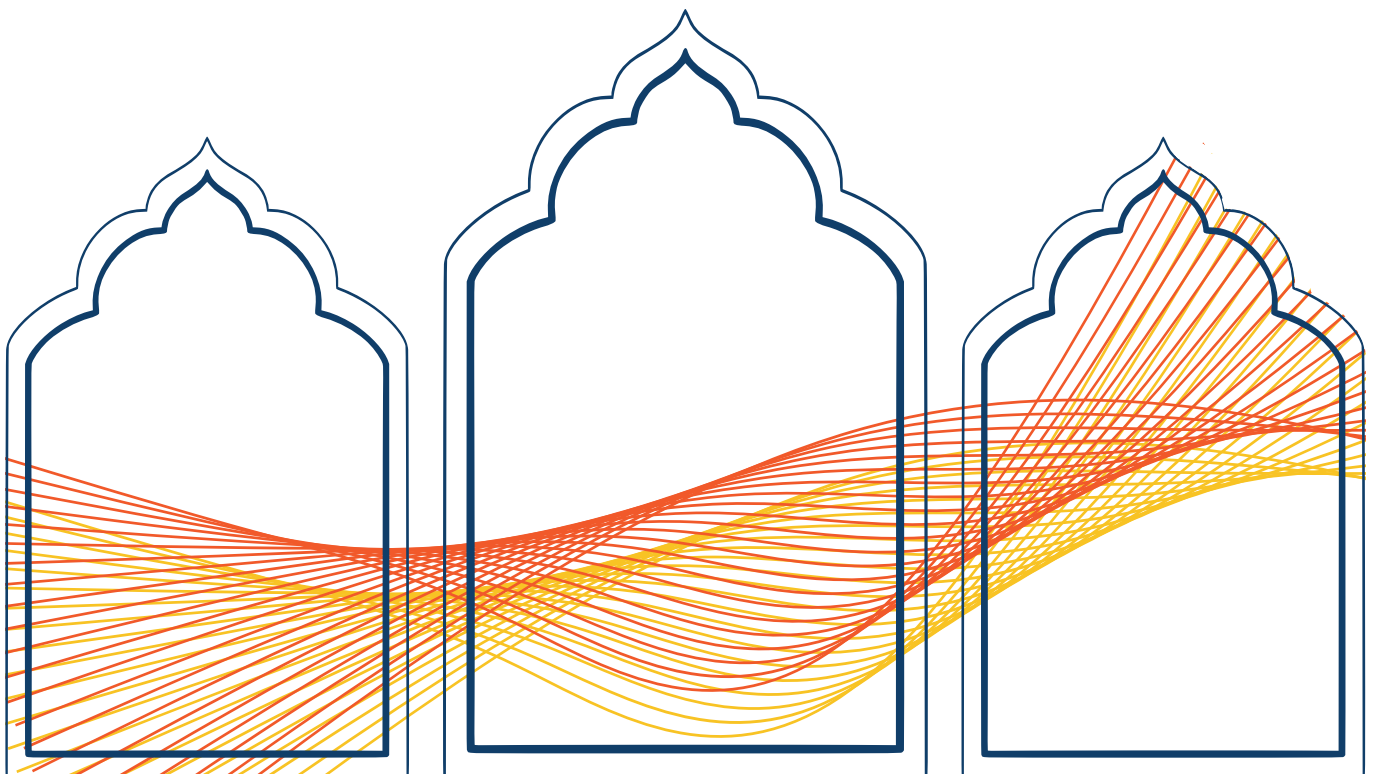


Navigating Telangana's Power Sector

Swetha Ravi Kumar and Ashwitha Ramesh Tunga

Technical Report

2024/01



Acknowledgments

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Report: Navigating Telangana's Power Sector

2024/01

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04 March 2024

Foreword

The Indian power sector is one of the world's largest systems. With a federal and state level governance system in place to oversee the power sector growth, examining the development of the sector makes is all the more interesting, as one can examine the similarities and differences on how it evolves in different states across India.

This report by FSR Global on the State of Telangana is a timely report, as it examines one of the well positioned states to perform well on power sector development indicators, as it is not only a resource rich state, but also one with a growing demand supported by growing GDP per capita.

The report thoroughly examines the policy and regulatory performance across the value chain of the power sector, giving a more detailed insight into the power sector complexities. The study carried out by FSR Global team is also coherent with the system level thinking that India currently needs. The analysis presented in the report is much needed and shall help in informing public policy and consequent commitment & actions,

The document can serve as a comprehensive reference document on Power sector of Telangana and complements the other reports being already developed, some of which are also published by PFC. The report can be utilized for further decision making and critical analysis from the respective vantage point of the reader.

I wish the FSR Global team congratulations and hope that they will continue the effort for other states as well.

Saurav Kumar Shah, IPS
Executive Director
Power Finance Corporation Ltd India

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Abbreviation

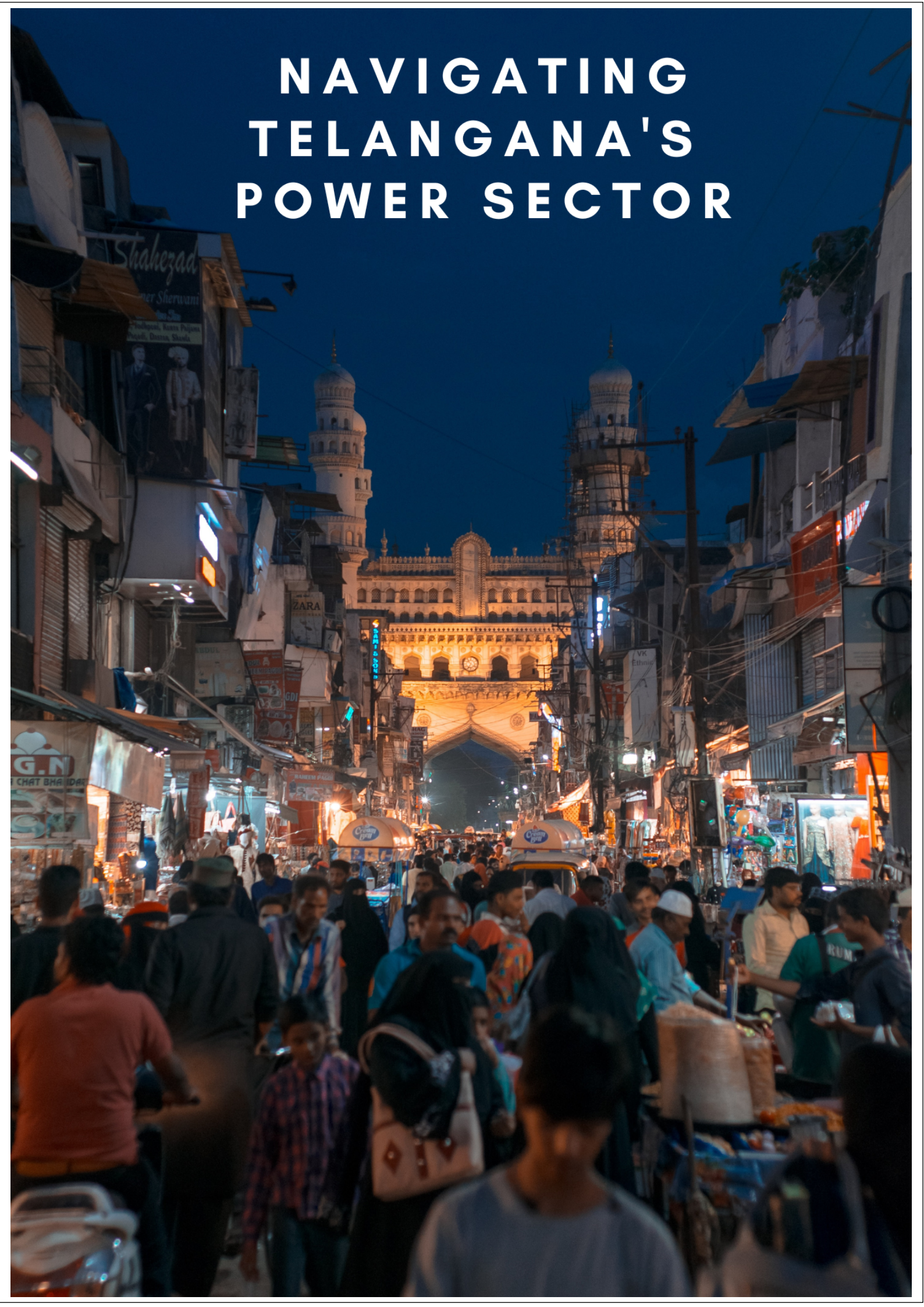
ABR	Average Billing Rate
ACE	Area Control Error
ACoS	Average Cost of Supply
AMI	Advanced Metering Infrastructure
AP	Andhra Pradesh
ARR	Aggregate Revenue Requirement
AT&C	Aggregate Technical & Commercial
BEE	Bureau of Energy Efficiency
BESS	Battery Energy Storage System
CAGR	Compounded annual growth rate
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
COP	Conference of Parties
CPP	Captive Power Plants
CPSU	Central Public Sector Undertaking
CSD	Consumer Security Deposit
CSPDCL	Chhattisgarh State Power Distribution Company Limited
CSS	Cross Subsidy Surcharge
CTUIL	Central Transmission Utility of India Limited
DBT	Direct Benefit Transfer
DISCOMs	Distribution Companies
DSM	Deviation Settlement Mechanism
DT	Distribution Transformers
EESL	Energy Efficiency Services Limited
EHT	Extra High Tension
EPS	Electric Power Survey
ESC	Energy Saving Certificate
ESS	Energy Storage Systems
EV	Electric Vehicle
FCRTS	Full Cost Recovery Tariff Schedule
FY	Financial Year
GDP	Gross Domestic Product
GENCOs	Generating Companies
GNA	General Network Access
GoTS	Government of Telangana State
Grid-India	Grid Controller of India Ltd
GSDP	Gross State Domestic Product
GSC	Grid Support Charges
GSI	Geological Survey of India
HT	High Tension
IICT	Indian Institute of Chemical Technology
InSTS	Intra State Transmission System
IPP	Independent Power Producer
IPTC	Independent Power Transmission Companies
ISTS	Inter State Transmission System
KRMB	Krishna River Management Board
LI	Lift Irrigation

LPS	Late Payment Surcharge
LT	Low Tension
LTOA	Long Term Open Access
MMT	Million Metric Tonne
MNRE	Ministry of New and Renewable Energy
MoP	Ministry of Power
MYT	Multiyear Tariff
NCE	Non-Conventional Energy
NDC	Nationally Determined Contribution
NPCIL	Nuclear Power Corporation of India Limited
NSEFI	National Solar Energy Federation of India
NSGM	National Smart Grid Mission
NTPC	National Thermal Power Corporation
POC	Point of connection
PGCIL	Power Grid Corporation of India Limited
PLI	Production Linked Incentives
PPA	Power Purchase Agreement
PSU	Public Sector Undertakings
PX	Power Exchanges
RA	Regulatory Assets
RAB	Regulatory Asset Base
RDSS	Revamped Distribution Sector Scheme
RE	Renewable Energy
REC	Renewable Energy Certificates
REMC	Renewable Energy Management Centre
RES	Renewable Energy Sources
REZ	Renewable Energy Zone
RICH	Research and Innovation Circle of Hyderabad
RPPO	Renewable power purchase obligation
RSTS	Retail Supply Tariff Schedule
RT-DAS	Real-Time Data Acquisition Systems
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAMAST	Scheduling Accounting Metering and Settlement of Transactions
SARAL	State Rooftop Solar Attractiveness Index
SEB	State Electricity Board
SECI	Solar Energy Corporation of India Limited
SECI	State Energy and Climate Index
SCADA	Supervisory control and data acquisition
SCCL	Singareni Collieries Company Limited
SEEI	State Energy Efficiency Index
SLDC	State Load Despatch Centre
STOA	Short Term Open Access
STU	State Transmission Utility
ToD	Time of Day
ToU	Time of Use
TSDISCOMs	Telangana State Distribution Companies
TSGENCO	Telangana State Power Generation Corporation Limited

Navigating Telangana's Power Sector

TSERC	Telangana State Electricity Regulatory Commission
TSSLDC	Telangana State Load Despatch Centre
TSNPDCL	Northern Power Distribution of Telangana State Limited
TSSPDCL	Southern Power Distribution of Telangana State Limited
TSREDCO	Telangana State Renewable Energy Development Corporation Limited
TSTRANSCO	Transmission Corporation of Telangana Limited
TSRTC	Telangana State Road Transport Corporation
UDAY	Ujwal DISCOM Assurance Yojana

NAVIGATING TELANGANA'S POWER SECTOR



1. Introduction

The Hon' Prime Minister of India, Shri Narendra Modi in his Conference of Parties (COP) 26 address made a few key announcements that set the tone for energy sector development in India. These included:

- India will add 500 Giga Watt (GW) of non-fossil energy capacity by the year 2030;
- India will meet 50 % of its energy demand through renewables;
- India will target to attain net-zero emissions by the year 2070.

In order for these targets to be realized, it is important now more than ever for the central and state governments to coordinate effectively and align efficiently, given that energy falls under the Concurrent List of the Indian Constitution (PFC, 2022b).

This report aims to examine the policy and regulatory landscape of the State of Telangana across the power sector value chain and identify the key focus areas for the state.

1.1 Why the State of Telangana?

Telangana is a southern-central state located in the Deccan Plateau and is the 11th largest Indian state in terms of geography and 12th largest in terms of population (37.6 million) (CEA, 2022a). It holds the 6th spot amongst the fastest growing state economies with a Compounded Annual Growth Rate (CAGR) of 6.1 % and contributes to 5% of the Indian Gross Domestic Product (GDP) (CAG, 2022; Government of Telangana, 2022). The per capita income in the state is higher than the national average and ranks 7th in the country and 3rd amongst the large states (Government of Telangana, 2022). In terms of Ease of Doing Business, the state is amongst the top 6 states in India, ranked as a 'top achiever' (PIB, 2022e).



The state is endowed with natural resources, it holds most of the vast coal deposits in the southern region of India, and has other mineral deposits such as uranium, iron ore, magnesium etc. (Government of Telangana, 2023). It is one of the top 10 renewable rich regions with a potential of 24 GW mainly including solar, wind and hydro. The state of Telangana currently has an installed power generation capacity of 18.5 GW as of 2023, of which 30% comes from renewables (CEA, 2022a; TSTRANSCO, 2023b). Telangana's power sector Public Sector Undertakings (PSUs) in 2021 contributed to 6.4 % of the state GDP (CAG, 2022).

While the state has been adding renewable energy installed capacity at a steady pace, when it comes to the performance of its power sector, primarily its two distribution companies, it ranks at position 43 and 47 out of the 51 utilities in the country (PFC, 2023). The performance of the power sector is essential to the continued economic growth of the state and country, as energy (thereby electricity) is intrinsically linked to development as production and consumption activities include energy as a basic unit (IEA, 2020). Therefore, succeeding in some pockets alone will not enable sustainable economic growth and it's important for all parts of the power sector value chain (generation, transmission,

distribution, and consumer) to engage and perform at its optimal best to power the economic growth engine.

1.2 Regulatory landscape of the Telangana Power Sector

The power sector is evolving at a rapid pace, moving from the traditional single flow systems to bi-directional flow system, aided by transformative innovations such as the 4Ds- digitalization, decarbonization, decentralization and democratization. Amidst this air of exciting transformation, **regulation** can be the enabler that leads the way to a global clean energy transition. Regulation creates and implements a framework or '**rules of the game**' that ensures fairness and a level playing field to all involved stakeholders. In this dynamic era of rapid innovation, regulation that does not reflect this change, will lead to negative externalities such as market power and incorrectly set incentives that do not reflect the policy goals (Bhagwat & RaviKumar, 2018).

The regulatory system consists of mainly two parts 1) **regulatory governance** - which refers to the institutional and legal design of the regulatory system and the framework under which decisions are made and 2) **regulatory substance** – which refers to the actual regulatory decisions made by the specified regulatory entity or other government entities. Schematically, the various indicators of these two dimensions of the regulatory system particular to the power sector have been depicted in Figure 1.

