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Study on Moving to a Self-Sustainable Power Distribution Sector

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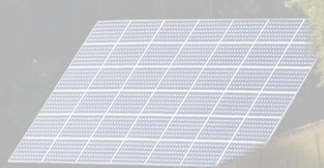

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Foreword

S K Pathak
Secretary General - FICCI

FICCI, in association with its knowledge partner EY, is happy to present the Report on **Moving to a Self-Sustainable Power Distribution Sector.**

Power distribution companies (Discoms) deal directly with end-consumers and collect cash, the life blood of the power sector value chain.

And yet operational and financial challenges remain for distribution companies (Discoms).

The report outlines how Discoms can do better, by operational / financial efficiencies, and technological upgradation. There are key recommendations for regulatory and policy framework, market structure, infrastructure, and technology landscape.

We hope all stakeholders will find this report useful.

S K Pathak

Glossary (1/3)

Abbreviation	Definition
AC	Alternating Current
ACS	Average Cost of Supply
AED	Agricultural Engineering Department
AMI	Automated Metering Infrastructure
APPC	Average Power Purchase Cost
ARR	Average Revenue Realised
AS	Additional Surcharge
ASAI	Average System Availability Index
AT&C	Aggregate Technical & Commercial losses
BEE	Bureau of Energy Efficiency
BESS	Battery energy storage system
BPA	Business Process Automation
BU	Billion Units
CAGR	Compound Annual Growth Rate
CAPEX	Capital expenditure
CEA	Central Electricity Authority
CFA	Central Financial Assistance
CHC	Community Health Centre
C&I	Commercial & Industrial consumers
Ckm	Circuit Kilometre
CMIE	Centre for Monitoring Indian Economy
CMR	Consumer Relationship Management

Abbreviation	Definition
CPP	Captive Power Plant
CSS	Cross subsidy surcharge
CTU	Central Transmission Utility
DAM	Day Ahead Market
DAC	Day Ahead Contingency
DC	Direct Current
DF	Distribution Franchisee
DSM	Demand Side Management
DT	Distribution Transformer
ESc	Energy Certificates
ECBC	Energy Conservation Building Codes
EHVDC	Extra High Voltage Direct Current
ERP	Enterprise Resource Planning
EV	Electronic Vehicles
FoR	Forum of Regulators
GDP	Gross Domestic Product
GFA	Gross Fixed Assets
GIS	Geographical Information System

Glossary (2/3)

Abbreviation	Definition
GSDP	Gross State Domestic Product
GST	Goods and Service Tax
GVA	Gross Value Added
GWh	Giga watt hour
HVDC	High Voltage Direct Current
IBF-IRS	Input based Franchisee – Incremental Revenue Sharing
ICT	Information and Communication Technology
IESA	The India Energy Storage Alliance
IEX	Indian Energy Exchange Ltd
Invit	Infrastructure Investment Trust
IPDS	Integrated Power Development Scheme
IPHS	Indian Public Health Standards
IPP	Independent Power Producer
IPTC	Independent power transmission companies
kWh	Kilo watt hour
LDCs	Least Developed Countries
LIS	Liquidity Infusion Scheme
LPG	Liquid Petroleum Gas
LPS	Late Payment Surcharge

Abbreviation	Definition
MBED	Market Based Economic Despatch
MICRO	Microgrid Initiative for Campus & Rural Opportunities
MVA	Mega Volt-Amp
MW	Megawatt
NEP	National Electricity Plan
NHM	National Health Mission
NSGM	National Smart Grid Mission
NMEEE	National Mission for Enhanced Energy Efficiency
OA	Open Access
OECD	Organization of Economic Cooperation and Development
p. a	Per Annum
PAT	Perform Achieve and Trade
PAU	Punjab Agricultural University
PHC	Primary Health
PIP	Program Implementation Plan
PLC	Programmable Logic Controller

Glossary (3/3)

Abbreviation	Definition
PLF	Plant Load Factor
PPA	Power Purchase Agreements
PPP	Public Private Partnership
PSUs	Public Sector Undertakings
PV	Photo Voltaic
QoS	Quality of Supply
R-APDRP	Restructured Accelerated Power Development and Reforms Programme
RDSS	Revamped Distribution Sector Scheme
RE	Renewable Energy
REMC	Renewable Energy Management Centres
RoW	Right of Way
SC	Sub centres
SCs	Supercapacitors
SCADA	Supervisory Control And Data Acquisition
SECF	State Energy Conservation Fund
SDGs	Sustainable Development Goals
SMES	Superconducting Magnetic Energy Storage
TBCB	Tariff Based Competitive Bidding
T&D	Transmission and Distribution
ToU	Time of Use

Abbreviation	Definition
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Executive Summary

We are approaching a decisive moment for India's ambitious targets for the power sector with 24X7 power for all, with 500 GW of renewable capacity by 2030. Many of the government's major initiatives, such as Make In India or Aatmanirbhar Bharat, have paved the way to reasonable access to high-quality and reliable power to ensure a win-win situation for all the stakeholders. However, the distribution sector has been the weakest link of the power sector, consistently making large losses, estimated at Rs 90,000 crore for FY 21 (NITI Aayog), reflecting weakness in operations, infrastructure, and regulation.

In order to achieve a high-growth, low-carbon economy, our power distribution sector must be overhauled to achieve sustainable profitability. So, taking the above concern into account, this report has been developed to identify various technological interventions and different business models to manoeuvre operational efficiency and financial viability for the distribution sector.

Further, to galvanize profitability for the DISCOMs, it needs institutional smartness - whether in power procurement, ensuring high-quality power supply, or encouraging private participation in distribution.
Hence, this report will be highlighting the above attributes of efficiency, in the subsequent chapters.

Chapter 1 talks about the need for study and provides an overview of the entire value chain across the Indian Power sector including Generation, Transmission, Distribution, and Power trading. This chapter highlights the various initiatives/ schemes, market segments, recent developments across the value chain, future scope, and the performance of the utilities for the FY 20 and it also covers the need for sustainability for the power distribution companies, followed by the key takeaways.

The study 'Moving to a Self-Sustainable Power Sector' comprehensively addresses the four areas: Analyzing the Socio-economic impact of unreliable Power, Identifying the Regulatory Reforms for making the Sector Self-Sustainable, the Need for Promoting Private Participation in the Sector and Identifying Technology Aspects for Reforming the Distribution segment. The assessment of the performance of DISCOMs will be assessed through different tasks in order to achieve the desired outcomes of the study, which is explained in Chapter 2 of this report.

The Indian Power Distribution sector has been at the forefront of the restructuring power business. Therefore, various reform initiatives/schemes have been undertaken by all Governments in the last three decades. With continuous reforms over the years, it is quite evident that that country has witnessed an installed capacity of 395 GW with a peak demand of 203 GW and peak met of around 200 GW for FY 22. The various reforms undertaken in the Power distribution sector and their impacts are discussed in Chapter 3. The cornerstone of Chapter 3, focuses on the performance of the leading DISCOMs in order to understand the operational and financial efficiency ,tariff rationalisaton, & linking of cost reflective tariff to LPS rule

Chapter 4, talks about linking sustainability to social benefits across Agriculture, Education, and Health & MSME sectors . This Chapter mainly focuses on analyzing the socio-economic impact of unreliable power and deriving the benefits from supplying 24*7 power supply in these three sectors. It also covers the opportunity cost for unreliable power across the sectors.

We believe this report will educate the stakeholders to understand the significance of moving to a self-sustainable power distribution sector, and the potential benefits achieved through reliable power supply across Agriculture, Health, and Education sectors. The study enlists multiple case studies, explained across the various chapters of this report.

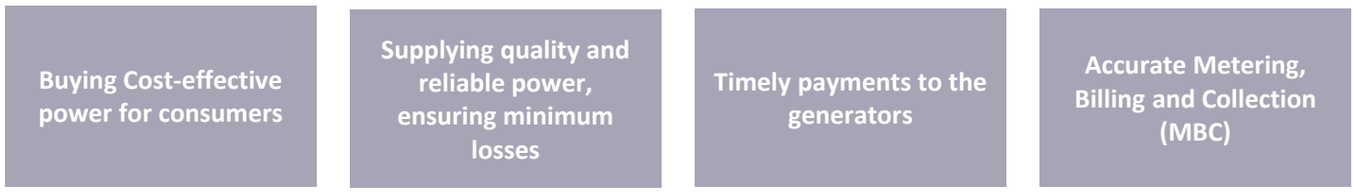
01

Introduction

1.1 About the Study

Power distribution companies are the most significant linkage in the power sector value chain as they are consumer facing and the revenue realisation point for the sector. It involves itself in billing and collection against their energy supplies (purchased from generators) so that a healthy cash flow is maintained towards the generation and transmission sectors to operate. But, it has been observed that due to its perennial cash collection and persistent delays/non-recovery of payments from consumers, DISCOMs are unable to make timely payments for their energy purchases from the generators. Hence, this gap is often met by borrowings, government subsidies, and at times reducing capital expenditure. This increases the DISCOMs' cost of borrowing (interest), which is again inevitably borne by the consumer. This vicious cycle results in unsustainability for the sector. This also leads to underperformance of the DISCOMs in their financial and operational activity resulting in lower capabilities of the DISCOMs to distribute quality and reliable power to fulfil their Universal Supply Obligation (USO) as defined in the Electricity Act 2003.

As a counter measure, the DISCOMs are putting their efforts to reach their objectives through:



Considering the above possible objectives of DISCOMs, this study will make an attempt to find out the ways towards moving to self-sustainability of DISCOMs and how it is going to influence different social factors particularly health, education and agriculture. In this regard it is essential to understand the challenges faced by utilities in revenue management, in network augmentation and technology adaptation. Further the study will also revolve around how private participation could decrease disparity in distribution business and which factors of regulatory reforms we have to consider to achieve self sustainability in power distribution sector.

The identified areas of our study are:

a) To study socio-economic impact of unreliability of power in Health, Agriculture and Education focussing more on rural and urban areas so that economic loss in terms of productivity and assets becoming non performing assets can be assessed.

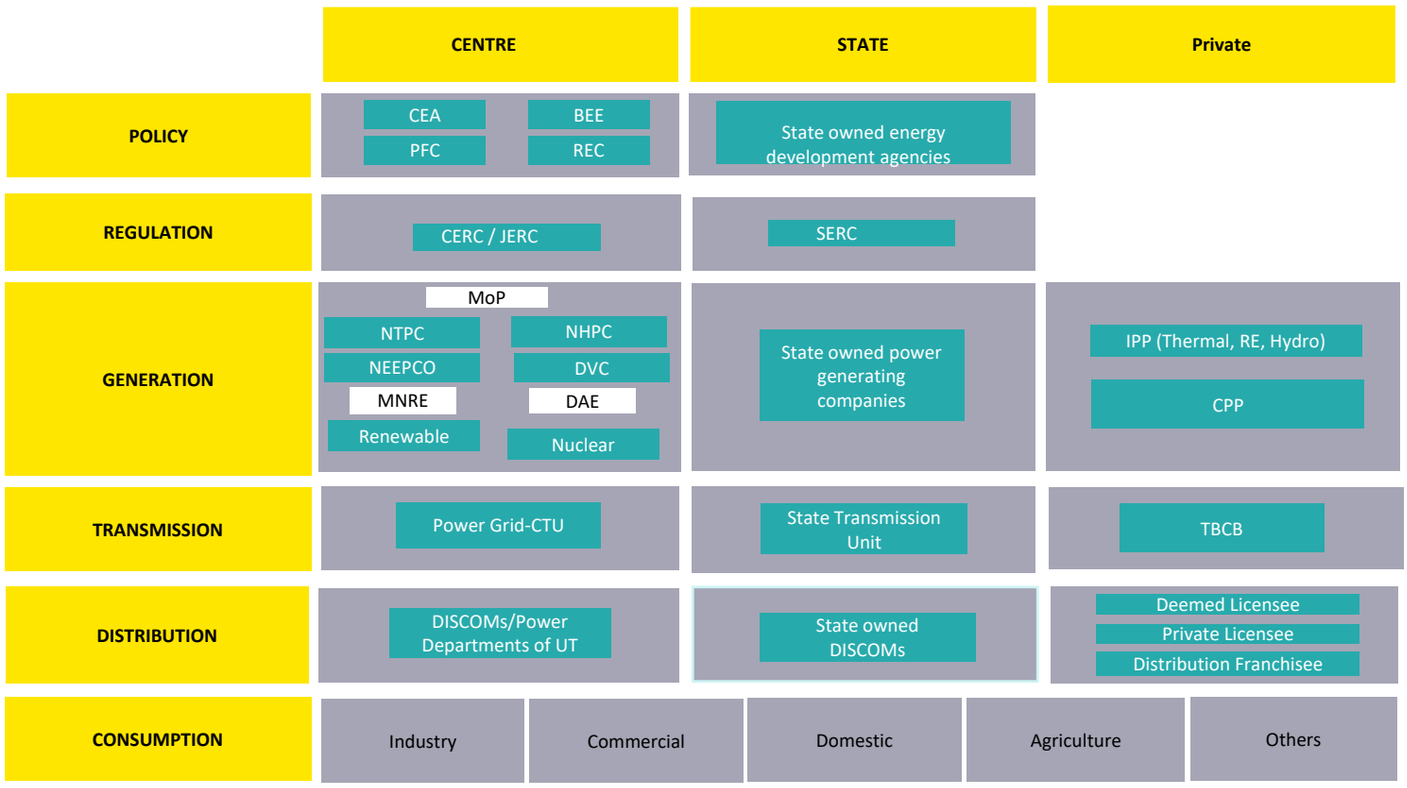
b) To study regulatory reforms since the inception of Electricity Act,2003 and successive amendments in the form of draft with regard to timely dispute resolution, sanctity of contract, efficacy of tariff rationalization, cross subsidy, open access ,how direct benefit transfer would bring more transparency and to assess bringing possible liquidity in distribution sector to revive financial turnaround of DISCOMs.

c) To study how long private participation can bring in more long term capital, so that more competition can be brought in distribution sector, focussing more on delicensing of distribution business as discussed in draft Electricity Amendment Bill 2021.

d) To study the technology penetration in DISCOMs considering Digitalisation, Decarbonisation, Decentralisation and to assess the sector in the field of energy efficiency, energy storage, pre-paid meters and data analytics.