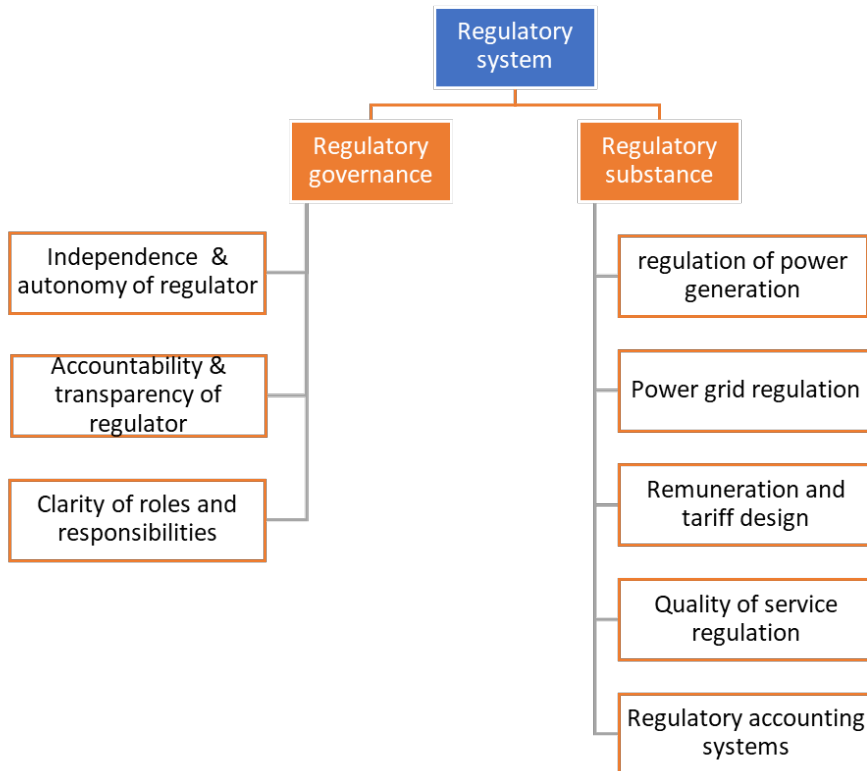


Figure 1: Dimensions of a regulatory system. Source: (Hadush & RaviKumar, 2019)

However, development of regulation is a challenging process, as its needs to control and orient an economic activity including monitoring, suggesting behaviour, introducing incentives, while balancing the needs of all stakeholders (Hadush & RaviKumar, 2019). This challenge is taken up a few notches when we also have to address the 4Ds. Therefore, it is important for regulation to be up to date to ensure a smooth and seamless transition to the new reality. In other words, regulation needs to be proactive and not only reactive.

Figure 2 shows the different power sector stakeholders both at the central government and state government levels.

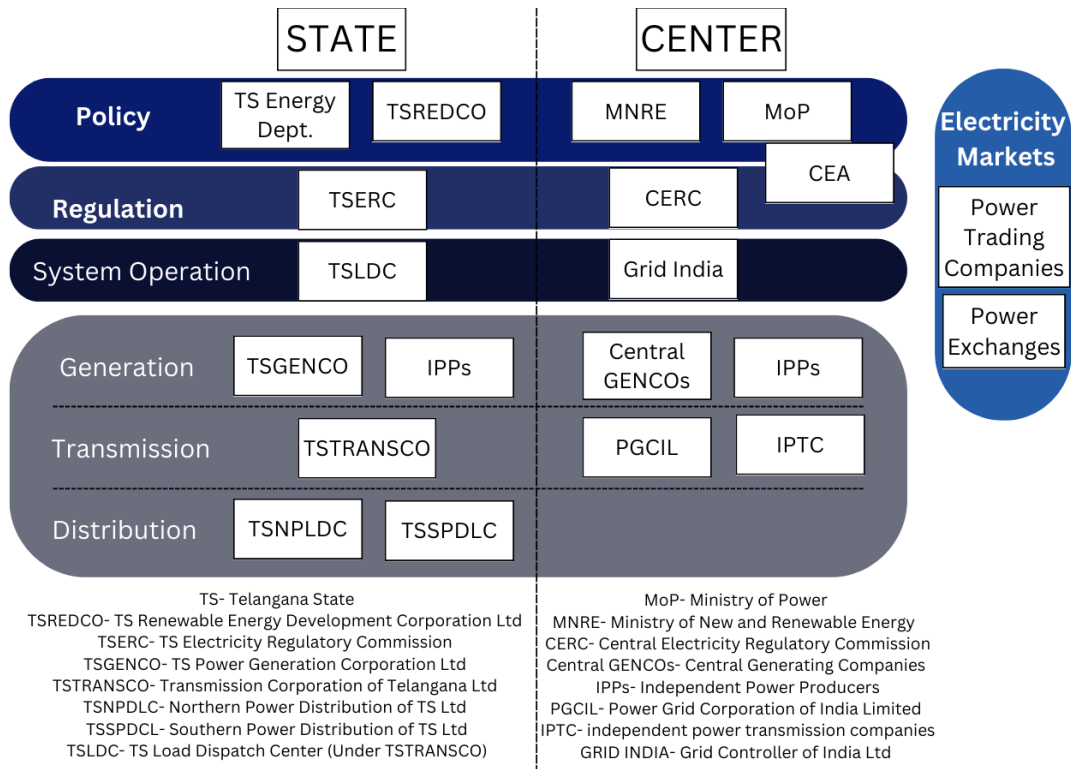


Figure 2: Institutional structure of the Power Sector, Telangana vs India. Source-Author

Policy: The electricity sector is mainly governed by the Ministry of Power (MoP) which is primarily responsible for the development of the sector. Ministry of New and Renewable Energy (MNRE) is the nodal ministry responsible for the development and deployment of new and renewable energy in India. The counterparts for Telangana State (TS) are the Telangana State Energy Department and Telangana State Renewable Energy Development Corporation Ltd. (TSREDCO) respectively. In addition, the statutory body i.e., Central Electricity Authority (CEA) advises the central and state governments and the respective regulatory commissions on policy and technical matters for the development of electricity sector.

Regulation: Central Electricity Regulatory Commission (CERC) is a statutory body, mainly responsible for regulation of tariff of central generating companies (GENCOs) and generating companies with composite schemes, tariff setting for inter-state transmission for transmission utilities, granting licenses, setting the grid codes and to develop and regulate the power markets in line with the development of the power sector. On the state front, the State Electricity Regulation Commissions (SERCs) are responsible for tariff setting and license grants at the state level (PFC, 2022a).

Utilities: To improve transparency and overall performance, the Electricity Act of 2003 mandated the unbundling of State Electricity Board (SEB) into functional constituents, viz Generation, Transmission and Distribution, and the successor entities were corporatized (Pargal & Mayer, 2014).

- Generation is the process of producing power from various fuel sources, carried out in the generation power plants or stations. The power producers can be centrally owned (central GENCOs), state owned (for TS- TSGENCO) or independent private producers (IPPs).

- Transmission systems carry bulk power from the generation plants to the distribution substations through a network, at high voltages. Power Grid Corporation of India Limited (PGCIL) is India's largest transmission utility at the central level accompanied by few independent power transmission companies. Transmission at TS is handled by Transmission Corporation of Telangana Limited (TSTRANSCO).
- Distribution systems receive this electricity at substations and supply electricity to the individual consumers through a distribution network. Distribution in Telangana lies with two distribution companies (DISCOMS), namely Northern Power Distribution of Telangana State Limited (TSNPDCL) in the north and Southern Power Distribution of Telangana State Limited (TSSPDCL) in the south.
- The load despatch centers are responsible for the optimal scheduling and despatch of electricity within the region, which in Telangana is handled by Telangana State Load Despatch Centre (TSLDC).

Electricity Markets: Electricity Markets were originally created to foster competition and counter the rising power prices. They are essentially open to all energy service providers, where buyers and sellers, either directly or through Power Trading companies (also known as Trading Licensees), or through Power Exchanges (PX), buy or sell electricity, Renewable Energy Certificates (RECs) or Energy Savings Certificates (ESCs) etc. As on 31st March 2022, there were 43 trading licensees, and three power exchanges, regulated by the Commission, involved in short-term, long-term power trading or both.

The following sections will detail the actors and factors influencing the performance across the power sector value chain in the State of Telangana.

GENERATION



2. Generation

Since the formation of the State of Telangana in 2014, the installed power generation capacity has nearly doubled in capacity, aided by the proactive measures of the state to increase its installed capacity in anticipation of the demand growth (Prayas Energy Group, 2020). Figure 3 shows the growth in the state's installed capacity addition over the years.

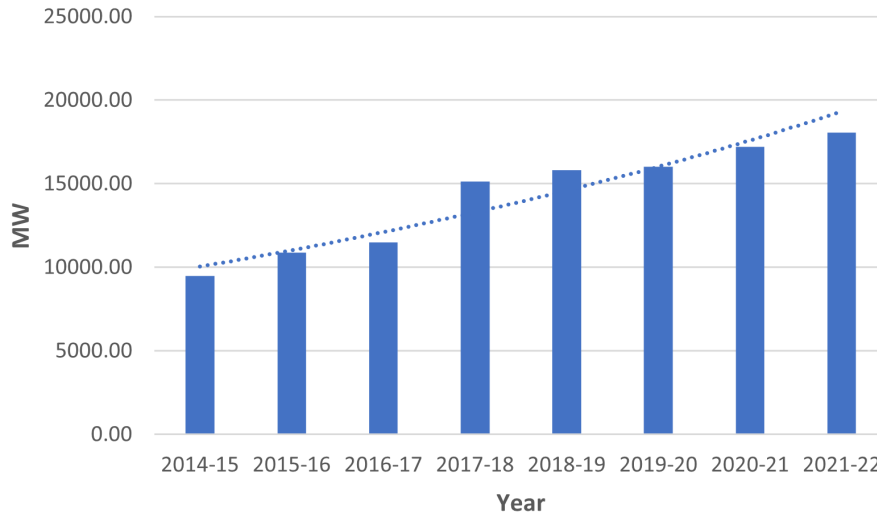


Figure 3: Installed capacity growth of Telangana. Source-(Government of Telangana, 2022)

The **installed power generation capacity mix** of the state is 18.5 GW and is still heavily coal dependent covering 51% (9.3 GW) of the total capacity. Followed by solar amounting to 28% (5.2 GW), hydro contributing 13% (2.5 GW) and gas capacity of 4.5% (831 MW). Share of other resources such as nuclear at 194 MW, wind at 128 MW, biomass/bagasse at 113 MW, municipal solid waste at 38 MW contribute to less than 5% of the total capacity mix (TSTRANSCO, 2023b). Figure 4 shows the installed generation capacity mix for the State of Telangana.

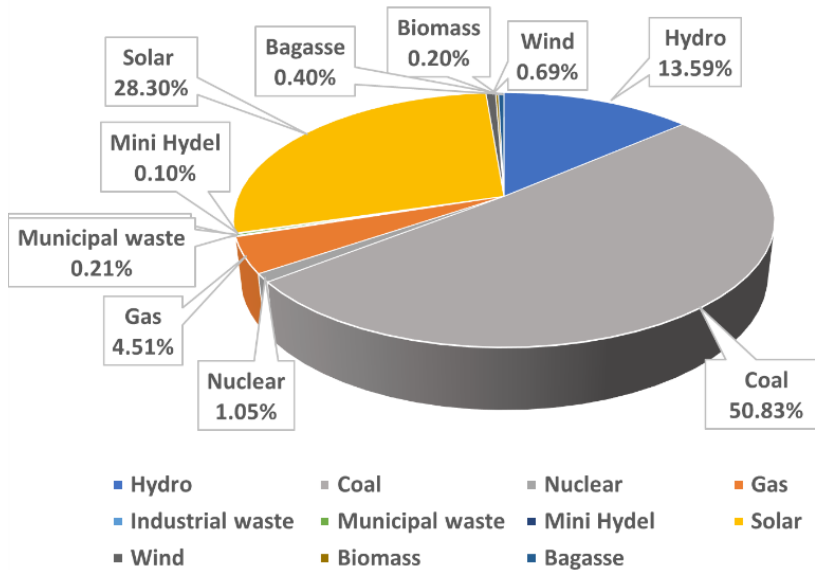


Figure 4: Installed generation capacity by source. Source- Author, Data- (TSTRANSCO, 2023a)

In the case of **ownership** of these installed generation capacity assets, the state utilities own 48% of the generation companies (GENCOs), followed by Independent Power Producers (IPPs) owing 39% and central utilities owning the remaining 13% (CEA, 2022b). While the central and state utilities invest into conventional large-scale capacity, the majority of the renewable energy investment is coming from the IPPs, with solar projects in particular dominating the market. Recently, central utility National Thermal Power Corporation (NTPC) installed the world's largest floating solar power plant in Ramagundam with a capacity of 100 MW (PIB, 2022a).

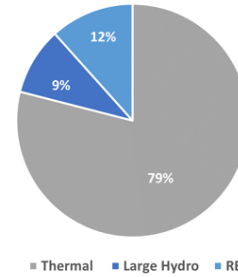


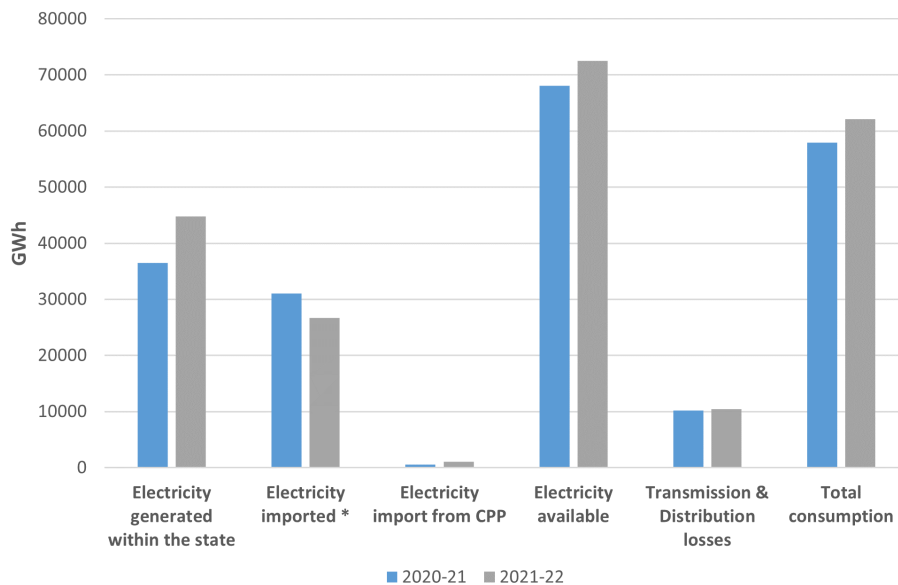
Figure 5: Electricity generation mix by source. Source-Author, Data-(CEA, 2023d)

The state does have a variety of generation capacity in the Financial Year (FY) 2022-23, and of the recorded **gross electricity generation** of 64242.6 GWh (64 TWh), the electricity mix was mainly comprised of thermal, hydro and renewable energy sources (RES). The gas capacity available, however, was not tapped into (refer to Figure 5)

2.1 Electricity supply and demand

For 37.60 million population in 2021, the state recorded an annual **per capita electricity consumption** of 2012 kWh (CEA, 2022b) and a total net electricity consumption of 57896.3 GWh and gross electricity consumption of 75665.13 GWh. Telangana has 16.8 million electricity consumers, of which the domestic consumers consumed 22.12%, commercial 8.37%, industrial 21.53% and agriculture was the largest consuming sector accounting for 38.45% of the total electricity consumption (Government of Telangana, 2022; TSTRANSCO, 2023b) (CEA, 2022b).

Figure 6, below shows that the State of Telangana met 62% of its total net electricity requirements in 2022 from the installed capacity within the state and the remainder was sourced via imports and through captive power plants (CPPs) (CEA, 2023c).



* Net import from central schedule, unschedule, bi-lateral, trading etc.

Figure 6: Annual Electricity supply and consumption for Telangana, comparison between 2020-21 and 2021-22 (CEA, 2022a, 2023c)

Telangana's electricity consumption requirement has been progressively increasing over the last years (refer Figure 7 (a)), and peak consumption is noticed in the summer months of March and April (refer to Figure 7 (b)).