1.2 Introduction to Indian Power sector

To achieve operational effectiveness and efficient governance, India's power sector has been well structured post enactment of Electricity Act, 2003. The market structure of the Indian Power Sector is outlined below:



- While Section 62 of the Electricity Act is for cost-plus determination of tariff for transmission, distribution and generation of electricity, on the other hand, Section 63 provides for adoption of tariff discovered through competitive bidding in accordance with the guidelines issued by GoI.
- When the Act was enacted, the primary focus was to reform the electricity sector and one of the ways to reform the sector was by attracting private investment into transmission, distribution and generation of electricity. The private participation could only be encouraged when there is transparency towards awarding projects, and returns associated with it.
- For this purpose, Section 63 was introduced so that there can be robust private participation in order to augment the power system in the country. When infrastructure projects are opened to public participation, one of the key objectives is to reduce unwanted costs.

India observed several Power Sector reforms since 2003 including un-bundling of the Utilities, improving the viability of DISCOMs, mobilisation of private investments in the sector and support large scale deployment of renewable energy. While market structure offers ample opportunities for private participation, a large part of the new private investment in the sector is limited to Generation (including Renewable Energy) and Transmission through tariff based competitive biddings. Privatisation efforts for Distribution Utilities are gradually eased up with Government's new policies and amendments.

1.2.1 Generation

India being the third-largest energy consuming country, energy use has almost doubled since 2015 with around 60% of demand met by coal, and rest 40% from other sources including renewables showcasing a coal dominance in the energy mix. As India is bouncing back from covid-induced slump in 2020, it is again witnessing a very dynamic period in its energy development. Over the coming years, it is expected that the electricity consumption would increase, where in the whole value chain have to work in tandem to meet its peak demand for which the whole power systems have to keep the pace with its growth from its current installed capacity of 395 GW.

Figure 1: Generation Mix (GW) – Feb 2022

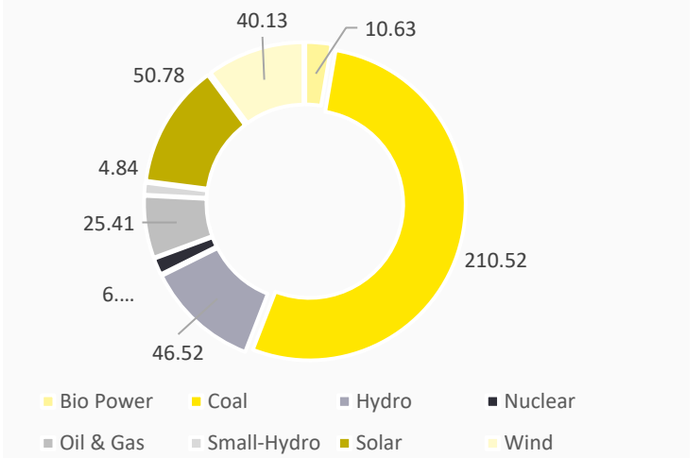
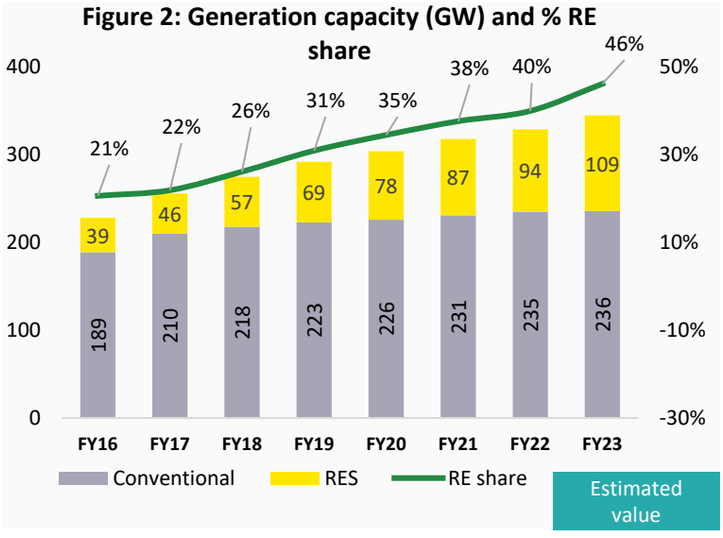


Figure 2: Generation capacity (GW) and % RE share



Source: CEA

Figure 3: Energy Required vs Energy Available

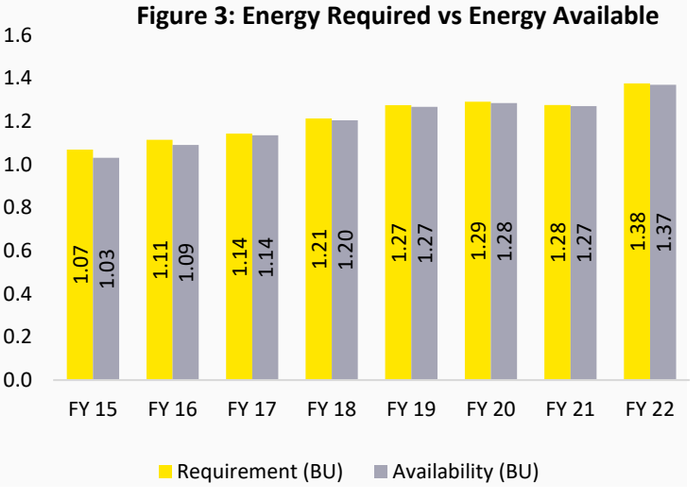
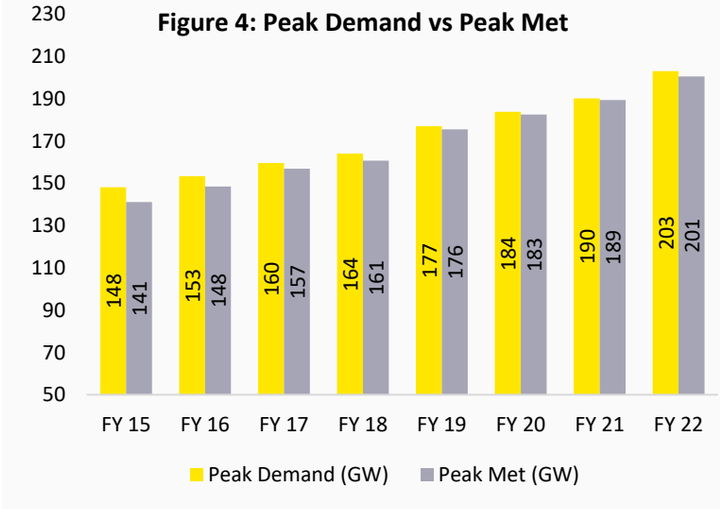


Figure 4: Peak Demand vs Peak Met



Source: CEA

From the above graph, a consistent growth can be seen in both energy required - peak demand and energy available - peak met. But if we consider the pandemic year of COVID-19, a marginal slump in energy required was observed as the economy slowdown was observed across all the industry.

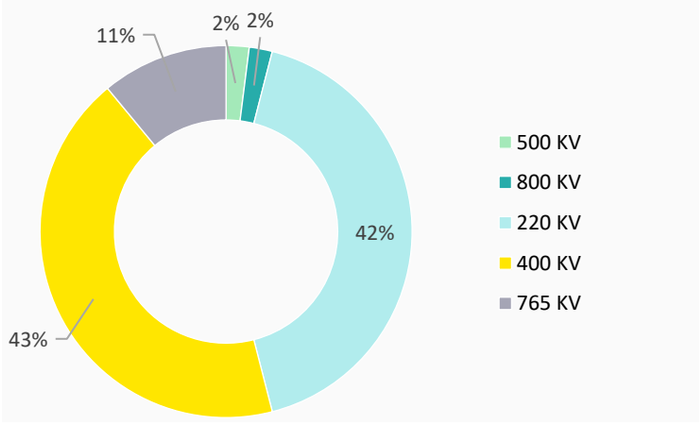
Performance of the Generation Utilities (As per PFC Utility Report, FY 20)

- **Profitability:** Generation utilities together incurred a profit of Rs 3,853 crore during FY 20. PPCL and JKSPDC have been among the top profit earners in generation utilities. However, OPGCL and MSPGCL have reported a loss of Rs 142 crore and Rs 126 crore respectively in FY 20.
- **Borrowings:** Total Borrowings increased by Rs 9,133 crore in FY 20 from Rs 2,18,966 crore as on March 31, 2019 to Rs 2,28,099 crore as on March 31, 2020.
- **Trade receivables:** Trade Receivables for generation utilities increased from Rs 87,874 crore as on March 31, 2019 to Rs 98,847 crore as on March 31, 2020. Receivables (no. of days of sale of power) have increased from 265 days as on March 31, 2019 to 291 days as on March 31, 2020.
- **Equity and Net worth:** Net worth for generation utilities increased by Rs 5,975 crore from Rs 1,04,301 crore as on March 31, 2019 to Rs 1,10,276 crore as on March 31, 2020. Equity increased by Rs 7,530 crore from Rs 89,939 crore as on March 31, 2019 to Rs 97,469 crore as on March 31, 2020.

1.2.2 Transmission

Power transmission sector in India has significantly evolved over the last decades. Initiatives like inter and intra-connection of regional grid, green corridor and continuous network strengthening and Tariff Based Competitive Bidding (TBCB) have been adding value to our transmission network.

Figure 5: Voltage wise breakup of Transmission lines (2019-2020)



Source: CEA

The Indian transmission network is mostly dominated by 400 and 220 kV AC transmission lines.

At present, ~11% of transmission lines operate at 765 kV AC lines.

Gradually, GOI/MOP is targeting to transition towards 800 kV and 500 kV EHVDC lines.

National Grid has an inter-regional transmission capacity of 1,12,250 MW, As on February 2022, the total transmission line length stood at 4,55,000 Ckm (220 kV and above) and the AC substation capacity stood at 1,095,000 MVA.

Figure 6: Transmission Lines

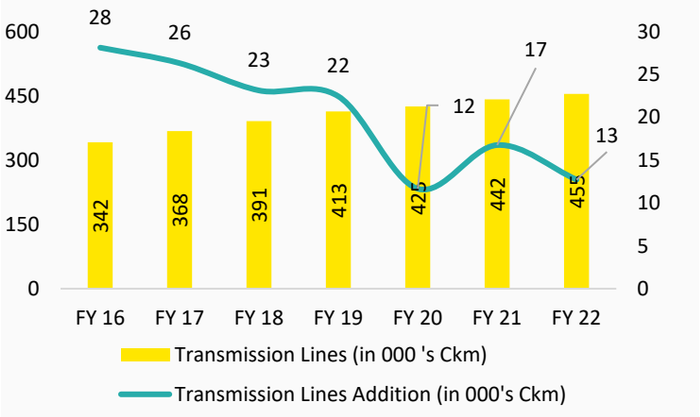
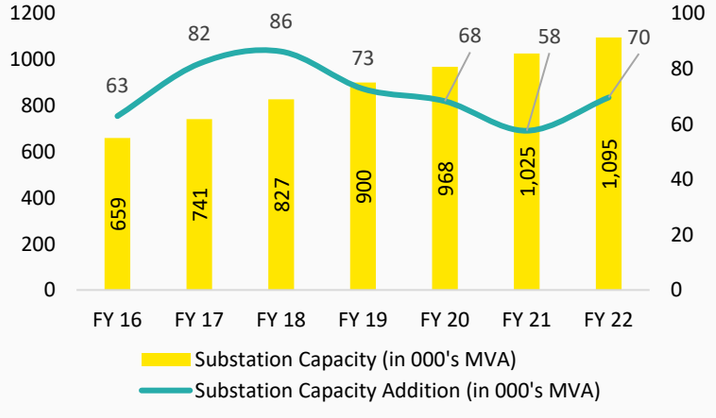


Figure 7: Substation Capacity (MVA)



Source: CEA

It can be observed that with the successful implementation of network augmentation schemes and grid expansion projects the transmission network has rose with a CAGR of ~4% since FY16 which is a positive sign for the power sector value chain.

The substation capacity has increased with a CAGR of 8%,showcasing the rise in the consumer base of different categories over the years.

Power Transmission in India is growing at a healthy pace with various system strengthening schemes and new capacity expansion schemes. Some of the key initiative includes introduction of TBCB, Green Energy Corridors and REMCs. However, some of the key bottlenecks in this expansion such as issues in Right of Way, delays due to forest clearances etc still remains and require interventions through policy measures.

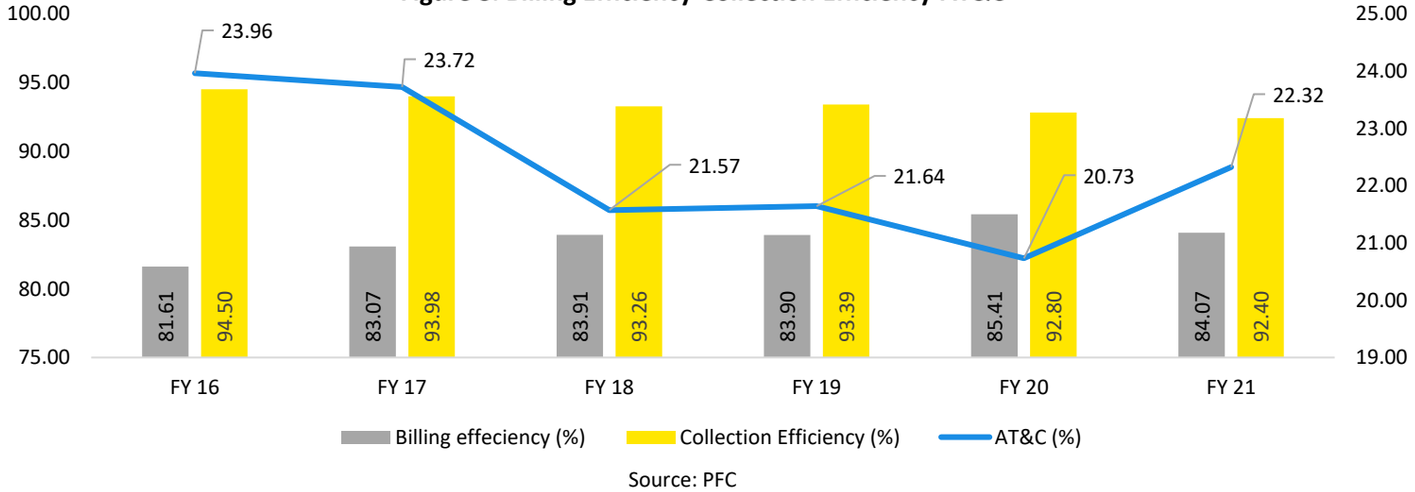
Performance of Transmission Utilities (As per PFC Utility Report, FY 20)