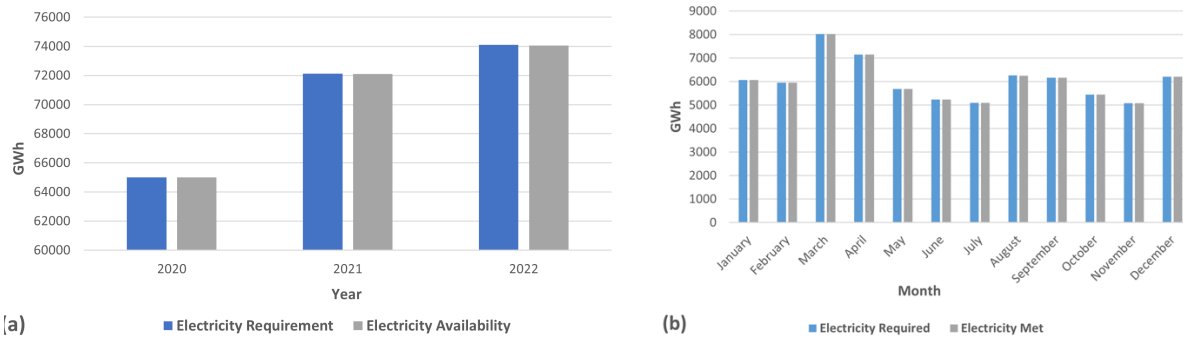


Figure 7 (a): Telangana Power Supply Position over three years. Source-Author, Data-(CEA, 2023f)
 Figure (b): Telangana Power Supply Position for 2022. Source-Author, Data-(TSSLDC, 2023)

In 2022, the average daily electricity requirement for Telangana was 199.51 GWh of which 199.48 GWh was met (TSSLDC, 2023). The largest peak demand was recorded in the month of March, and the least demand in June. Figure 8 shows the maximum peak demand recorded for the state across the months in the year 2022. A peculiar case of demand deficit was recorded in August 2022, owing to the central government restricting Telangana from buying and selling power on the Indian Energy Exchange, citing dues of the DISCOMs as the reason for the sanction (TOI, 2022b). This flags two issues: one- that more state and private sector investments are needed to meet the rising electricity demand and two- reformation of the DISCOMs to ensure future security of supply.

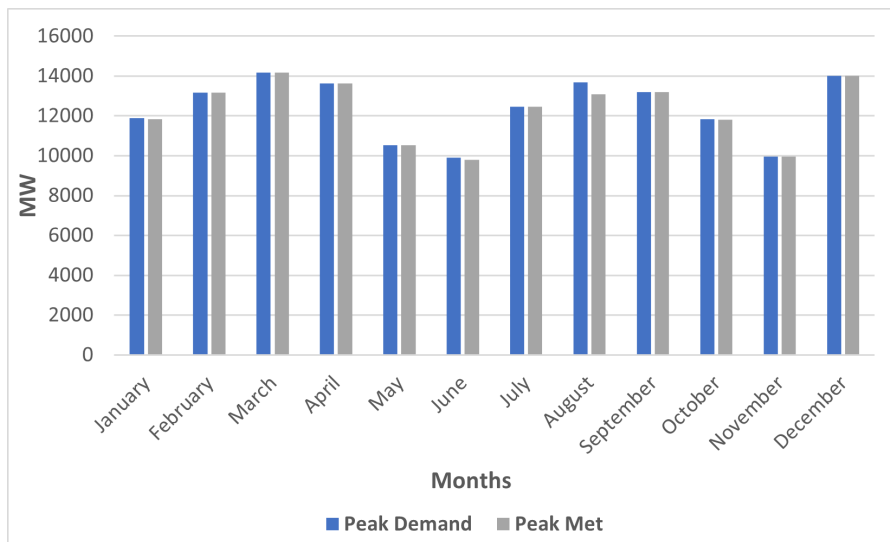
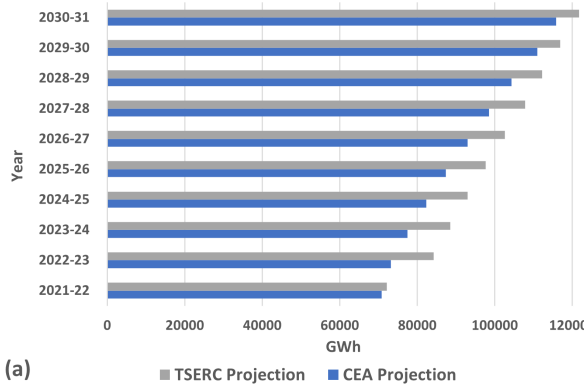


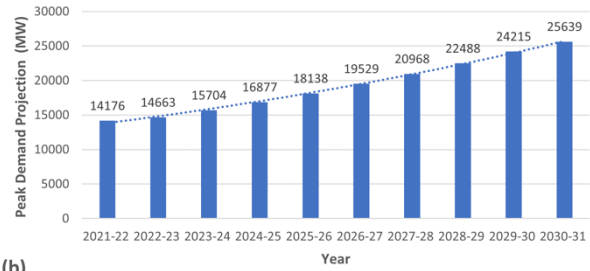
Figure 8: Telangana's Unrestricted Peak Demand for 2022. Source-Author, Data-(CEA, 2023f)

An important aspect of power sector planning is the estimation of future demand and DISCOMs planning the supply position for the same. In this regard, CEA conducts its Electric Power Survey (EPS) periodically to assess the state-wise demand for medium and long terms and in its recent survey it projects the demand for the years 2021-22 to 2031-32. This CEA analysis is calculated using 'partial end use methodology', and was done separately for various consumer categories such as domestic, commercial, irrigation etc.

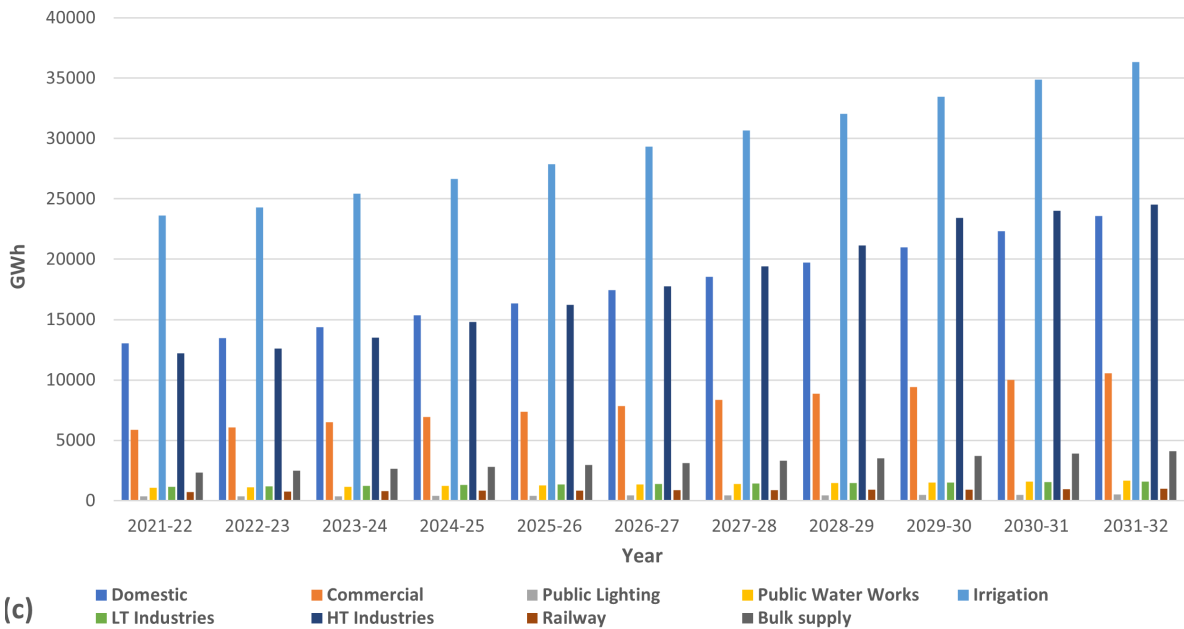
For Telangana, CEA has forecasted a 70% increase in electricity requirement from 70,871 GWh in 2022, reaching up to 115,862 GWh by 2031 (refer to Figure 9 (a)) (CEA, 2022b). The State of Telangana in its own analysis predicts a slightly higher number for the same (refer to Figure 9 (a)) (TSERC, 2022b). In the case of peak electricity demand, CEA projects a whopping increase of 90.8 % for the same time period, increasing from 14.2 GW in 2022 to 25.6 GW in 2031 (refer to Figure 9 (b)). The irrigation (agriculture) sector remained the consistent leading consumer, forecasted to reach 34000 GWh by 2030 Figure 9 (c) (CEA, 2022b).



(a) Figure 9 (a): Electricity requirement forecast, CEA vs TSERC. Source-Author, Data-(CEA, 2022b; TSERC, 2022b)



(b) Figure 9 (b): Peak demand forecast. Source-Author, Data-(CEA, 2022b)



(c) Figure 9 (c): Consumer category wise electricity consumption forecast. Source-Author, Data-(CEA, 2022b)

2.2 Factors influencing the generation mix

2.2.1 Role of renewables

Renewable Potential: India has large potential for RES and Telangana in particular was identified amongst the top 10 RE rich states in the country with an estimated RE potential of 24.7 GW, constituting 2.26% of the country's overall distribution (refer to Table 1).

Source-wise Estimated Potential of Renewable Power during 2021-22 (in MW)							
Wind Power @120 m	Solar Energy	Small Hydro Power	Biomass Power	Cogeneration bagasse	Waste to Energy	Total	TS share in all India potential (%)
4244	20410	102				24756	2.26

Table 1: Telangana's source wise estimated potential of RE Power in MW. Source-(MOSPI, 2020)

Renewable Installations: As of 2023, Telangana has an installed renewable energy generation capacity of 5222.82 MW solar, and 128 MW of wind (TSTRANSCO, 2023b). The estimated renewable potential when compared with the installed capacity thus reflects the huge potential that lies ahead for Telangana to invest in these renewable technologies (refer to Figure 10).

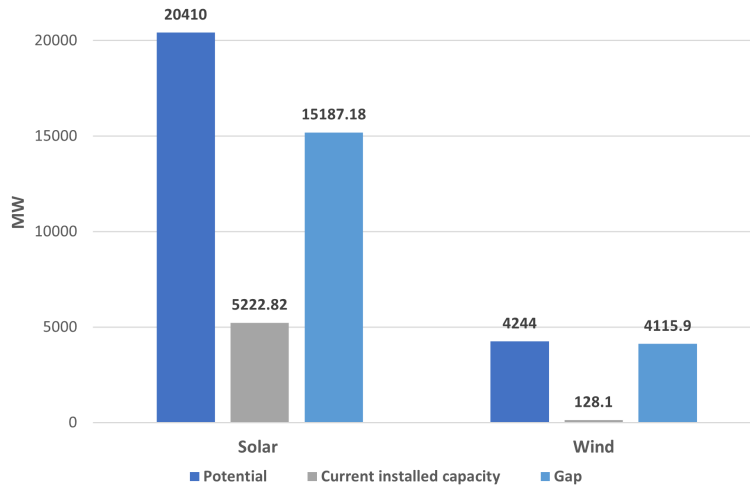


Figure 10: RE Installation Gap, Telangana. Source: Author, Data-(MOSPI, 2020; TSTRANSCO, 2023b)

In the year 2019, the State of Telangana stood 2nd with a score of 72.2 in the State Rooftop Solar Attractiveness Index (SARAL), a MNRE initiative ranking the performance, policy framework, maturity, implementing environment of setting rooftop solar amongst states (MNRE, 2018). Telangana also has unique flagship projects such as India's largest floating power plant of 100 MW capacity in collaboration with NTPC and the harnessing of 5MW of solar rooftop via the partnership of Telangana State Road Transport Corporation (TSRTC) with TSREDCO (EQ International, 2018).

Renewable Targets: Telangana was allocated 3.7% (6,457 MW) of the 2022 national renewable energy target. Of this, the share of solar was 69% (4,457 MW) and wind was at 31% (2,000 MW) (NITI Aayog, 2017). In addition, the state had established its own RE targets of achieving 2 GW by 2022 (Asia Pacific

Energy, n.d.). Telangana has already successfully achieved these, with a total RE installed capacity of 5.4 GW as of 2023.

Renewable purchase obligation: To promote renewable generation, TSERC has also announced renewable power purchase obligations (RPPO) for the upcoming years, wherein concerned entities are obliged to purchase minimum quantity of electricity from RE sources from its total energy consumption as shown in Table 2.

RPPO (%) / Year	2022-23	2023-24	2024-25	2025-26	2026-27
Solar	7.50	8.00	9.00	10.00	11.00
Non-Solar	1.00	1.25	1.50	1.75	2.00
Total	8.50	9.25	10.50	11.75	13.00

Table 2: Telangana's Renewable Purchase Obligation. Source-(TSERC, 2022b)

If we look at the data from the previous years, TS DISCOMS have already maintained a good track record in terms of meeting solar RPPO. Non- solar RPPO were marginally met (refer Table 3).

Financial Year	Solar RPPO %		Non-Solar RPPO %		Total RPPO %	
	As mandated by TSERC	As achieved by TSDISCOMs	As mandated by TSERC	As achieved by TSDISCOMs	As mandated by TSERC	As achieved by TSDISCOMs
2018-19	5.33	9.57	0.67	0.83	6.00	10.40
2019-20	5.77	9.86	0.73	0.67	6.50	10.53
2020-21	6.21	9.20	0.79	0.79	7.00	9.99
2021-22	7.10	8.52	0.90	0.94	8.00	9.46

Table 3: RPPO Compliance by TSDISCOMs. Source- (TSERC, 2022b)

RE Curtailment: The National Solar Energy Federation of India (NSEFI) wrote a letter to the TSLDC in 2020, on the uninformed curtailment of the renewable energy generators, which went against the must-run status for the renewables. The state had curtailed to a tune of 12 GW (7.2 GWh) of solar power since the lockdown in 2020 (NSEFI, 2020). Curtailment of solar generation during the day, while the DISCOMS were simultaneously purchasing from fossil-based generator goes against the merit order principle. With already heavy investments, such RE curtailments lead to the IPPs incurring significant revenue losses (NSEFI, 2020). And such curtailment measures by the State will only deter potential investors from investing in the renewable generation capacity of the state, hindering the prospect of tapping into the state's significant RE potential.

2.2.2 Role of coal

Coal Mining: Telangana has coal reserves of 11,257 million tonnes in the Godavari Valley of Telangana spread across 7 districts (refer Table 4). The cumulative total estimated coal reserve (resource) of the country as per the Coal Inventory published by Geological Survey of India (GSI), as on 01.04.2022 is 3,61,411.46 million tonnes.

Estimated Reserves of Coal (as on 01st April 2022) in million tonnes				
Proved	Indicated	Inferred	Total	Total share across India (%)
11257	8344	3433	23034	6.37

Table 4: Estimated Coal Reserves of Telangana. Source- (Government of Telangana, 2022)

The Singareni Collieries Company Limited (SCCL) in Telangana is a government owned coal mining corporation, and has the second largest share of working mines in the country, with 42 working mines as of 2022 and has closed 9 of its coal mines as of 2021 (PIB, 2022b). SCCL had pledged to supply 81% (57 MT) of its coal capacity in the FY 22-23 to thermal power plants to Telangana and other southern states (The Hindu, 2022). As part of the Andhra Pradesh Reorganization Act (Ministry of Law and Justice, 2014), the central government via NTPC has promised to establish a 4000 MW (5X800MW) supercritical thermal power facility in Telangana of which 85% power will be allocated to the state (PIB, 2019). In connection to this, SCCL will provide the coal linkage for Phase 1 - 2X800MW, and in case of limitation on coal availability, NTPC can procure coal from other coal mines in the country (BHEL, 2017; Ministry of Coal, 2023).

Coal Power Plants: As aforementioned, the state is heavily reliant on coal power plants contributing to 51% of the installed generation capacity and 79% of the corresponding electricity generation. Owing to the growing demand profile of the state, the new thermal power plants such as Bhadradi Thermal Power Station (BTPS), Yadadri Thermal Power Station (YTPS) and NTPC's Telangana Super Thermal Power Project would help bridge some of the need, but given the fact that these plants have had delays in their commissioning, the state is forced to procure power from other sources at a higher cost (Prayas Energy Group, 2022).

However, in the drive to decarbonize its electricity mix, in 2022, TSERC notified that Telangana State has no future plans for expansion of thermal power generation plants to cater to the needs of the long-term power demands and instead will be going with solar power capacity addition (TSERC, 2022c). Complementarily, although India intends to reduce coal-based power generation to meet its decarbonizing targets, considering the expected increase in demand post the pandemic, CEA in its recent notice has advised power generating utilities to not retire any thermal plants until 2030 and ensure availability of units by modernizing and renovating them if necessary (CEA, 2023d). However, the selection of which coal power plant needs refurbishments or decommissioning should consider political economy factors such as, capital needed for renovation and modernization (R&M), not burdening the end consumer due to lock-in of legacy Power Purchase Agreements (PPAs), environmental emissions and displacement of jobs (Shrimali & Jindal, 2020).

Coal Emissions: Based on SO₂ emission, a recent study stated Telangana as the second dirtiest coal power buyer in the country. The study found that 74 per cent of power stations supplying power to the state are unclean and do not meet the Sulphur dioxide norms (CSE, 2021).