- **Profitability:** Transmission utilities together incurred a profit of Rs 2,134 Cr during FY 20, as compared to a loss of Rs 1,533 Cr in FY 18. KPTCL, TSTRANSCO, WBSETCL, GETCO & BSPTCL have been among the top performers in the transmission utility business during the year.
- **Borrowings:** Total Borrowings by transmission utilities increased by Rs 9,955 crore in FY 20 from Rs 1,08,231 crore as on March 31, 2019 to Rs 1,18,186 crore as on March 31, 2020.
- **Trade receivables:** Trade Receivables for transmission utilities increased from Rs 25,658 crore as on March 31, 2019 to Rs 32,567 crore as on March 31, 2020. Receivables in days increased from 267 days as on March 31, 2019 to 315 days as on March 31, 2020.
- **Equity and Net worth:** Net worth for transmission utilities stood at Rs 87,828 crore and equity was Rs. 63,005 crore as on March 31, 2020 as compared to net worth of Rs 82,026 crore and equity of Rs 59,789 crore as on March 31, 2019.

1.2.3 Distribution

Distribution companies are the downstream of the power sector supply chain and is the most stressed area. Most distribution utilities are making major losses as a consequence of expensive long-term power purchase agreements, poor infrastructure, and inefficient operations. These losses, in turn, prevent them from making the investments required to improve the quality of the power supply and to prepare for the wider penetration of renewable energy.

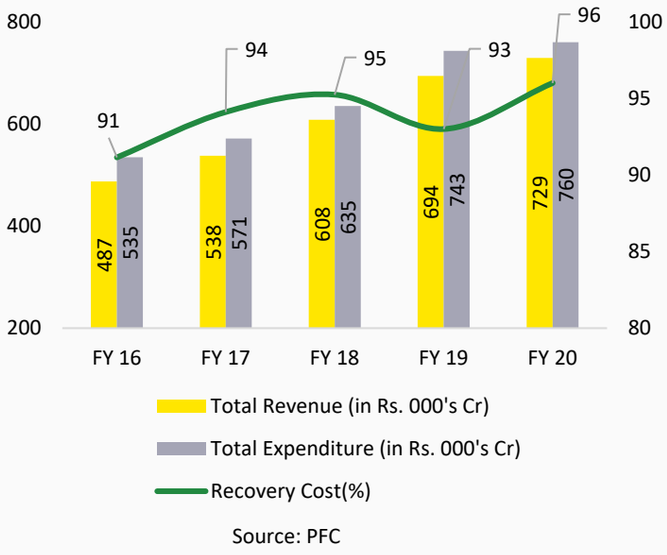
Figure 8: Billing Efficiency-Collection Efficiency-AT&C



Source: PFC

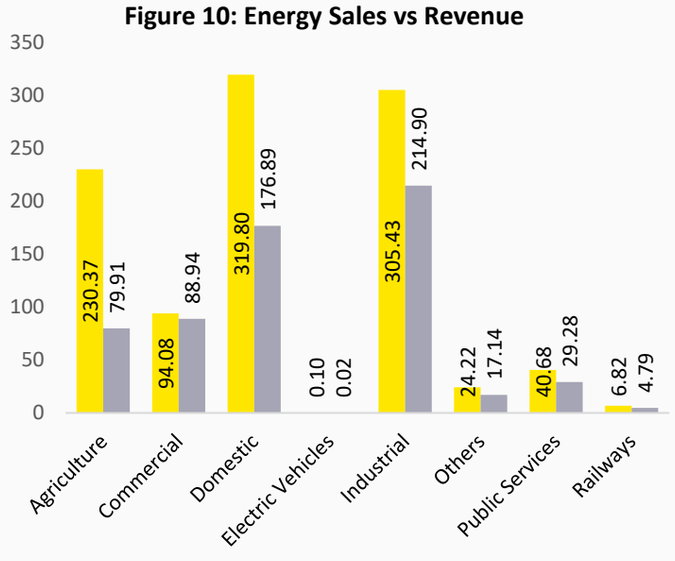
From the above figure, it can be observed that the AT&C losses of the DISCOMs declined from FY 16 to FY 18. The trend of decline in AT&C losses can be inferred by the billing and collection efficiency of DISCOMs. Figure- depicts the Billing and Collection efficiency trends since FY 16.

Figure 9: Total Revenue, Expenditure, Recovery of Cost (%)



Source: PFC

Figure 10: Energy Sales vs Revenue



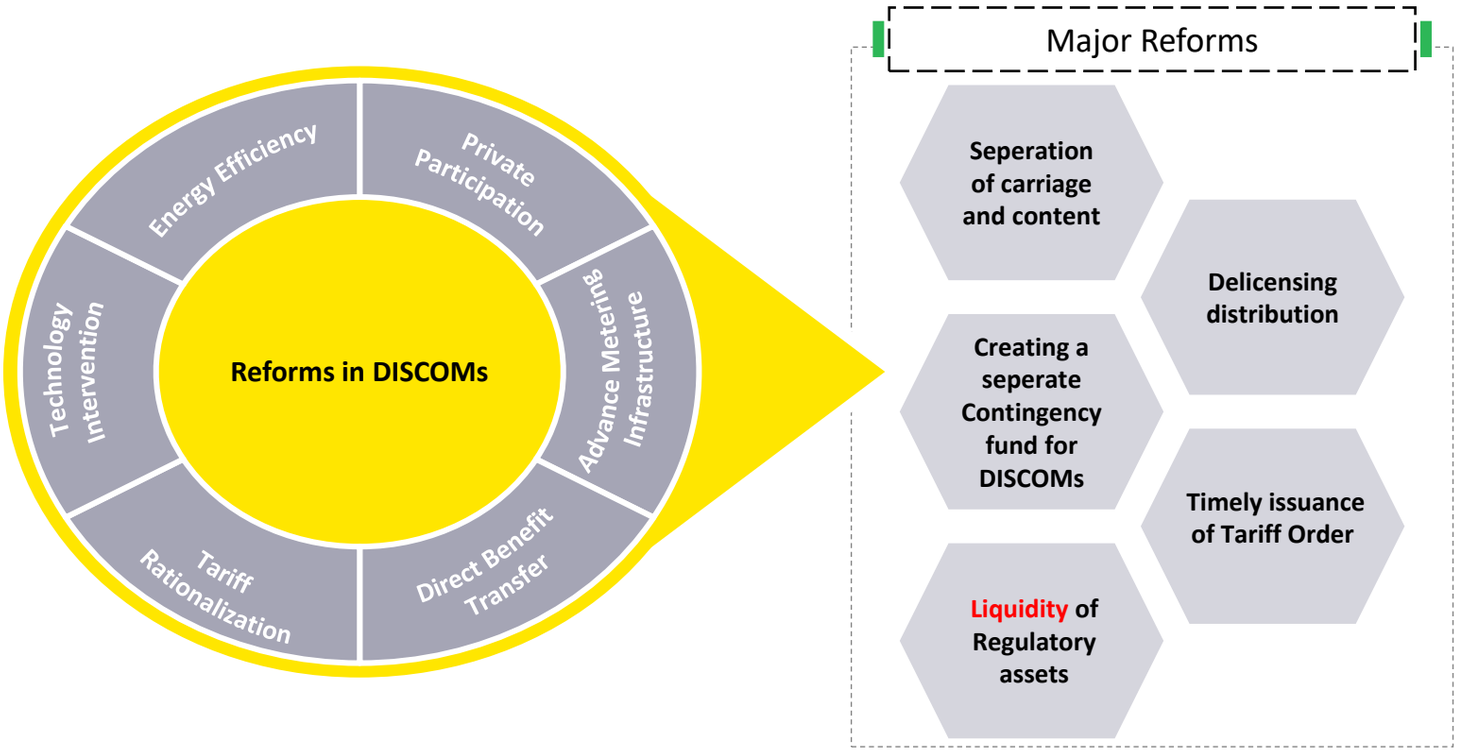
Source: CEA/EPS

As of 31st March 2022, the DISCOMs overdue amount has risen up to ~Rs 1,03,331 Cr which is 2% more than the last year (which stood at Rs 1,01,572 Cr). Further, because of high tariff charges higher paying and bulk load consumers are opting for open access and captive generation for reducing their power bills.

In addition to it, marginal decline of AT&C loss which is ~20% as compared to the targeted AT&C loss of 15%, bringing disparity in billing and collection efficiency which fuels up the DISCOMs losses.

From the above graph, it can be clearly confirmed that DISCOMs have to focus more on curtailing losses from Agriculture, Domestic consumers where power supply is more but realisation of revenue is less.

Some of the major reforms which demands for the sustainability of DISCOMs are listed below:



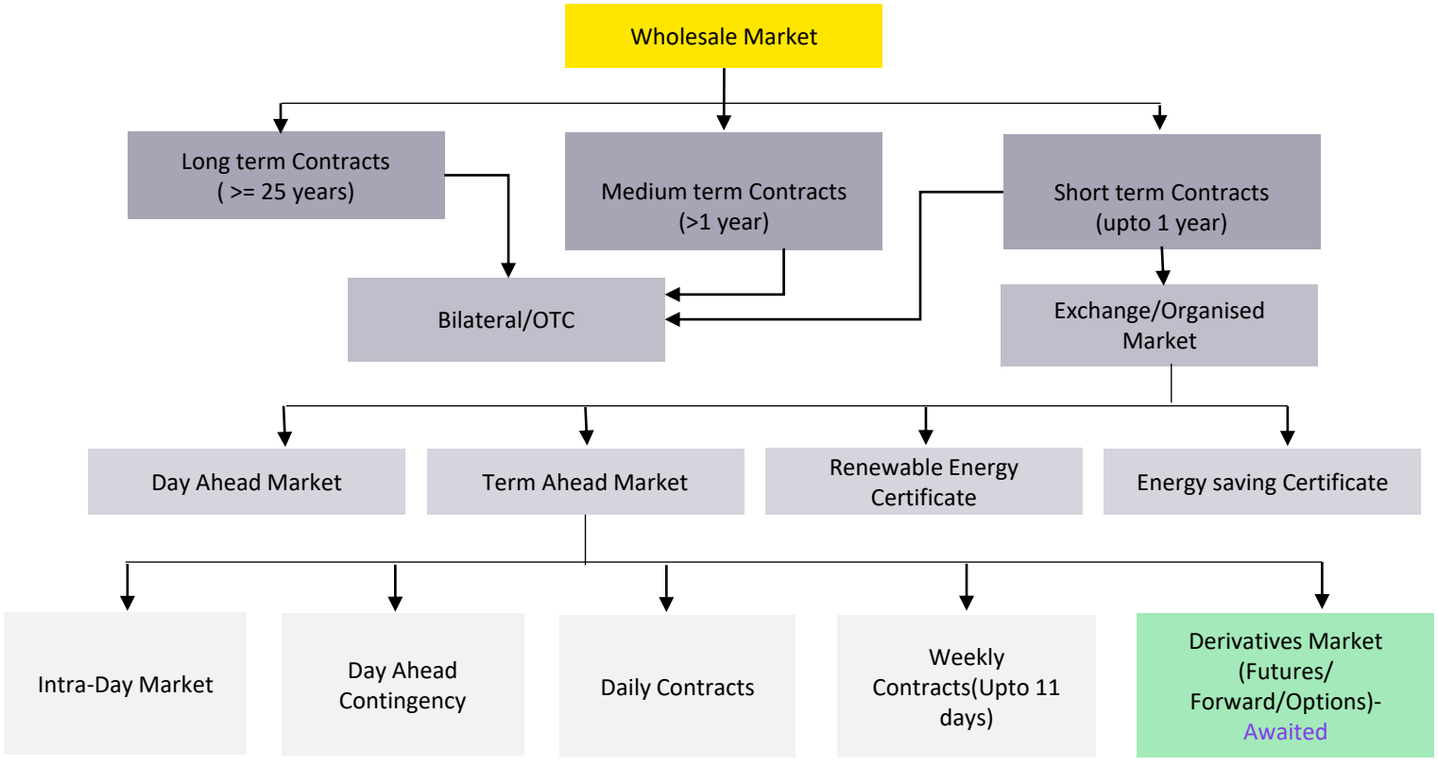
Power Trading

Definition of 'Trading' in Electricity Act 2003 – *"trading" means purchase of electricity for resale thereof and the expression "trade" shall be construed accordingly;*

As per the Section 66 of the Electricity Act, 'The Appropriate Commission shall endeavour to promote the development of a market (including trading) in power in such manner as may be specified and shall be guided by the National Electricity Policy.'

Power is traded like a commodity at Power Exchanges like IEX (India Energy Exchange) and PXIL (Power Exchange India Ltd).

Overview of Power Market in India



Market Segments

Market Based Segments	Description
Day-Ahead Market since June,08	▪ Delivery for next day ▪ Price discovery: Closed , Double-sided Auction
Intraday Market & Day-Ahead Contingency Round the clock since Jul'15	▪ Intraday: For Delivery within the same day ▪ Day Ahead Contingency: Another window for next day ▪ Gate closure : 3 hours
Term-Ahead Contracts since Sep,09	▪ For delivery up to 11 days a. Daily contracts b. Weekly Contracts
Renewable Energy Certificates since Feb,11	▪ Green Attributes as Certificates ▪ Sellers : RE generators not under feed in tariffs ▪ Buyers: Obligated entities; 1MWh equivalent to 1 REC
Energy Saving Certificates (Since 26 Sep'17)	▪ 1 EScert= 1 Mtoe (Metric Tonne Oil Equivalent)

Recent Developments

Green term ahead market (GTAM)	Real time Market (RTM)
It is an initiative planned by the government that would allow spot trading of renewable energy through power exchanges. This trading window would let corporate consumers to buy renewable power without entering into a PPA agreement	This initiative enables power market to trade electricity through 48 auctions in a day, where a new auction session is held every half an hour. It offers flexibility to the distribution utilities in addressing their varying schedule with delivery of power at just an hour's notice from the closure of the bid session.