2.2.3 Complementary technologies

As we have more renewable energy in the power system, other complementary technologies will play an important role in either utilizing the excess renewables when there is not enough demand consumption or enabling more renewable energy investments to produce power to X products.

Green Hydrogen: The National Green Hydrogen Mission aims at producing 5 MMT (Million Metric Tonne) per annum and with an associated renewable energy capacity addition of about 125 GW by 2030 (RaviKumar & Bakshi, 2023). In line with that, the Research and Innovation Circle of Hyderabad (RICH)—an initiative of the Government of Telangana, and the Hyderabad Science and Technology Cluster under the Office of the Principal Scientific Adviser to the Government of India organized a Stakeholder discussion to initiate the concept of setting up of a hydrogen valley in Telangana (RICH, n.d.). Likewise, in an industry-academia partnership, Hyderabad-based Indian Institute of Chemical Technology (IICT) and NTPC have agreed to collaborate in the area of green hydrogen production

through renewable energy. NTPC will work with the researchers at IICT to deliver viable solutions for the power sector (Telangana Today, 2023).

Battery Storage: The central government recognizes Energy Storage Systems (ESS) as a crucial technology to enable this transition for an increasingly renewable-based capacity. CEA estimates that India needs 41.6 GW/208 GWh of battery energy storage by 2030 (CEA, 2023e). In line with the MoP guidelines on Battery Energy Storage Systems (BESS) and the Production Linked Incentives (PLI) for domestic production of advanced chemistry cell battery manufacturing provided (PIB, 2022d), the Amar Raja Batteries Limited set up a Gigafactory battery manufacturing facility in the State of Telangana. The manufacturing plant will have Lithium cell capacity upto 16 GWh and battery pack capacity upto 5GWh (Business Standard, 2023). Telangana also launched the 'Telangana Electric Vehicle and Energy Storage Policy', envisaged for the years 2020-2030 (Government of Telangana, 2020)

2.2.4 Cross border dispute

The bifurcation of the state of Andhra Pradesh (AP) and Telangana, continues to politically impact the electricity issues in these states. Given Telangana's geological conditions, it is dependent on uplifting water from Krishna River to serve its hydro generation capacity. The ongoing dispute has AP requesting the Krishna River Management Board (KRMB) to restrain Telangana against utilizing water beyond its agreed quota of 34% from reservoirs for hydel power generation (TOI, 2023a) and TS requesting KRMB to restrain AP from going ahead with the pumped-storage hydroelectric projects on Krishna River (TOI, 2022a). In addition, financial settlement between the two states for the power purchased is also not done in a timely manner. Telangana not only has security of supply issues from the water management issues, but also from the untimely settlement of power bill arrears to AP generation companies (TOI, 2023b).

2.3 Key takeaways

- Telangana is heavily reliant on coal power plants contributing to 51% share of the installed generation capacity and 79% of the corresponding electricity generation. Going forward, the state regulator has already announced no new coal plants will be added, however, the transition away from coal will depend on many politico-economic factors and should be planned and phased out in a just manner. On the renewables front, the state has been steadily adding renewable energy generation capacity and has exceeded its 2 GW target by 2022, but less than the NITI Aayog target set for them which was 6.4 GW by 2022. In addition, TSDISCOMs have also maintained a good track record in meeting their renewable power purchase obligations set by the state regulator.
- The installed power generation capacity of Telangana only meets close to half of its total electricity requirements, the remainder is met via imports and captive power plants. In preparation for the future, by 2031 the state should plan for resource adequacy to meet its forecasted electricity requirement of 115,862 GWh (70% increase since 2022) and peak demand requirement of 25.6 GW (90.8% increase since 2022).
- Security of supply is a key issue for the state, as it is dependent on interstate resources for imports, and the added complexity of key resource constraints such as hydro to operate its own generating unit. In addition, the inability of the DISCOMs to clear the power bill arrears not only has a cross border issue with states like AP, but also poses real threat of procurement of power from the wholesale spot market, for which DISCOM management needs to be addressed. In order to meet the state's growing electricity demand, more investments are needed to ensure availability of power within the state, and therefore measure such as RE curtailment should be limited to ensure private sector participation in further building of generation assets.
- The State has been at the forefront of setting up some unique flagship projects such as India's largest floating power plant, Gigafactory battery manufacturing facility and laying the ground for setting up of a hydrogen valley.

TRANSMISSION



3. Transmission

Transmission will play a crucial role in the drive to decarbonization on two fronts, first to transit large scale renewable electricity generated from source to consumer, and second to connect different operating zones to help balance and integrate intermittent renewables (Athawale & Felder, 2023). As of 2013, India became the world's largest synchronous national electricity grid by linking all the regions within the country to become 'One Nation - One Grid - One Frequency'; operating within the permissible frequency band of 49.95- 50.05 Hz (CERC, 2022; PIB, 2023a).

3.1 Transmission capacity

State capacity: In the State of Telangana, Transmission Corporation of Telangana Limited (TSTRANSCO) is the licensee company operating and controlling the transmission business as well as the State Load Despatch Center (SLDC) activities. As of April 2023, the TSTRANSCO has 27,987 circuit kilometers (ckm), and transmission capacity of 52126.5 MVA (as of 2018) and 378 substations as shown in Figure 11 (TSTRANSCO, 2023c).

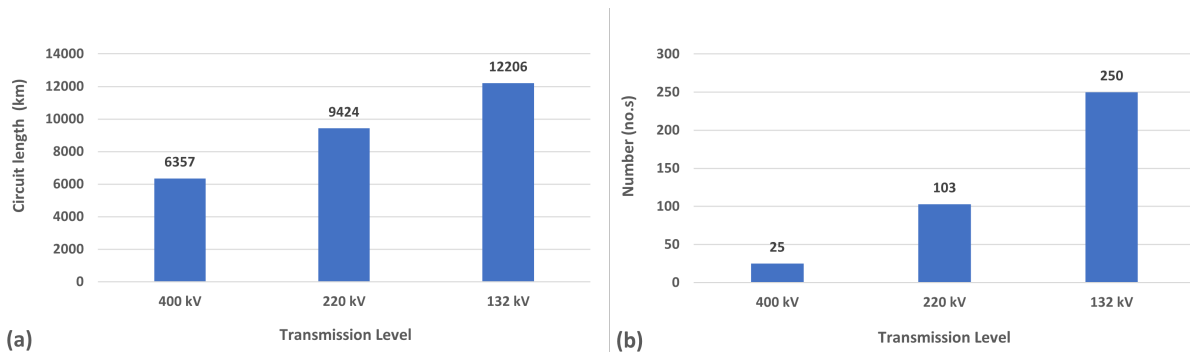


Figure 11 (a): TSTRANSCO total system length and Figure 11 (b): TSTRANSCO number of substations at different transmission levels (TSTRANSCO, 2023b)

For FY 2023-24, TSTRANSCO has approved contracted capacity of 21,866 MW (of which 67.71 MW was of Open access capacity) with the TSDISCOMs (TSERC, 2020a). For FY 2021-22 the actual contract capacity recorded with the TSSLDC was 16,521.72¹ (of which 314.70 MW was open access) (TSTRANSCO, 2022b, 2022a). A split of the contracted capacity between renewable generation and conventional generation between the two TSDISCOMs and the split between open access and TSDISCOMs for FY 21-22 is as shown in Figure 12.

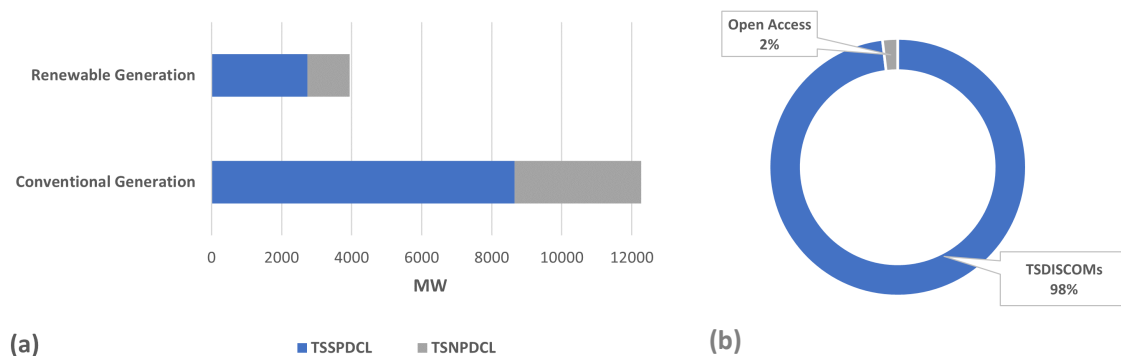


Figure 12 (a): Source type distribution of TSTRANSCO transmission contracted capacities between TSDISCOMs and Figure (b) Share of open access contracts (TSTRANSCO, 2022a)

¹ The number reflects the data provided by TSSLDC; the same data provided by TSTRANSCO are slightly lower as TSTRANSCO reports only from 132 kV and upward, while TSSLDC reports from 11 kV level (TSERC, 2023a)

Telangana currently has high power transmission lines in the categories of 400 KV, 220 KV and 132 KV with a total ckm of 27,987 as on March 2023. In the 2023 pipeline, the state of Telangana plans to add a total of 6287 ckm, which also includes a 765 KV line between Warora pool (Maharashtra) and Warangal (Telangana), commissioned to be completed in 2022-23 (TARANG, 2023). The detailed breakup of the lines are listed in Table 5. The table includes pipeline projects both under Inter State Transmission System (ISTS) and Intra State Transmission System (InSTS).

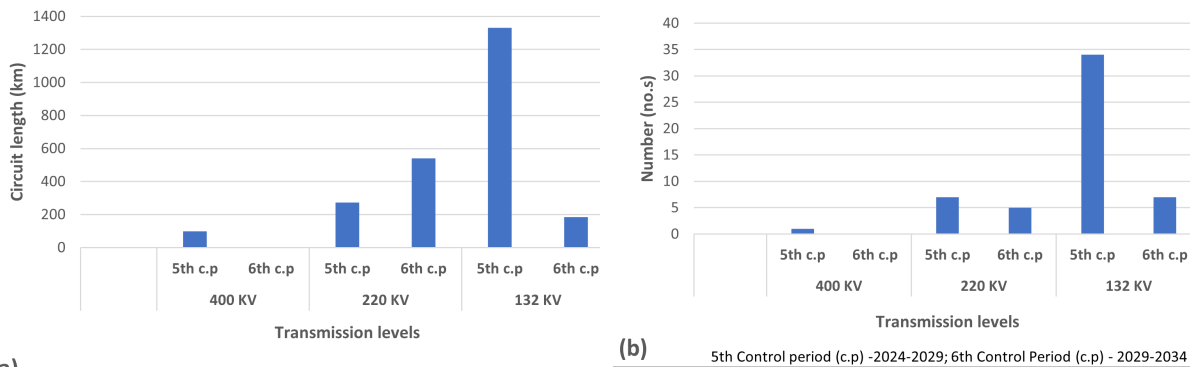
	HVDC			765 KV	400 KV	230 KV	220 KV	132 KV	110/90 KV
	800 KV	500 KV	320 KV	O.H	O.H	O.H	O.H	O.H	O.H
Current status (in ckm)					6357		9424	12206	
New project pipeline – 2023									
Completed (in ckm)					10		188		
Under construction (in ckm)				885	3657		1549		

Table 5: Transmission lines status for the State of Telangana (in circuit kilometres) (TARANG 2023; TSTRANSCO, 2023c)

CTU capacity: In the case of ISTS, under the CERC draft General Network Access (GNA) Regulation 2022, the deemed transmission contracted capacity quantity for the State of Telangana is 6140 MW, however the total contracted capacity with PGCIL/ Central Transmission Utility of India Limited (CTUIL) is 4119.574 MW. Based on stakeholder consultation, it was stated that any further allocation of transmission capacity from PGCIL should be done in a planned manner and should be apportioned to TSDISCOMs keeping in mind their long-term contracts of the required capacity and not be assigned arbitrarily, as the burden of the same falls both on the TSDISCOMs and there by the end consumer (TSERC, 2023c). Furthermore, under PM-Gati Shakti program, Telangana will be a part of ‘Inter-Regional links’ project, where 4603 ckm capacity is planned to be added by 2024-25 amongst 5 states (PIB, 2023b).

3.2 Transmission capacity planning

Considering the factors like new consumer addition to the grid, projected growth in demand, and affordable renewable power being installed across the country, the Commission needs to ensure that reliable transmission systems are put in place in a time and cost-effective manner (TSERC, 2020a). TSTRANSCO in its resource planning has indicated the transmission capacity addition plan for the control periods of 2024-2029 (5th) and 2029-2034 (6th) as shown in Figure 13.



(a) 5th Control period (c.p) -2024-2029; 6th Control Period (c.p) - 2029-2034
 Figure 13 (a): TSTRANSCO planned transmission length and Figure (b) TSTRANSCO planned substations for the 5th (2024-2029) and 6th (2029-34) control periods (TSTRANSCO, 2023a)

To execute these forward plans TSTRANSCO has projected a net investment of INR 3,323.4 million for the 5th control period and INR 9419.6 million for 6th control period (TSTRANSCO, 2023a).

Renewable energy zones: Considering India's goal to achieve 500 GW of RE capacity addition by 2030, CEA has published a transmission system road map for additional transmission capacity planning for reliable RE integration. MNRE/Solar Energy Corporation of India Limited (SECI) have identified Renewable Energy Zones (REZs) up to 181.5 GW of which 13 GW lies in Telangana, consisting of 3 GW from wind and 10 GW from solar respectively. Details of the identified RE potential zones along with likely storage to be installed and the requirement of evacuation system is given in Table 6. The transmission system installation is tentatively planned to be executed in three phases, in 2025, 2027 and 2030 respectively and the proposed transmission lines are as shown in Table 7 and Figure 14 (CEA, 2022c).

District	Pooling Station	Identified Potential (GW)		Maximum Dispatch (GW)	BESS (GW), to be set up by generators	Evacuation System (GW)
		Wind	Solar			
Rangareddy	Rangareddy	1	2.5	3	1	2
Medak	Medak	1	2.5	3	1	2
Nizamabad	Nizamabad-II	1	2.5	3	1	2
Karimnagar	Karimnagar	0	2.5	2.5		2.5
Total		3	10	11.5	3	8.5

Table 6: Potential RE Zones with evacuation system for Telangana. Source-(CEA, 2022c)

District	Pooling Station	Planned Transmission Lines in ckm		
		765 KV	400 KV	132 KV
Rangareddy	Rangareddy		155	
Medak	Medak		60	
Nizamabad	Nizamabad-II	210		
Karimnagar	Karimnagar		100	
Total		210	315	

Table 7: Planned transmission lines addition (ckm) for the identified RE pooling stations Source-(CEA, 2022c)

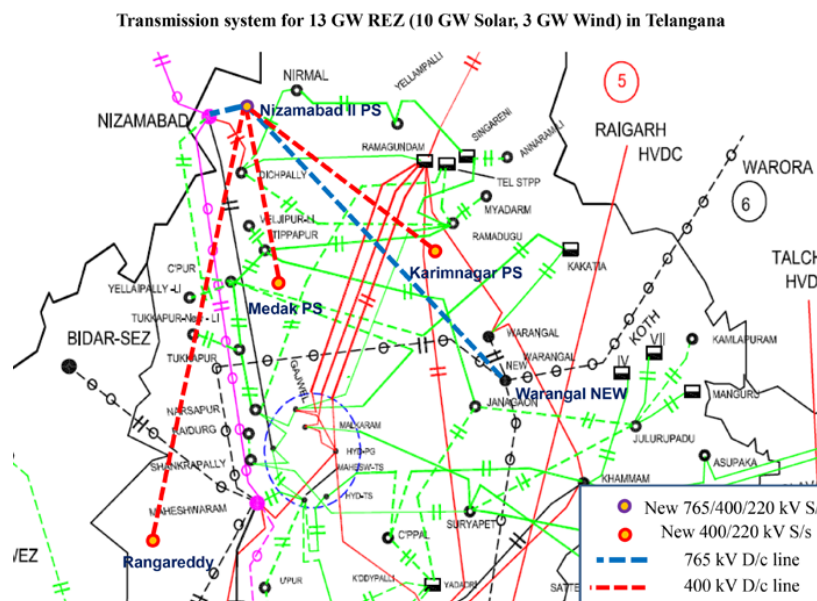


Figure 14: Transmission System for potential RE Zones in Telangana. Source: (CEA, 2022c)

3.3 Transmission tariff

The users of transmission system have to pay transmission charges and also bear the transmission loss for both energy and capacity. The transmission charges payable and energy losses to be borne shall be related to the contracted capacity in kW, at the entry point (TSERC, 2020a).