The evolution of the wholesale power market

While power procurement is still largely tied to long-term bilateral PPAs (86%), there has been a slow but healthy growth in the wholesale markets.

Short-term power purchase through power exchanges increased from 0.4% in 2009 to 4% in 2019. To strengthen the wholesale market, India recently launched the real-time electricity market (RTM) on June 1st, 2020 at the India Energy Exchange Limited (IEX) and the Power Exchange India Limited (PXIL) wholesale market platforms.

This is in addition to the existing products: Day-Ahead Market (DAM), Term-Ahead Market (TAM) and Renewable Energy Certificates (REC).

The RTM is designed as a half-hourly market with 48 auction sessions of 15-minute duration. By narrowing the trading window, RTM promised to provide buyers and sellers an opportunity to correct any mismatch of demand and supply closer to delivery, thereby enabling DISCOMs to manage demand variation more efficiently.

For generation companies, RTM provides the ability to optimise and sell power surplus better while improving the ability to manage renewable intermittency. RTM even permits generators with long-term PPAs to participate allowing them to sell any unanticipated surplus generation. RE generators can also obtain RECs from any unanticipated surplus generations.

The introduction of Green Term Ahead Market (GTAM) on September 1st, 2020, which allows RE developers to sell green power in the open market without the need for long-term PPAs, has already seen a significant uptake by DISCOMs. Electricity scheduled through the GTAM also contributed to the RPO compliance of the buyer.

Key highlights

1

IEX achieves 7,574 MU volume across all the market segments in April'22

2

RTM achieves 1,704 MU volume achieving a significant 16% YoY growth with the average monthly price at Rs 9.55 per unit

3

Green market sees 336 MU volume & REC market sees 2.49 Lakh RECs traded during April'22

2003, Enactment of EA → 2007, CERC guidelines on PX → 2008, Regulation for OA → 2008:DAM, 2009: Term Ahead Contracts → 2011:REC, 2015: Intraday

Benefits to participants

a. Better Price Discovery

- Neutral and unbiased platform
- More transparent price discovery mechanism

b. Payment Security undertaken by Power Exchange

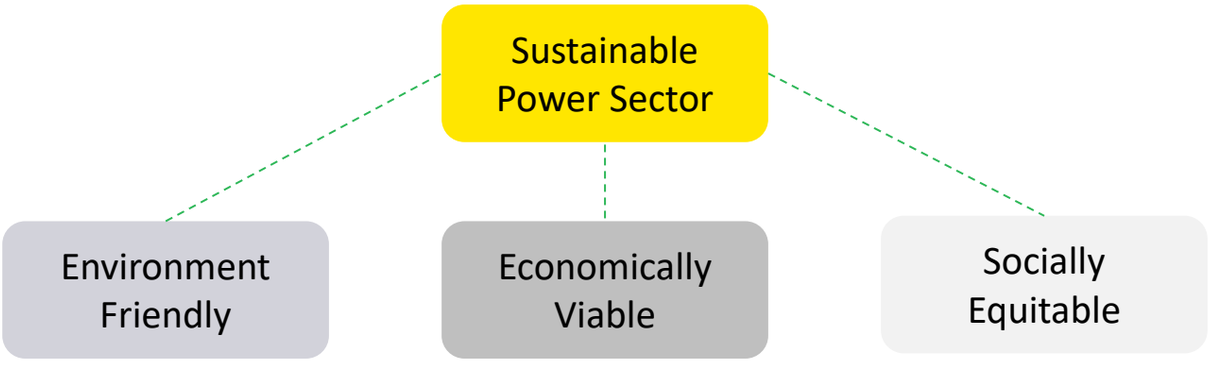
- Healthy cash flow as pay-out on immediately after delivery date

Future Scope

- Back office processes like validation, confirmation and settlement can be highly automated and hence increase process efficiency within the back office, which is required especially when trading volume is constantly rising.
- Introduction of BI tools and modern data layer technologies will increase efficiency and enhance the steering across the portfolios as well as improve decision making in front office.
- So far, data science or machine learning use cases are rarely implemented. Participants have different focuses on trying various digital use cases.

1.3 The Importance of a Self-Sustainable Power Sector

A self-sustainable power sector in India is not only essential for meeting the growing energy needs but also for reducing greenhouse gas emissions and combating climate change. By transitioning to renewable energy sources, increasing energy efficiency, and implementing innovative technologies



A Sustainable power sector goal.

Meeting current and future energy needs sustainably is a key challenge for achieving the global objective of reducing climate change while sustaining economic growth and raising living standards. Affordable and reliable energy is critical for health, education and economic growth. We need to make sure we're thinking green in all aspects of our lives and businesses. We need to make sure power plants and other equipment are as eco-friendly as possible, and that we're conserving resources in the best way possible. We need to be smart about how we use energy and make sure we're using it in a sustainable way

A self-sustaining power sector is a system that meets three key sustainability criteria: it's cost-effective, eco-friendly, and helps the community. These criteria need to be met from start to finish, from power production to transmission, distribution, and use.

Therefore, our challenges are to:

- Produce, transmit, and use energy in an environmentally responsible manner.
- Reduce costs by improving business practices and operating efficiency.
- Increase the reliability and quality of the power supply.

Based on the above challenges we have to make reforms on the different aspects on power sector sustainability matters

Environment Sustainability.

India's power sector is set to undergo a major transformation over the next ten years (2020-29). The demand for electricity is expected to increase, the electricity mix is set to change, and the market is set to become more dynamic. The country's objective is to provide access to quality electricity to all citizens at all times. In order to sustain the country's progress, India needed more fuel to produce electricity. This can have a significant impact on the environment and climate change as India's main power generation units still use fossil-based fuel, which is one of the reasons behind the carbon emission and greenhouse effect. In order to protect the environment and ensure a brighter future for our future generations, we must reduce the reliance on fossil fuels in our energy production and transition to renewable energy sources in order to make our energy sector more sustainable.

Economical Sustainable

In India, a power generating company (genco) typically sells electricity to an electricity distribution company (Discom), which in turn raises energy bills on a monthly basis in proportion to the amount of electricity sold. A power purchase agreement (PPA) signed by both parties governs their relationship. The distribution of electricity is the responsibility of discoms, which are usually owned by the state and must meet the demand for electricity in their area. Numerous discoms are currently losing money due to technical and commercial inefficiencies. End consumers delay and default on payments, which causes discoms to delay subsequent payments to power producers, escalating the issue.