The approved state transmission multiyear tariff (MYT) for the 4th Control period is as shown in Table 8.

Financial Year	Transmission Tariff	Transmission Losses
	Rs/KW/month	%
2019-20	92.31	2.78
2020-21	105.19	2.71
2021-22	111.68	2.64
2022-23	129.45	2.57
2023-24	145.14	2.50

Table 8: Approved Transmission Tariff and Losses for the 4th Control Period. Source-(TSERC, 2020a)

Open access: Open Access Regulation by CERC dictates - ‘to provide non-discriminatory open access to its transmission system for use by (i) any licensee or generating company on payment of the transmission charges; or (ii) any consumer as and when such open access is provided by the State Commission under subsection (2) of section 42, on payment of the transmission charges and a surcharge thereon, as may be specified by the Central Commission’ (TSERC, 2020a). Likewise, the State of Telangana also has its own Open Access Regulation, which allows for contracted capacity above 1MW to apply for open access and is considering allowing above 100 kW under green open access. Depending on the duration open access can be short-term open access (STOA) or long-term open access (LTOA) (TSERC, 2023b).

- For Long-term open access transactions (2 years or more) the nodal agency is State Transmission Utility (STU) - TSTRANSCO
- For Short-term open access transactions (other than LTOA, and no more than 1 year) the nodal agency is State Load Dispatch Centre (SLDC) - TSSLDC

Typically, open access charges include - central transmission charges, state transmission charges, wheeling or distribution charges, cross-subsidy surcharge, additional surcharge and SLDC charges (TSERC, 2023b). The transmission charges paid by TSDISCOMs for first half (H1) of FY 2022-23 in actual is INR 0.67/kWh (TSERC, 2022a).

DISCOMs pay transmission charges based on the contracted capacities. However, during generation deficit, DISCOMs purchase power from short term sources. In order to avoid double billing of transmission charges for both long-term capacities as well as for short-term purchases, proposals are underway to the Commission to exempt the DISCOMs from payment of transmission charges on short-term purchases made from both intra-State and Inter-State sources, as long as their peak load is within their approved contracted capacity (TSERC, 2020a).

Also, transmission tariff for STOA and power exchange transactions were usually calculated in units of Rs/kW/month. Since these transactions occur in days or matter of hours, TSTRANSCO has requested TSERC to considering changing the units to MW/hour (TSERC, 2020a).

Transmission losses: TSERC has approved TSTRANSCO's transmission loss at 2.5% under the Multiyear Tariff (MYT) for the 4th control period from FY 2019-20 to FY 2023-24. The ISTS losses are estimated to be 4.02% based on notified losses. Specifically in the case of power purchased from the State of Chhattisgarh the loss considered is 3 % as approved by the Chhattisgarh State Electricity Regulatory Commission (CSERC). In the case of two solar projects, the transmission losses were waived off based on the ISTS Tranche-VI scheme, Central Public Sector Undertaking (CPSU) Scheme offered by the Ministry of Power (MoP) (TSERC, 2022d)

3.4 System operations

Deviation Settlement Mechanism (DSM): In a power system with an increasing share of renewables, it is important to ensure grid stability now more than ever given the variable nature of solar and wind (IEA, 2020). Imbalances in control area are usually measured in terms of Area Control Error (ACE). A deviation from schedule due to power plants outages, error in forecast of resource availability (in case of solar or wind), demand forecast error or load variation can result in ACE. A positive ACE indicates over-generation and causes the grid frequency to rise and a negative ACE means under generation and causes the grid frequency to drop. DSM Regulation helps address this issue, and Telangana has introduced a draft First Amendment Regulation, 2022, on DSM, which not only has DSM charges but also imposes penalty for repeat offenders. In addition, MoP is in advanced stages of commissioning a Renewable Energy Management Centre (REMC) in Telangana to help with better forecasting and scheduling of renewable generation in the State of Telangana, to address the intermittency and invariability of renewable generation capacity and to integrate them at TSSLDC (MoP, 2022).

Ancillary services: For Telangana, the 99 percentile ACE score for positive is 620 MW and for negative is 595 MW and this value should be considered as secondary reserve requirement for balancing services. Currently the reserve assessment is done based on load forecast trend analysis, which takes into account the previous day, weather forecast and day of the week. The reserve availability is assessed based on declarations made by all generators. Based on hydro resource availability a 500 MW spinning reserve is being maintained to meet any contingency. In the case of non-availability of hydro resource, spinning reserve is being maintained in the form of back down of thermal generators as per Merit Order (which is calculated based on composite tariff). When there is surplus generation, pumped hydro storage is being implemented in Srisailem and Nagarjuna Sagar hydel stations, which is called upon in case of peak demand or other contingencies (SANTULAN, 2020).

SAMAST: The Scheduling, Accounting, Metering and Settlement of Transactions (SAMAST) framework is currently being rolled out in Telangana as part of its DSM regulation. The framework was introduced with the aim of ensuring an efficient mechanism to properly schedule and settle electricity transactions in a transparent manner for the power transactions across intra-state boundaries (SAMAST, 2016).

TSSLDC prepares a monthly statement of state energy account for each time block for buyers and sellers. DSM charges would be prepared by TSSLDC on a weekly basis. The energy accounting will be done by billing units of the TSDISCOMs. Settlement between buyers and sellers will be carried out through the mutual agreed terms as part of their power purchase agreements, as long as they are consistent with the DSM regulation (TSERC, 2020c).

In Telangana, the number of interface energy meters is typically 1332 across 1017 interface points. The software being used to archive the energy meter data is Oracle, and the data is available for above five years. The energy meter data is being used to help with scheduling, but the data is not available open access on the TSSLDC website (SAMAST, 2016).

3.5 Key takeaways

- Under the 'One Nation – One Grid – One Frequency', the transmission expansion has been phenomenal, with Telangana having approved contracted capacity of 21,866 MW from TSTRANSCO and 4119.5 MW from CTU.
- In preparation for the future demand and generation addition, the state already has a forward-looking plan both by TSTRANSCO looking at overall expansion plans for the control periods of 2024-2029 (5th) and 2029-2034 (6th) and specifically for the case of renewables, MoP has identified four key districts – Rangareddy, Medak, Nizamabad and Karimnagar that will have dedicated evacuation corridor for the REZs.
- In terms of transmission planning, what needs to be kept in mind is the case of over capacity planning in an untimely manner, which will result in increased transmission tariff and thereby impacting the cost to end consumers. This will require coordination between various stakeholders such as CEA, TSTRANSCO, MoP, TSERC to ensure transmission capacity and investments are planned cohesively and allocation of the same is done effectively.
- The Telangana regulator has been steadily bringing down transmission charges based on the rules provided by MoP, which comes as a relief to both generators as well as consumers. In addition, the regulator has also set the allowed transmission losses for the coming years.
- On the system operations front, the State of Telangana currently has a draft DSM regulation, which will bring in the necessary measures to ensure grid security and reliability. SAMAST framework is being rolled out in the state, which upon successful implementation will enable uniformity in scheduling, accounting, metering and settlement for intra-state generation as well as inter-state generation.
- Reporting of system operations metering data via an open access system on the SLDC website can help with data transparency, and this can easily be done given the SLDC already uses commercial off the shelf software that allows for long term data recording.

DISTRIBUTION



4. Distribution

One of the main stakeholders in the power sector landscape are the distribution companies, who play a vital role in providing electricity by serving as a link between generators and end consumers, such as agricultural, residential, industrial and commercial sectors (PFC, 2023). India has 88 DISCOMs and the State of Telangana is serviced by two state owned distribution utilities namely Northern Power Distribution Company of Telangana Limited (TSNPDCL) and Southern Power Distribution Company of Telangana Limited (TSSPDCL).

Telangana DISCOMs (TSDISCOMs) serve a consumer base of 16.78 million people, of which TSNPDCL serves 6.34 million customers across 17 districts of North Telangana and TSSPDCL caters to 10.436 lakh customers across 15 districts of South Telangana. A snapshot of the two TSDISCOMs is presented in Table 9.

	TSNPDCL	TSSPDCL
Number of customers	63,48,874	1,04,36,589
% Agricultural customers	19.72	12.82
% C&I customers	8.84	11.7
Gross input energy	22,620 GWh (3% change *)	52,030 GWh (17% change *)
Total energy sold	19,871 GWh (4% change*)	46,029 GWh (14% change *)
Revenue booked	INR 15,426 Cr (32% change *)	INR 33,277 Cr (38% change *)
Profit after tax	INR -204 Crore	INR -627 Crore

**Compared to FY 2021 2022*

Table 9: Statistics of TSNPDCL and TSSPDCL for FY 2022 - 2023. Source-(PFC, 2023)

4.1 Supply management

4.1.1 Consumer categories

Telangana offers power supply to 20 categories of consumers under the jurisdiction of both the TSDISCOMs. The percentage share of consumers for TSDISCOMs across Low Tension (LT), High Tension (HT) and Extra High Tension (EHT) is presented in Figure 15.

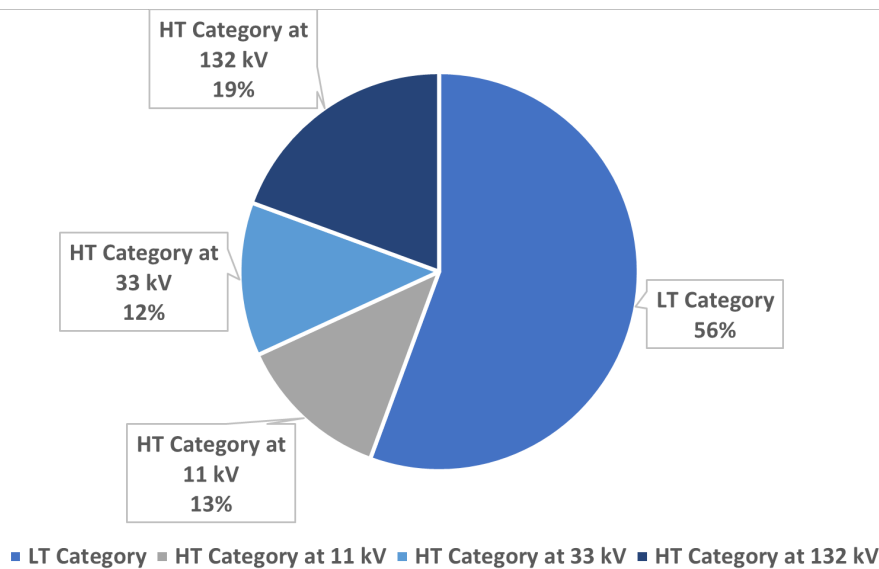


Figure 15: Consumer Sale projections approved by TSERC, HT/LT category wise (GWh). Source-Author, Data-(TSERC, 2023c)

Likewise, the percentage share of electricity sales made to different consumer categories is as shown in Figure 16.

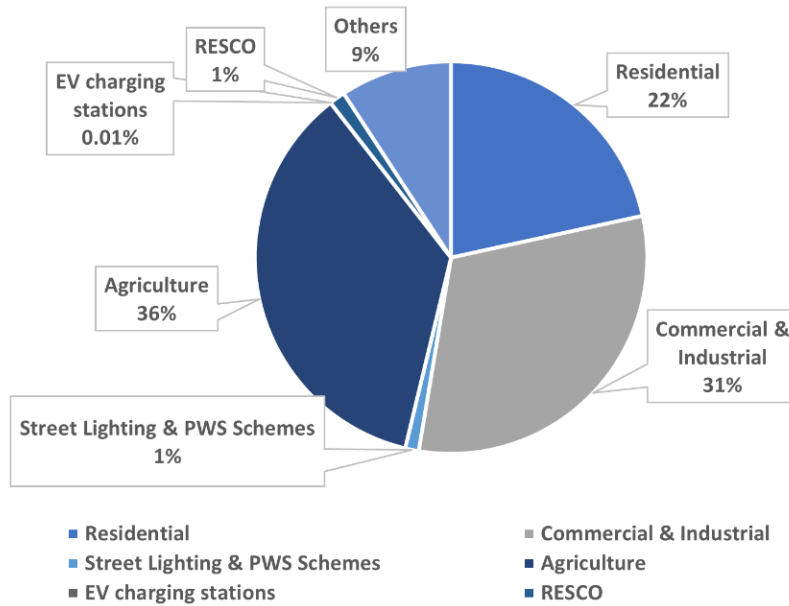


Figure 16: Consumer category-wise sales projections (GWh). Source-Author, Data- (TSERC, 2023c)

The highest electricity consuming category is Agriculture under both the TSDISCOMs, and the key driver for increase in demand in this category is due to the Lift Irrigation (LI) Schemes, supported by the Government of Telangana to meet the water needs of its agricultural consumers and the supply of 24X7 electricity to its agricultural consumers. However, TSERC has requested the TSDISCOMs to explore the possibility of supplying electricity to agricultural consumers at specified hours, keeping the peak load management for the state in mind. In addition, TSERC has also requested TSDISCOMs to do away with automatic starters to regulate the consumption of electricity.

The Government of Telangana allocated INR 49,314 crore as a subsidy towards free power supply to the agriculture sector between 2014-15 and 2021-22 (Government of Telangana, 2022). In addition, one of the operational parameters under the Ujwal DISCOM Assurance Yojana (UDAY) scheme is the segregation of feeders for agricultural and non-agricultural consumers for better management of subsidy, providing uninterrupted power supply to agricultural consumers, as well as to help in peak load management. However, a recent study found that Telangana recorded the lowest in terms of progress in meeting UDAY feeder segregation target (Michael et al., 2023). The latest recorded progress of the state according to UDAY dashboard is only 9%, with TSSPDCL and TSNPDCL achieving 7% ,11 % respectively (MOP, 2023).

4.1.2 Power procurement

The power requirement of TSDISCOMs is met from Power Purchase Agreements (PPAs) with various sources which include- Telangana State Power Generation Corporation Limited (TSGENCO), Central Sector Generating Stations (NTPC Ltd., NLC India Limited & Nuclear Power Corporation of India (NPCIL)), Singareni Collieries Company Limited (SCCL), Chhattisgarh State Power Distribution Company Limited (CSPDCL), Independent Power Producers (IPPs), Bi-lateral/inter-state purchases (TSERC, 2022d).

Power purchase in the state is managed by the Telangana State Power Coordination Committee (TSPCC) on behalf of the DISCOMs. TSTRANSCO is the chair of TSPCC, and power purchase is thus centrally managed by the state government (Prayas Energy Group, 2020b). TSPCC has two sub-committees namely Power Trading Committee which is responsible for power procurement from all generators, scheduling load relief, if any and issues related to SRLDC at the regional level and also inter-state sales and Balancing and Settlement Committee which is responsible for reviewing energy accounting and billing of power trade between DISCOMs and settlement of imbalances for the same (TSERC, 2023).

The TSDISCOMs have projected the total electricity generation availability of 96553.85 GWh for FY 2023-24 and have requested power purchase of 83,113.06 GWh. For FY 2023-24, TSERC has approved a total purchase of 84156.35 GWh from various sources. Out of the available generation sources, the DISCOM wise share from all the sources except RES within the State has been considered as 70.55% for TSSPDCL and 29.45% for TSNPDCL (TSERC, 2023c). In addition, as per RPPO regulation, TSDISCOMs are mandated to purchase a minimum of solar and non-solar RE of 9.25% for 2023-24, 10.50 % for 2024-25, 11.75% for 2025-26 and 13% for 2026-27 (TSERC, 2023c).

Based on the generation availability and the approved power purchase figures, there is surplus power available amounting to 8509.22 GWh for FY 2023-24. The availability of the surplus power is not a constant, and as per TSERC projections of monthly energy requirement and availability, the state is likely to have power deficit of 887.14 GWh in April 2023 and 618.28 GWh in March 2024, and this deficit is to be procured from short-term purchases (TSERC, 2023c).

4.1.3 Power purchase cost

Based on the approved power purchase cost by the regulator (refer Table 10), for the TSDISCOMs in the FY 2023-24, the power procurement price per unit of electricity is INR 4.39/kWh comprising of fixed component of INR 1.59/kWh, variable component of INR 2.64/kWh and other charges of INR 0.16/kWh (TSERC, 2023c).

Source	Claimed		Approved	
	Quantum (GWh)	Total (crore)	Quantum (GWh)	Total (crore)
TSGenco	34735.15	16115.48	31887.96	14472.44
CGS	23079.28	10151.81	21126.95	8876.84
Others	13339.35	7510.32	22969.47	10373.19
Renewables	11959.28	5187.7	11896.02	5074.46
DISCOM-DISCOM purchase	0	0	1408.26	260.69
DISCOM-DISCOM sale	0	0	-1408.26	-260.69
Sale of Surplus Power	0	0	-3724.05	-1862.02
Total	83113.06	38965.32	84156.35	36934.46

Table 10: Power Purchase cost for TSDISCOMS for FY 2023-24 (TSERC, 2023c)

TSDISCOMs shall be allowed to recover the power purchase cost for supply to its consumers based on TSERC approved power procurement plan covering each year of the control period. In this regard, as per regulation, the TSDISCOMs are required to fill the true-up power purchase costs including variation in power purchase cost of previous year along with the Aggregated Revenue Requirement (ARR) by end of November each year. However, the TSDISCOMS were not able to file the power procurement

details on time until FY 2021-22, and recognizing these delayed filings, TSERC has notified stringent penalties for non-compliance, wherein the rate of return on equity shall be reduced by 0.5% per month of non-filing (TSERC, 2023c). Table 11 shows the net true-up/true-down for power purchase cost as claimed by TSDISCOMs over the previous years. Given the commitment received from the Government of Telangana in March 2023 offering financial aid to TSDISCOMs for a period of five years, TSERC is not passing on the True-up burden onto the end consumers (TSERC, 2023c). Accordingly, for FY 2022-23, the Commission has approved the true-up of Rs.811.38 crore and true-down of Rs.409.00 crore for TSSPDCL and TSNPDCL respectively.

FY	Claimed				Approved			
	True-Up/ True-down	Addl. Support provided by GoTS	Loss funding provided by GoTS	Net True up/ True down	True-Up/ True down	Addl. Support provided by GoTS	Loss funding provided by GoTS	Net True up/ True down
2016-17	2303.68	2262.62	310.43	-269.37	2370.35	0	0	2370.35
2017-18	1608.3	1298.27	548.53	-238.5	1486.86	2262.62	310.43	-1086.19
2018-19	5015.6	2400	2004.68	610.92	4703.9	1298.27	548.53	2857.1
2019-20	5652.34	2000	3028.27	624.07	5632.67	2400	2004.68	1227.99
2020-21	4941.23	0	3344.18	1597.05	4941.23	2000	3028.27	-87.04
2021-22	8790	0	0	8790	7941.32	0	3344.18	4597.14
2022-23 (Provisional)	901.29	0	0	901.29	402.38	0	0	402.38
Total	29212.44	7960.89	9236.09	12015.46	27478.71	7960.89	9236.09	10281.73
Reversal of UDAY savings (RST order 2017-18 & 2018-19) claimed in Distribution True-up ²								2232.84
Grand total including UDAY								12,514.57

Table 11: Power Purchase Cost variation for the period FY 2016-17 to FY 2021-22 - INR in crores (TSERC, 2023c)

4.1.1.4 Grid access charges

Open access charges: As discussed in the section of Transmission, the charges that the TSDISCOMs can levy on the open access consumer is wheeling charges, cross subsidy surcharge (CSS) and additional surcharge. For the FY 2023-24, TSERC has approved the distribution wheeling charges as INR 1.17/kWh (TSERC, 2023b). The CSS determined by the commission for the FY 2023-24 across different HT consumers is as shown in Table 12. The TSDISCOMs in FY 2023-24 proposed an additional surcharge of

² Since TSERC has considered the eligible savings/benefits under UDAY in the wheeling charges true-ups, the savings earlier passed in retail supply business for FY 2017-18 and FY 2018-19 are being reversed in the power purchase true-ups.

INR 9.86/kWh, for which TSERC has approved INR 0.39/kWh (TSERC, 2022a), which is in line with the MoP's rule of capping the surcharge on open access at 20% of the Average Cost of Supply as per the Electricity (Amendment) Rules, 2022 (TSERC, 2022a).

Consumer Category		TSSPDCL (in INR/kWh)	TSNPDCL (in INR/kWh)
HT Category at 11 kV			
HT-I	Industry	2.03	2.02
HT-II	Others	2.45	2.43
HT-III	Airports, Railway stations and Bus stations	2.24	2.1
HT-IV	Irrigation, Agriculture & CPWS	0.95	0.31
HT-VI	Townships and Residential Colonies	1.83	1.88
HT-VII	Temporary Supply	3.16	3.16
HT-IX	Electric Vehicle Charging Station	1.44	nil
HT Category at 33 kV			
HT-I	Industry	1.79	1.71
HT-II	Others	2.04	2.58
HT-IV	Irrigation, Agriculture & CPWS	1.28	1.29
HT-VI	Townships and Residential Colonies	1.74	1.98
HT-VII	Temporary Supply	2.8	5.29
HT Category at 132 kV and above			
HT-I	Industry	1.59	1.67
HT-II	Others	1.77	8.24
HT-III	Airports, Railway stations and Bus stations	1.8	nil
HT-IV	Irrigation, Agriculture & CPWS	1.4	1.58
HT-V	Railway Traction & HMR	1.65	1.36
HT-VI	Townships and Residential Colonies	nil	1.65

Table 12: Summary of CSS determined by the Commission for FY 2023-24 (in INR/kWh) (TSERC, 2023c)

Captive consumer charges: Based on the proposal from TSDISCOMs in FY 2022-23, TSERC has requested the Grid Coordination Committee to study the levy of Grid Support Charges (GSC) on the captive power plants for availing benefits during their parallel operation with the distribution licensees' grid network. The committee came out with recommendations in August 2022, but given the TSDISCOMs current retail supply tariff methodology and applicability of GSC is different, TSERC has again referred the matter to the Grid Coordination Committee to come with suitable recommendations.

4.1.5 Retail supply tariff

Retail Supply Tariff is the rate charged by DISCOMs to supply electricity to non-open access customers which includes charges for wheeling and retail supply (DERC, 2007). The retail supply tariff approved by TSERC for the State of Telangana for the FY 2023-24 is presented in Table 13 for select consumer categories.

Consumer Category		Fixed/Demand Charge		Energy Charge	
		Unit	INR Unit/Month	INR/kWh or INR/kVAh	
Residential	Domestic				
	LT-I(A)	0-50	kW	10	1.95
	LT-I(A)	51-100	kW	10	3.1
	LT-I(B)	0-100	kW	10	3.4
	LT-I(B)	101-200	kW	10	4.8
	LT-I(B)(ii)	0-200	kW	10	5.1
	LT-I(B)(ii)	201-300	kW	10	7.7
	LT-I(B)(ii)	301-400	kW	10	9
	LT-I(B)(ii)	401-800	kW	10	9.5
	LT-I(B)(ii)	Above 800	kW	10	10
Townships and Residential Colonies					
HT-VI	11, 33, 132 kV	kVA	260	7.3	
Commercial & Industrial	Non-Domestic/Commercial				
	LT-II(A)	0-50	kW	60	7
	LT-II(B)	0-100	kW	70	8.5
	LT-II(B)	101-300	kW	70	9.9
	LT-II(B)	301-500	kW	70	10.4
	LT-II(B)	Above 500	kW	70	11
	Industry LT				
	LT-III		kW	75	7.7
	Cottage Industries				
	LT-IV(A) & (B)	kW		20/kW subject to a minimum of INR 30/Month	4
	Industry (General) HT				
	HT-I	11 kV	kW	475	7.65
	HT-I	33kV	kW	475	7.15
HT-I	132 KV	kW	475	6.65	
Street Lighting	LT-VI(A)	Panchayats	kW	32	7.1
	LT-VI(A)	Municipalities	kW	32	7.6
	LT-VI(A)	Municipal Corporations	kW	32	8.1
Agriculture	Agricultural LT				
	LT-V(A)	Corporate farmers	kW		2.5
	LT-V(A)	Non- Corporate farmers	kW		0
Irrigation and Agriculture HT					

	HT-IV A	11, 33, 132 kV	kW	275	6.3
EV charging stations	EV LT				
	LT-IX		kW	50	6
	EV HT				
	HT-IX	11, 33, 132 kV	kVA	100	6
RESCO	HT-VIII	11 kV	kW		4.84

Table 13: Retail Supply Tariff Schedule determined by TSERC for FY 2023-24. Source-(TSERC, 2023c)

In addition to the general retail supply tariff classification, TSDISCOMs offer **Time-of-Use (ToU)** tariff to its HT consumers. The ToU or Time of Day (ToD) as it is referred to in the FY 2023-24 Tariff Order, is presented in Table 14 and is applicable to HT consumer categories types - industry general, poultry farms, other, wholly religious places; airports, railway stations and bus stations, and electric vehicle (EV) charging stations (TSERC, 2023c).

Description	During the Period	ToD Tariff over Retail Supply Energy Charges for FY 2023-24
Time of Day (ToD)	6-10am and 6-10pm	Plus INR 1/unit
Time of Day (ToD)	10pm to 6am	Minus INR 1/unit

Table 14:Time of Day (ToD) Tariff over Retail Supply Energy Charges for FY 2023-24. Source-(TSERC, 2023c)

For FY 2023-24, the regulator extends the special **Green Tariff** to all categories of consumers in HT & LT. The approved Green Tariff rate is INR 0.66/unit over and above the retail supply tariff of the respective category. In this regard, the regulator has asked the TSDISCOMs to issue Green energy certificate on a monthly basis to its consumers, clearly mentioning the green attributes (TSERC, 2023c).

4.1.6 Distribution losses

In the MYT Order for the 4th Control Period from FY 2019-20 to FY 2023-24 for TSDISCOMs, the regulator TSERC has approved distribution losses for LT – 4.75%, 11 kV – 4.10% and 33 kV – 3.60% for TSSPDCL and in the case of TSNPDCL LT- 4.75%, 11 kV- 3.77% and 33 kV- 3.48% (TSERC, 2023c). The regulator has directed TSDISCOMs to take strict measures to reduce losses in areas experiencing higher losses, and in this regard TSDISCOMs are to submit quarterly reports on the measures taken and the corresponding quarter-wise energy audit reports are to be made available in public domain (TSERC, 2023c).

The billing efficiency reported for TSNPDCL is 91% in FY 2021-22 and for TSSPDCL it is 92.8% in FY 2020-21. The collection efficiency for the two TSDISCOMs as compared to the national average is presented in Figure 17. The data shows TSSPDCL performing close to the national average, while in the case of TSNPDCL there is sharp variation in its performance year after year (PFC, 2023)(TSERC, 2023c).

For FY 2021-22, the System Average Interruption Frequency Index (SAIFI) index for TSNPDCL was 58.10, and for TSSPDCL it was 22.69. Likewise, the System Average Interruption Duration Index (SAIDI) index for TSNPDCL was 41.27 and for TSSPDCL was 14.66 (CEA, 2023a). As per central government policy and through Power Finance Corporation (PFC) sanction, Telangana state is rolling out Real-Time Data Acquisition Systems (RT-DAS) to accurately measure reliability of power distribution network and

facilitate suitable administrative action to enhance power reliability through a real time data acquisition system (TSSPDCL, 2022).

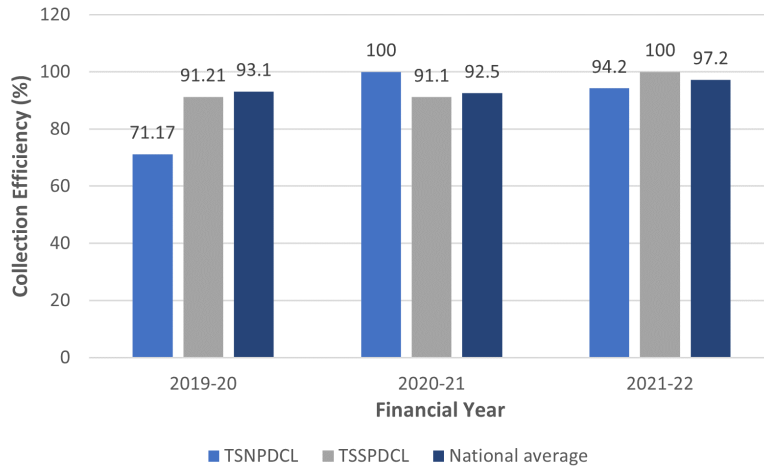


Figure 17: Collection efficiency (%) of TSDISCOMs and the national average. Source- Author, Data- (PFC, 2022b, 2023)

The Aggregate Technical & Commercial (AT&C) losses provide a realistic picture of the DISCOM loss situation, a combination of energy loss – including technical loss, theft, inefficiency in billing; and commercial loss – including default in payment, inefficiency in collection (NPP, 2023). Figure 18 shows the AT&C losses for the two TSDISCOMs over the last three years as compared to the national average. Under the Ujwal DISCOM Assurance Yojana (UDAY) scheme MoU with the state in 2017, the AT&C loss target set for TSSPDCL was 9.90% and for TSNPDCL it was 10%, however the TSDISCOMs were not able to meet these targets, with TSSPDCL only managing to achieve it in FY 2021-22 (MOP, 2017; PFC, 2023). Overall, the AT&C loss trajectory (as shown in Figure 18) has been reducing due to the various loss reduction measures, improved collection efficiency and strategic investments undertaken by the TSDISCOMs (TSERC, 2023c). Furthermore, the full implementation of the Revamped Distribution Sector Scheme (RDSS) is expected to improve AT&C losses. In addition, the regulator has asked the TSDISCOMs to conduct consumer awareness programs in areas with high AT&C losses (TSERC, 2023c) and has approved INR 81.60 crores for TSNPDCL and INR 22.36 crores for TSSPDCL, as capital investment towards loss reduction for FY 2023-24 (TSERC, 2020b).

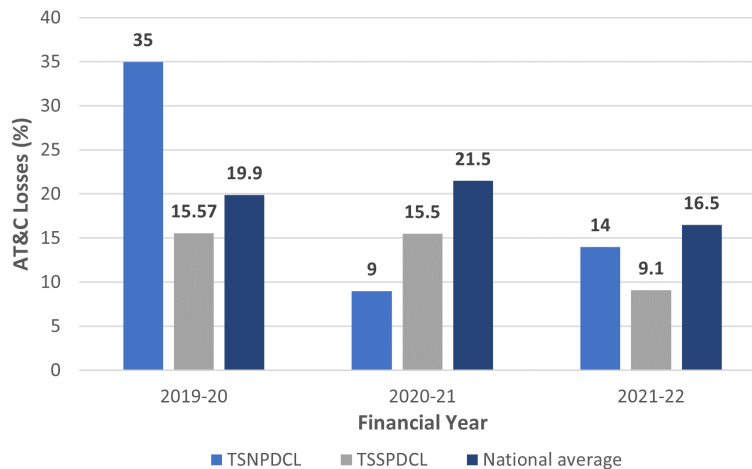


Figure 18: Aggregate Technical & Commercial (AT&C) Losses (%) of TSDISCOMs and the national average. Source- Author, Data- (PFC, 2022b, 2023)

4.2 Financial parameters

4.2.1 Average cost of supply (ACoS)

It is the average cost imposed by all consumers on the DISCOMs irrespective of their individual cost of supply. The Electricity Act, 2003 mandates SERCs to ensure that retail supply electricity tariff is cost reflective for each category, while simultaneously reducing the cross subsidies component on the various consumer categories (Pachouri et al., 2020).

The TSERC approved the State's ACoS for and representative consumer category for the FY 2023-24 is listed in Table 15. The average CoS for FY 2023-24 works out to INR 6.70/kWh, INR 7.82/kWh and INR 7.02/kWh for TSSPDCL, TSNPDCL and at the State level respectively. The CoS at the state level has slightly reduced by 0.14% in FY 2023, which previously recorded Rs 7.03/kWh in FY 2021-22 (TSERC, 2022d, 2023c)

Consumer Category	Claimed (INR/kWh)		Approved (INR/kWh)			
	TSSPDCL	TSNPDCCL	TSSPDCL	TSNPDCCL	State	
Residential	Domestic LT					
	LT-I	8.29	9.44	6.91	7.59	7.09
	Townships and Residential Colonies					
	HT-VI (11kV)	6.29	6.5	8.29	10.55	8.37
	HT-VI (33kV)	6.20	5.98	6.54	7.591	6.67
	HT-VI (132kV)	nil	4.87	NA	5.04	5.04
Industrial	Non-Domestic/Commercial HT					
	LT-II	8.39	9.25	7.28	8.35	7.5
	Industrial					
	LT-III	8.55	8.39	7.47	7.8	7.52
	HT-I (11kV)	6.59	5.89	7.84	9.56	8.17
	HT-I (33kV)	5.69	5.58	5.92	5.83	5.92
	HT-I ((132kV)	5.02	4.85	4.9	5.2	4.93
	Cottage Industries					
	LT-IV	8.49	10.26	7.05	9.48	8.21
	Agricultural	Agriculture LT				
LT-V		8.47	9.93	7.47	8.73	8.01
Agriculture & Irrigation HT						
HT-IV (A&B) 11kV		6.32	6.11	5.63	6.12	5.87
HT-IV (A&B) 33kV		6	5.27	4.8	4.96	4.89
HT-IV (A&B) 132kV		5.36	5.25	5.53	6.59	5.96
Street Lighting & PWS	LT-VI	8.08	10.04	7.12	9.49	8.19
General Purpose	LT-VII	9.23	9.45	7.32	9.49	8.19
Temporary Supply	LT-VIII	9.23	9.45	10.39	11.27	10.45
RESCOs	HT-VIII	nil	5.1	NA	6.501	6.5
EV charging station	LT-IX	10.63	6.48	6.7	0	3.8
	HT-IX	6.68	6.1	12.18	NA	12.18
Average CoS		7.06	8.04	6.7	7.821	7.02

Table 15: Cost of Service for FY 2023-24 (INR/kWh). Source- (TSERC, 2023c)

Telangana computes its CoS using the methodology of Embedded cost of supply (ECoS). The advantage of this method is that costs are embedded among different consumer categories across various voltage levels and their corresponding allocation factors can be worked out based on granular data that is available with the TSDISCOMs (Pachouri et al., 2020).

The Distribution and Transmission costs accounted for 18.64% and 10.34% of the total allocated cost of service respectively, making generation the most expensive chunk of the cost of service, i.e., 71% of the total cost.

4.2.2 Aggregate revenue requirement (ARR)

ARR is the basis for recovery of charges by the DISCOMs from its consumers (Bharadwaj et al., 2017). It includes power purchase cost, distribution cost, ISTS charges & InSTS charges, SLDC charges, Interest on Consumer Security Deposit (CSD) and supply margin (TSERC, 2023c). Table 16 shows the TSERC approved ARR numbers for the TSDISCOMs for the FY 2023-24.

Both TSDISCOMS claimed a total ARR of INR 54,058 crores for FY 2023-24, with power purchase amounting to 72% of the ARR. TSERC has however approved INR 52,000 crores, as shown in the table below (TSERC, 2023c).

Particulars	Claimed (INR Crore)			Approved (INR Crore)		
	TSSPDCL	TSNPDCL	Total	TSSPDCL	TSNPDCL	Total
Power purchase cost	27654.99	11310.21	38965.20	26183.99	10750.47	36934.46
Distribution cost	5268.36	4081.42	9249.78	5168.36	4081.42	9249.78
InSTS charges	2670.27	1126.29	3796.56	2670.27	1126.29	3796.56
ISTS charges	1081.98	451.19	1533.17	1081.98	451.19	1533.17
SLDC charges	32.81	13.69	46.50	32.81	13.69	46.50
Interest on CSD	311.96	81.08	393.04	293.44	78.77	372.21
Supply Margin	42.83	31.27	74.10	42.83	31.27	74.10
ARR	36963.21	17095.16	54058.35	35473.67	16533.11	52006.78

Table 16: Aggregate revenue requirement (ARR) for FY 2023-24 (in INR crore). Source- (TSERC, 2023c)

The ACS-ARR gap for the state of Telangana across the two TSDISCOMs is shown in Figure 18: Aggregate Technical & Commercial (AT&C) Losses (%) of TSDISCOMs and the national average. Source- Author, Data- (PFC, 2022b, 2023)Figure 19, as per PFC data 2023. While the ARR and sales have been increasing over the years, there has been no increase in the subsidy amount provided by the Government of Telangana (TSERC, 2022d). The DISCOMs in the filings have submitted that they were able to recover only 13% of ARR through existing fixed/demand charges, for the FY 2022 (TSERC, 2022d).

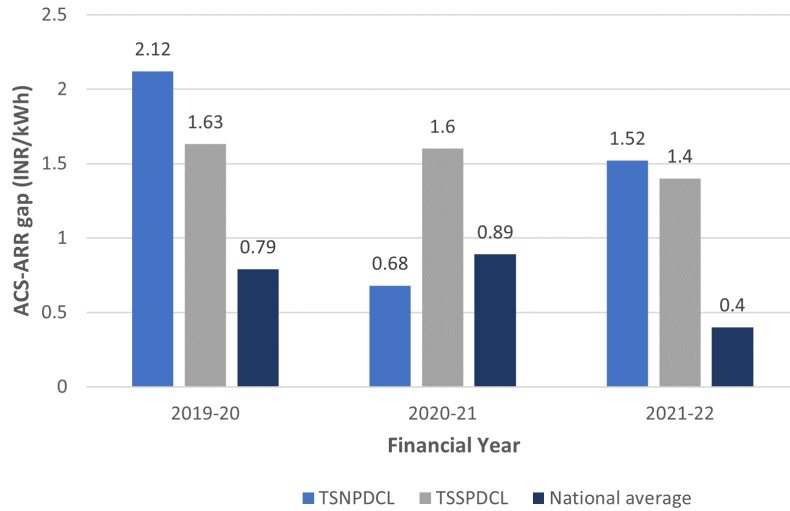


Figure 19: ACS-ARR gap for TSDISCOMS and national average. Source-Author, Data-(PFC, 2023)

4.2.3 Revenue gap

It is determined by the regulator based on the ACoS minus Average Billing Rate (ABR) level for each consumer category; after adjusting the positive and negative cross subsidy throughout and including the GoTS subsidy commitment (TSERC, 2023c). For the FY 2023-24, the revenue gap with existing tariffs claimed by the TSDISCOMs was INR 3211 crores for TSSPDCL and INR 7324 crores for TSNPDCL, summing to a total of INR 10,534 crores. TSERC however determined a net revenue deficit of INR 9124.82 crores, with INR 1349.52 crore for TSSPDCL and INR 7775.30 crore for TSNPDCL.

Particulars	Claimed (INR Crore)			Approved (INR Crore)		
	TSSPDCL	TSNPDC	Total	TSSPDCL	TSNPDC	Total
Aggregate Revenue Requirement	36963.2	17095.16	54058.36	35473.67	16533.11	52006.78
Revenue from Current Tariffs (net of incentive)	33521.24	9737.7	43259.04	33974.5	9052.35	43026.84
Non-Tariff Income	28.18	33.81	61.99	28.18	33.81	61.99
Revenue from Cross Subsidy Surcharge	100.8	-	100.8	98	-	98
Revenue from Additional Surcharge	102.23	-	102.23	23.48	-	23.48
Revenue Deficit/Surplus at Current Tariffs	(-) 3210.64	(-) 7323.65	(-) 10534.29	1349.52	7775.3	9124.82

Table 17: Revenue deficit/(surplus) at current tariffs (in INR Crore) for FY 2023-24. Source-(TSERC, 2023c)

In the Central government's Electricity (Timely Recovery of Costs due to change in Law) Rules, 2021, it states that if the cost of power purchase were to increase, it must be passed on to the end consumers. These rules apply to a generating company and transmission licensee to recover costs due to a change in law, from distribution companies on a monthly basis and allowing distribution company to pass through the costs on to the consumers (MoP, 2021). However, given the expectation from the Telangana State Government which has committed to bridge the revenue gap and to ensure full recovery of ARR as approved by the regulator, TSERC has not passed through the costs to the end consumer in its True-up/True-down fillings for FY 2022-23 (TSERC, 2023c). In addition, in 2022, TSERC has directed the TSDISCOMs to improve their internal efficiency and reduce the gap between ACS and

ARR. In this regard, to better manage the largest retail consumer category of Agriculture, the regulator asks TSDISCOMs to achieve 100% distribution transformers (DT) metering within a period of twelve months and to publish the quarterly progress on the status of implementation of the same. TSDISCOMs are also considering segregating agricultural feeders to better regulate the power supply. (TSERC, 2022d).

To improve the TSDISCOMs cash position, Days Receivable should go down from 267 days (TSNPDCL) and 130 days (TSSPDCL) to less than 60 days and Days Payable should go down from 356 days (TSNPDCL) and 375 days (TSSPDCL) to 45 days as per the Late Payment Surcharge (LPS) norms (PFC, 2023).

When the tariffs imposed on electricity consumers do not adequately cover the power purchase costs of DISCOMs, SERCs instead of increasing tariffs, or postponing the action, often permit the DISCOMs to record this shortfall as receivables. These receivables are then called Regulatory Assets (RA). The accumulated RA form the Regulatory Asset Base (RAB), which are to be amortized along with interest in future years. Natural calamities, funding terminal liabilities, delayed implementation of tariff revision, contractual obligations are other instances that can lead to the creation of RAB (ICRA, 2021). While the TSDISCOMs have been reporting significant losses, TSERC has not yet created any regulatory asset for Telangana (ICRA, 2021; PFC, 2022b).

4.2.4 Subsidy

Typically, subsidies comprise of tariff subsidy and non-tariff subsidy amounts. While the tariff subsidy is the state government's reimbursement to the DISCOMs channeled to respective customer categories, the non-tariff subsidy is distributed under various central/state schemes such as UDAY to support financially weak DISCOMs in the form of loan-takeover, loss takeover, equity infusion, among other practices (PFC, 2023). Domestic consumers are charged a subsidized tariff (lower than average cost of supply), and Industrial and Commercial consumers are charged a higher tariff, above the average cost of supply of electricity, to cross subsidize the domestic consumers, adding on to the complexity of tariff estimation (Bharadwaj et al., 2017).

For FY 2023-24, the subsidy amount requirement submitted to the Government of Telangana is the total revenue gap amount of INR 9124.82 crores.

Consumer Category	TSSPDCL	TSNPDCL	CESS Sircilla	Total
LT-I: Domestic	644.32	713.97	22.73	1381.02
LT-V: Agricultural	705.20	632.98	305.62	7743.80
Total	1349.52	7446.95	328.535	9124.82

Table 14: Subsidy amount requirement submitted to GoTS for FY 2023-24. Source-(TSERC, 2023c)

The Government of Telangana has confirmed its commitment to provide subsidy to the tune of INR 9,124.82 crore out of the total budget allocated for an amount of INR 12,102.75 crore to be reimbursed to the DISCOMs consequent to the approval of retail supply tariff by the regulator for the FY 2022-23 (TSERC, 2022d).

After inspecting the cost, revenue, subsidy for each consumer category, TSERC has determined the Full Cost Recovery Tariff Schedule (FCRTS), after apportioning the non-tariff income and surplus of revenue from subsidizing categories. In the case of absence of any external subsidies, the commission states that levying tariff as per FCRTS as opposed to the scheduled Retail Supply Tariff Schedule (RSTS) (shown in Table 18), will help TSDISSCOMs generate revenue to fully recover the approved ARR (TSERC, 2023c).

Consumer Category	Fixed/Demand Charge		Energy Charge		
	Unit	Rate (INR/Unit/Month)	INR/kWh or INR/kVAh		
			Scheduled RSTS	Required FCRTS	
			TSSPDCL	TSNPDCL	
LT-I: Domestic	kW	10	1.95	6	6.89
LT-V: Agricultural (Other than Corporate farmers)	HP		0	0.62	8.02

Table 18: Comparison of scheduled tariff vs FCRTS as determined by the Commission Source: Author Data-(TSERC, 2023c)

Subsidy disbursement has been lagging in the power distribution sector over many years, leading to considerable subsidy arrears out of the 24 states which booked tariff subsidy, Telangana was among the 18 states to disburse 100% of the amount, for the FY 2021-22. However, under non-tariff category, the subsidy disbursal for Telangana’s DISCOMS was low (~39%), since the UDAY subsidy booked in FY 2021-22 was received in FY 2022- 23, and hence was not considered in the FY 2021-22 DISCOM ratings by PFC. If we were to look at the overall subsidy disbursement, for instance, in the FY 2020-21, for TSNPDCL - total subsidy received was 61% of the subsidy booked and for TSSPDCL - total subsidy received was 18 % of the subsidy booked (PFC, 2023). Thus, these shortcomings reinforce the need to consider subsidy disbursal through direct benefit transfer (DBT) instead of channeling through DISCOMs to reduce their financial burden.

4.2.5 Debt equity ratio (D/E)

It is a metric used to measure the DISCOM’s financial leverage thus indicating its overall financial health. The lower the DER the better the financial position. Higher levels of debts and interest result in higher D/E ratios, indicates high risk and therefore, averts favorable investment, thus hindering DISCOM’s performance (Pandey et al., 2022).

In the case of TSDISCOMs, under UDAY scheme, 75% of the total debt (INR 11,897 crore) as on 30.09.2015, which amounts to INR 8,923 crore will be taken over. INR 7,723 crore is to be transferred to DISCOMs in the form of equity and the balance INR 1200 crore will then be taken over by the State Government as per MoU with UDAY (TSERC, 2022d).

As of December 2021, the arrears reported by TSDISCOMs are INR 9974.56 (TSSPDCL) and 8489.25 (TSNPDCL) (TSERC, 2023c). According to NITI Aayog’s State Energy and Climate Index (SECI) assessment, the all-India average DISCOMs debt-equity ratio was 0.011 and Telangana DISCOMs had a score a 0.0 indicating a net negative worth (Pandey et al., 2022).

TSDISCOMs ranking: As per PFC’s annual DISCOM ranking exercise, TSSPDCL was ranked 44 out of 53 and TSNPDCL was ranked 46 out of 53 for FY 23 and in order to improve its scoring a series of measures need to be implemented for the turnaround of the TSDISCOMs.

4.3 Innovative enablers for the TSDISCOMs

4.3.1 Smart grids

National Smart Grid Mission (NSGM) was established by the Central government under MoP in 2015, to accelerate Smart Grid deployment in India by planning and monitoring implementation of policies and programmes related to Smart Grid activities (NSGM, 2023b). Telangana brought into effect its Smart Grid Regulation in 2021, which includes components such as Advanced Metering Infrastructure (AMI), microgrids, demand response, supervisory control and data acquisition (SCADA), distribution generation, peak load; outage; asset management, wide area measurement system, energy storage systems, renewable integration, grid to vehicle and vehicle to grid, smart grid data collection, and dynamic tariff (TSERC, 2021).

As part of smart grid pilot projects initiated by MoP, Telangana's pilot projects will be equipped with the following smart grid functionalities - AMI enabled for both residential and industrial, peak load management, outage management system, power quality and SCADA (NSGM, 2023a).

Smart meters: In 2018, the Central government launched The Smart Meter National Programme (SMNP), to deploy smart meters across the country, by Energy Efficiency Services Limited (EESL), a joint venture of PSUs under Ministry of Power. SMNP aims to replace 250 million conventional meters with smart meters by 2022, with urban DISCOMs being covered in the first phase. Telangana is one of the states that has entered into agreements with EESL, where EESL will bear all the capital expenditure and operating expenses for smart-meter roll-out programme. In addition, RDSS aims at deployment of 250 million smart prepaid meters for all domestic by March 2025, of which 100 million are to be installed in first phase by December 2023 (PIB, 2022c). States associated with UDAY also get financial support for deployment of smart meters for all consumers with a consumption of over 200 units per month (REC, 2023).

As per the UDAY dashboard, as per March 2023, the smart metering rollout achieved by the TSDISCOMs is 38,727 as presented in Table 19: Smart metering progress of Telangana. Source-Author, Data-(MOP, 2023)Table 19.

TSDISCOMs	200-500kWh		Above 500kWh	
	%	No. of meters	%	No. of meters
TSNPDCL	0	12025	19%	3033
TSSPDCL	0	0	16%	23669
Total	2%	12025	16%	26702

Table 19: Smart metering progress of Telangana. Source-Author, Data-(MOP, 2023)

According to Bureau of Energy Efficiency's (BEE) State Energy Efficiency Index (SEEI), Telangana is one among the thirteen states in the country that has provided data on the number of utility consumers with smart meters. However, the state was not listed in those who made use of the smart meter data for analysis (Bureau of Energy Efficiency, 2022).

TSERC in 2023 has directed the TSDISCOMs to submit a time-bound action plan for replacement of existing meters with prepaid smart meters (TSERC, 2023c). Accordingly, to the TSDISCOMs detailed project report, smart prepaid metering for all existing consumers (excluding agriculture consumers) and system metering under RDSS would amount to INR 9308,37 Crores.

4.3.2 Electric vehicles

To ensure faster adoption of Electric Vehicles (EVs) and to enable the state as an attractive destination for investment, Telangana launched the 'Telangana Electric Vehicle and Energy Storage Policy', envisaged for the years 2020-2030 (Government of Telangana, 2020). The special EV tariff category proposed under the Policy, is reflected in the retail tariff order of the state shown in Table 13. Telangana has a total of 111 charging stations of which 77 of them are public chargers (TSREDCO, 2023). Table 20 shows the electricity consumption by the public charging stations across the two TSDISCOMs.

DISCOM	Major City	Month	No of EV Charging Stations excluding Heavy Duty Vehicles charging stations	No of PCS specific to Heavy Duty Vehicles (E-bus etc.)	Electricity Consumed in EV Charging Stations (excluding Heavy Duty Vehicles PCS) (in Kwh)	Electricity Consumed in Heavy Duty PCS Only (in Kwh)	Total Electricity Consumed (in GWh)	
TSSPDCL	Hyderabad	Apr, 22	7	0	1700	0	0.002	
		May, 22	16	0	4817	0	0.005	
		Jun, 22	18	1	7.383	73	0.007	
		Jul, 22	22	1	10911	270	0.011	
		Aug, 22	27	2	12869	861	0.014	
		Sep, 22	27	3	16739	2630	0.019	
		Oct, 22	28	3	19325	4560	0.024	
		Nov, 22	33	5	27339	13289	0.041	
		Dec, 22	36	5	30221	21393	0.052	
		Jan, 23	39	6	34000	54000	0.088	
		Feb, 23	42	6	30000	74000	0.104	
		Sub Total				196000	173000	0.369
TSNPDCL	Adilabad, Hanamkonda, Kamareddy, Karimnagar, Khammam, Mahabubabad, Nirmal, Nazimabad, Peddapally, Warangal	Apr, 22	0	0	0	0	0	
		May, 22	1	0	286	0	0	
		Jun, 22	1	0	223	0	0	
		Jul, 22	1	0	472	0	0	
		Aug, 22	5	0	630	0	0.001	
		Sep, 22	9	0	583	0	0.001	
		Oct, 22	13	0	620	0	0.001	
		Nov, 22	18	0	1611	0	0.002	
		Dec, 22	20	0	3329	0	0.003	
		Jan, 23	25	0	4140	0	0.004	
		Feb, 23	29	0	5507	0	0.006	
		Sub Total				17401	0	0.017

Table 20: Electricity Consumption Details of EV charging stations of TSDISCOMs for FY 2022-23 (CEA, 2023b)

In 2021-2022, five popular EV companies viz Triton Electric, Liteauto GmbH, Gravton Motors, One Moto India, Biliti Electric (with a total investment of Rs 5147 Crore) signed agreements with the state government to set up their manufacturing units in the (Telangana Today, 2022).

4.3.3 Energy efficiency

As the energy sector is responsible for 75% of the GHG emissions, energy efficiency becomes key lever for meeting India's updated Nationally Determined Contribution (NDC) on emission intensity reduction (Bureau of Energy Efficiency, 2022). As per BEE's SEEI assessment which examines State's policies and regulations, financing mechanisms, institutional capacity, adoption of energy efficiency and energy savings, Telangana emerged as a frontrunner with 74 points in 2021 and stood 5th in energy conservation awards for the FY 2021-22 (Bureau of Energy Efficiency, 2022). Likewise, Telangana also performed well under NITI Ayog's SECI assessment, under the Energy efficiency implementation measures category, which measured the energy consumed per GDP indicating how efficiently the resources were utilized to meet the needs (Pandey et al., 2022).

On the other hand, in its effort to enable its consumers to go for energy efficient appliances TSDISCOM-TSNPDCL has entered into a Joint Venture (JV) with EESL to implement demand side measures including both support for technical aspects as well as for aggregation of capital (TSERC, 2022d).

4.4 Key takeaways

- Telangana has a centralized approach to procuring power for its two DISCOMs and the regulator approved power purchase for the state in FY 2023-24 is 84156 GWh (as supposed to 96553.85 GWh available), at a power procurement of electricity INR 4.39/kWh. If there is variation in the power purchase cost, ideally TSDISCOMs can recover it during their true-up/down filings. But over the last years TSDISCOMs have not been filing this on time (except for the current year), thereby not allowing regulators enough time to make their assessment before annual tariff orders are approved for the MYT control period. Although the state seems to have surplus power, it is not a constant over the year, and for deficit months TSERC suggests power procurement from the spot market.
- The grid access charges for open access consumers such as wheeling, CSS and additional surcharge for the state have been approved by the regulator for the current financial year. In the case of additional surcharges, while the TSDISCOMs claimed INR 9.86/kWh, TSERC has only approved Rs 0.39/kWh, which is in line with MoP to cap it at 20% of average CoS. For captive consumers, TSERC is considering the opinion of the Grid Coordination Committee to levy Grid Support Charges (GSC).
- As part of the MYT methodology, the state has approved retail supply tariff for the current year for its 20 consumer categories. Including special tariffs over the retail supply tariff, such as the Time-of-Use (ToU) tariff for its HT consumers (+/- INR 1/unit) and Green Tariff (+ INR 0.66/unit) for all HT and LT consumers.
- The state regulator has capped the distribution losses for the state at a maximum of 4.75% for the current year. The ex-post billing efficiency reported for TSDISCOMs is between 91%-93% and the collection efficiency is between 94% - 100%. Overall, the AT&C loss trajectory has reduced due to the various loss reduction measures, improved collection efficiency and strategic investments undertaken by the TSDISCOMs. The full implementation of RDSS and the regulator's request to install DT metering for all agricultural consumers as well as conducting consumer engagement programs for all consumers will further improve AT&C losses.

- Telangana computes its CoS using ECoS methodology, and for the current year the ACoS for the state is 7.02/kWh. The ARR claimed by TSDISCOMS for the current year is INR 54.058 crore of which power purchase cost alone amounts to 72% of the ARR. While the ARR and electricity sales have been increasing over the years, yet there has been no increase in the subsidy amount provided by the Government of Telangana. Although TSERC for the current year determined a net revenue deficit of INR 9124.82 crores, given the commitment from Telangana government, the regulator has not passed on the costs to the consumers. The TSDISCOMs do not have a regulatory asset base and are dependent on the state government to bridge the revenue gaps. Subsidy disbursement by the GoTS has been lagging in the power distribution sector over many years, leading to considerable subsidy arrears. While the State government has been paying 100% of the tariff subsidy, the non-tariff subsidy disbursed to the TSDISCOMs was low (~39%), due to the UDAY subsidy booked in FY 2021-22 being received in FY 2022- 23. In this regard, introduction of DBTs for subsidy disbursal can help reduce the financial burden on DISCOMs.
- As of December 2021, the arrears reported by TSDISCOMs is INR 9974.56 (TSSPDCL) and 8489.25 (TSNPDCL). According to NITI Aayog's State Energy and Climate Index (SECI) assessment, the all-India average DISCOMs debt-equity ratio was 0.011 and Telangana DISCOMs had a score a 0.0 indicating a net negative worth. In terms of TSDISCOMs cash position, TSDISCOMs are performing well below par for both days receivable and days payable. As per PFC's annual DISCOM ranking exercise, TSSPDCL was ranked 44 out of 53 and TSNPDCL was ranked 46 out of 53 putting them in the bottom bucket of the Indian DISCOMs list.
- On the innovation front, Telangana brought into effect its smart grid regulation and as part of the pilot projects supported by the central government it will demonstrate a few key smart grid functionalities such as AMI, peak load management, outage management system, power quality and SCADA. As per the UDAY dashboard as of March 2023, the smart metering rollout achieved by the TSDISCOMs is 38,727 meters. Accordingly, to the TSDISCOMs implementing smart prepaid metering for all existing consumers (excluding agriculture consumers) and system metering under RDSS would amount to INR 9308,37 crores. Telangana has a total of 111 charging stations of which 77 of them are public chargers, which collectively consume 0.017 GWh. EVs also have a special tariff category proposed as part of the annual retail supply tariff order. In the case of energy efficiency, the state emerged as a frontrunner in all indices.

5. Telangana power sector snapshot

Based on our detailed analysis the synthesized view of the power sector in Telangana covering both regulatory substance and content is presented below:

Generation

1. Telangana is heavily reliant on coal power plants contributing to 51% share of the installed generation capacity and 79% of the corresponding electricity generation. Going forward, the state regulator has already announced no new coal plants will be added, however, the transition away from coal will depend on many politico-economic factors and should be planned and phased out in a just manner. On the renewables front, the state has been steadily adding renewable energy generation capacity and has exceeded its 2 GW target by 2022, but less than the NITI Aayog target set for them which was 6.4 GW by 2022. In addition, TSDISCOMs have also maintained a good track record in meeting their renewable power purchase obligations set by the state regulator.
2. The installed power generation capacity of Telangana only meets close to half of its total electricity requirements, the remainder is met via imports and captive power plants. In preparation for the future, by 2031 the state should plan for resource adequacy to meet its forecasted electricity requirement of 115,862 GWh (70% increase since 2022) and peak demand requirement of 25.6 GW (90.8% increase since 2022).
3. Security of supply is a key issue for the state, as it is dependent on interstate resources for imports, and the added complexity of key resource constraints such as hydro to operate its own generating unit. In addition, the inability of the DISCOMs to clear the power bill arrears not only has a cross border issue with states like AP, but also poses real threat of procurement of power from the wholesale spot market, for which DISCOM management needs to be addressed. In order to meet the state's growing electricity demand, more investments are needed to ensure availability of power within the state, and therefore measure such as RE curtailment should be limited to ensure private sector participation in further building of generation assets.
4. The state has been at the forefront of setting up some unique flagship projects such as India's largest floating power plant, Gigafactory battery manufacturing facility and laying the ground for setting up of a hydrogen valley.

As the State of Telangana transitions, it needs to set ambitious targets and find optimal ways in which it can green its electricity mix while ensuring capacity adequacy, as the demand is expected to increase by 70% in 2031, and this needs to be done keeping in mind the coal political economy factors, ease of doing business for renewable energy generators and the ability of the DISCOMs to pay generators in a timely manner.

Transmission

5. Under the 'One Nation – One Grid – One Frequency', the transmission expansion has been phenomenal, with Telangana having approved contracted capacity of 21,866 MW from TSTRANSCO and 4119.5 MW from CTU.
6. In preparation for the future demand and generation addition, the state already has a forward-looking plan both by TSTRANSCO looking at overall expansion plans for the control periods of 2024-2029 (5th) and 2029-2034 (6th) and specifically for the case of renewables, MoP has identified four key districts – Rangareddy, Medak, Nizamabad and Karimnagar that will have dedicated evacuation corridor for the REZs.
7. In terms of transmission planning, what needs to be kept in mind is the case of over capacity planning in an untimely manner, which will result in increased transmission tariff and thereby impacting the cost to end consumers. This will require coordination between various stakeholders such as CEA, TSTRANSCO, MoP, TSERC to ensure transmission capacity and investments are planned cohesively and allocation of the same is done effectively.
8. The Telangana regulator has been steadily bringing down transmission charges based on the rules provided by MoP, which comes as a relief to both generators as well as consumers. In addition, the regulator has also set the allowed transmission losses for the coming years.
9. On the system operations front, the State of Telangana currently has a draft DSM regulation, which will bring in the necessary measures to ensure grid security and reliability. SAMAST framework is being rolled out in the state, which upon successful implementation will enable uniformity in scheduling, accounting, metering and settlement for intra-state generation as well as inter-state generation.
10. Reporting of system operations metering data via an open access system on the SLDC website can help with data transparency, and this can easily be done given the SLDC already uses commercial off the shelf software that allows for long term data recording.

The transmission expansion has been phenomenal in the State of Telangana aided by both state and central efforts, including to integrate renewables, but better coordination between the various stakeholders is needed to ensure the state does not end up with over capacity. Also, timely implementation of DSM regulation and the SAMAST framework will further improve data reporting and transparency and enable resource adequacy.

Distribution

11. Telangana has a centralized approach to procuring power for its two DISCOMs and the regulator approved power purchase for the state in FY 2023-24 is 84156 GWh (as supposed to 96553.85 GWh available), at a power procurement of electricity INR 4.39/kWh. If there is variation in the power purchase cost, ideally TSDISCOMs can recover it during their true-up/down fillings. But over the last years TSDISCOMs have not been filing this on time (except for the current year), thereby not allowing regulators enough time to make their assessment before annual tariff orders are approved for the MYT control period. Although the state seems to have surplus power, it is not a constant over the year, and for deficit months TSERC suggests power procurement from the spot market.

12. Power procurement from generation companies takes up bulk of the ACoS (~71%), leaving little room for distribution and transmission companies in terms of revenue and corresponding investments needed to strengthen the grids, which is essential for future growth, particularly with more renewables in the power system.
13. The grid access charges for open access consumers such as wheeling, CSS and additional surcharge for the state have been approved by the regulator for the current financial year. In the case of additional surcharges, while the TSDISCOMs claimed INR 9.86/kWh, TSERC has only approved Rs 0.39/kWh, which is in line with MoP to cap it at 20% of average CoS. For captive consumers, TSERC is considering the opinion of the Grid Coordination Committee to levy Grid Support Charges (GSC).
14. As part of the MYT methodology, the state has approved retail supply tariff for the current year for its 20 consumer categories. Including special tariffs over the retail supply tariff, such as the Time-of-Use (ToU) tariff for its HT consumers (+/- INR 1/unit) and Green Tariff (+ INR 0.66/unit) for all HT and LT consumers.
15. The state regulator has capped the distribution losses for the state at a maximum of 4.75% for the current year. The ex-post billing efficiency reported for TSDICOMS is between 91%-93% and the collection efficiency is between 94% - 100%. Overall, the AT&C loss trajectory has reduced due to the various loss reduction measures, improved collection efficiency and strategic investments undertaken by the TSDISCOMs. The full implementation of RDSS and the regulator's request to install DT metering for all agricultural consumers as well as conducting consumer engagement programs for all consumers will further improve AT&C losses.
16. Telangana computes its CoS using ECoS methodology, and for the current year the ACoS for the state is 7.02/kWh. The ARR claimed by TSDISCOMS for the current year is INR 54.058 crore of which power purchase cost alone amounts to 72% of the ARR. While the ARR and electricity sales have been increasing over the years, yet there has been no increase in the subsidy amount provided by the Government of Telangana. Although TSERC for the current year determined a net revenue deficit of INR 9124.82 crores, given the commitment from Telangana government, the regulator has not passed on the costs to the consumers. The TSDISCOMs do not have a regulatory asset base and are dependent on the state government to bridge the revenue gaps. Subsidy disbursement by the GoTS has been lagging in the power distribution sector over many years, leading to considerable subsidy arrears. While the State government has been paying 100% of the tariff subsidy, the non-tariff subsidy disbursed to the TSDISCOMs was low (~39%), due to the UDAY subsidy booked in FY 2021-22 being received in FY 2022- 23. In this regard, introduction of DBTs for subsidy disbursal can help reduce the financial burden on DISCOMs.
17. As of December 2021, the arrears reported by TSDISCOMs is INR 9974.56 (TSSPDCL) and 8489.25 (TSNPDCL). According to NITI Aayog's State Energy and Climate Index (SECI) assessment, the all-India average DISCOMs debt-equity ratio was 0.011 and Telangana DISCOMs had a score a 0.0 indicating a net negative worth. In terms of TSDISCOMs cash position, TSDISCOMs are performing well below par for both days receivable and days payable. As per PFC's annual DISCOM ranking exercise, TSSPDCL was ranked 44 out of 53 and TSNPDCL was ranked 46 out of 53 putting them in the bottom bucket of the Indian DISCOMs list.
18. On the innovation front, Telangana brought into effect its smart grid regulation and as part of the pilot projects supported by the central government it will demonstrate a few key smart grid functionalities such as AMI, peak load management, outage management system, power quality and SCADA. As per the UDAY dashboard as of March 2023, the smart metering rollout achieved by the TSDISCOMs is 38,727 meters. Accordingly, to the TSDISCOMs implementing

smart prepaid metering for all existing consumers (excluding agriculture consumers) and system metering under RDSS would amount to INR 9308,37 crores. Telangana has a total of 111 charging stations of which 77 of them are public chargers, which collectively consume 0.017 GWh. EVs also have a special tariff category proposed as part of the annual retail supply tariff order. In the case of energy efficiency, the state emerged as a frontrunner in all indices.

Power procurement planning is done in a centralized manner by the state, but to ensure decarbonization, how these procurements will be made going forward needs effective planning in a manner that does not increase cost to consumers. At the DISCOM end, better financial management will be key and to make this happen, the current arrear, payable/receivable days and bad D/E ratios needs to be improved to ensure the TS DISCOMs become preferable parties to do business with. The regulator has MYT regulation in place, including catering to special consumer categories, however the non-compliance of the TS DISCOMs in meeting reporting deadlines and the untimely subsidy settlement by the state government is hindering the turnaround of the TSDISCOMs. On the technical front, roll out of smart grid initiatives needs to speed up to help TSDISCOMs benefit from the impact of these technologies thereby aiding in their turnaround.

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