Although the growth of India's RE sector is impressive, still more facilitation policy is expected from the government to attract more private developers for renewable field with long-term PPA so that a sense of confidence is built within the investors. Some of the actions required by the Government for Energy Sustainability are listed below,

Power distribution companies' (Discoms) financial health has deteriorated over time, primarily because of high losses and non-collection of dues and subsidies. Discoms are unable to pay generation companies (GenCos) on time because of these accumulated losses

To achieve financial sustainability in the power sector of India, there are several strategies that can be implemented

Reducing transmission and distribution losses would lead to improved revenue collection, and thus financial stability.

Implementing smart meters and advanced metering infrastructure would help in efficient billing and collection of revenue from consumers..

Promoting renewable energy sources such as solar power would reduce dependence on expensive imported fossil fuels and create a more sustainable financial model for the sector

Restructuring of electricity tariffs to reflect the true cost of production and distribution would improve financial viability for both producers and distributors. Finally, improved governance and regulatory mechanisms that ensure transparency

Social Sustainability

Social sustainability is a crucial aspect of the power sector in India. The power sector not only impacts the economy but also the lives of people, especially those who are marginalized. Thus, social sustainability becomes imperative to ensure that all sections of society have equal access to energy services and benefits. It is essential to address issues such as affordability, reliability, safety, and health concerns while ensuring that energy access does not lead to further social inequalities.

1

One of the key initiatives is the electrification of remote villages through renewable sources of energy. This has not only provided access to electricity but also created employment opportunities in these areas.

Another initiative is the implementation of energy efficiency programs in households and industries, which has reduced energy consumption and lowered carbon emissions

2

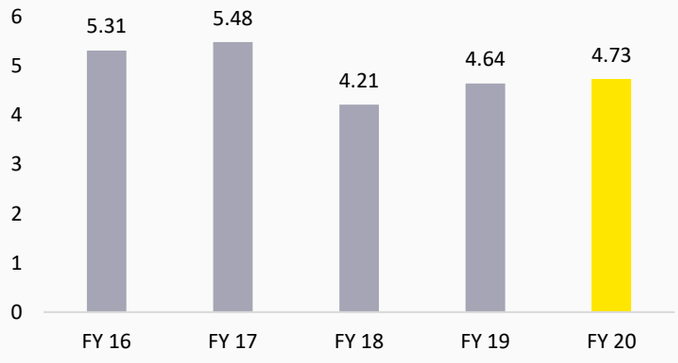
3

To prioritize access to electricity for marginalized communities, such as those living in rural areas or urban slums. This can be done through targeted interventions like providing subsidies for renewable energy solutions, improving grid connectivity, and implementing innovative financing models.

Necessity for Sustainability

DISCOMs sustainability is a key challenge for the whole power sector value chain. It has been observed that untimely payment to GENCOs have lead to a huge dues over the years. According to the PRAAPTI portal, the current overdue stands around Rs 1.35 Lakh Crore at national level which is making the whole power sector unsustainable. Further Forum of Regulators (FoR),2021 in its recent report observed that for 12 states the power purchase cost was the largest contributor to the Average Cost of Supply (ACS) of DISCOMs, wherein coal based power purchase was the major contributor to DISCOMs power cost.

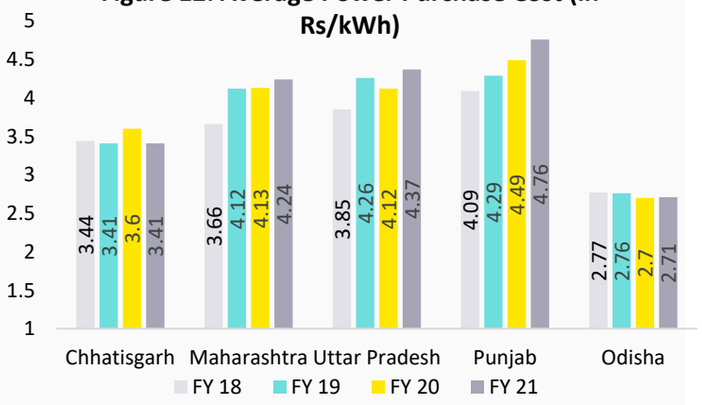
Figure 11: APPC (Rs/kWh)



Source: PFC

As shown in the above graph, at national level it is observed that Average Power Purchase cost (APPC) in the year FY 18 is 4.21 Rs/kWh and it is rising over the subsequent years. Hence, this range showed a continuous rise in APPC, which contributed to the rise of Average cost of supply (ACS).

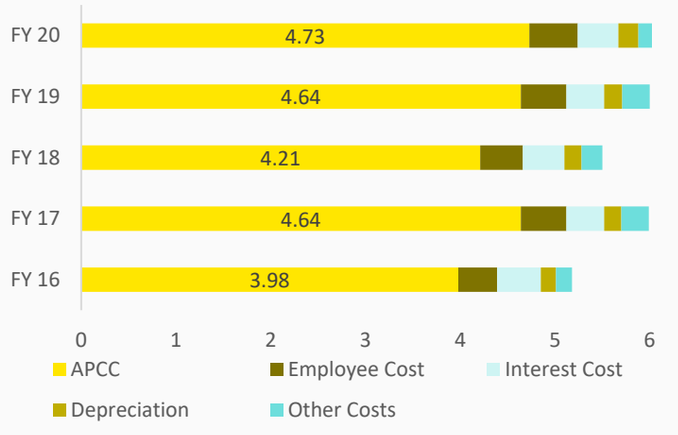
Figure 12: Average Power Purchase Cost (in Rs/kWh)



Source: Tariff orders

At state level, Punjab, Maharashtra & Uttar Pradesh, which are India's highest energy consuming state, saw a steady rise in the APPC. Most DISCOMs in these states are state owned. At the same time Odisha saw a very constant APPC. Odisha is a state where DISCOMs are privately owned resulting in a very competitive tariff .

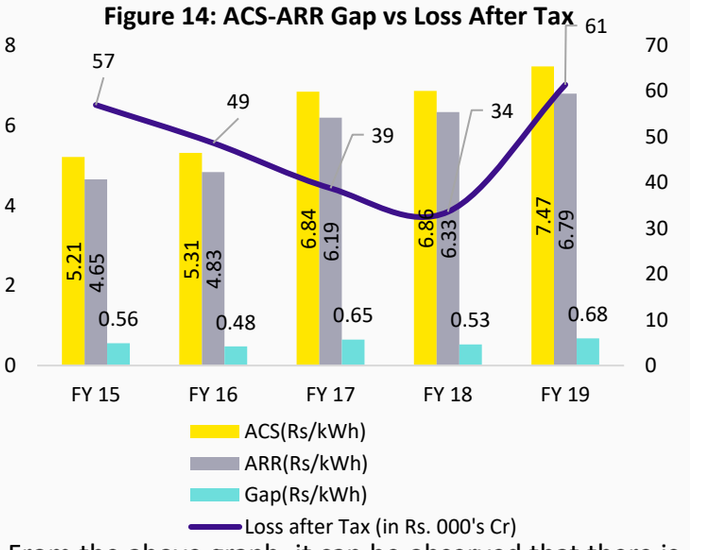
Figure 13: ACS Components (Rs kWh)



Source: PFC

From the above graph, major contribution comes from Average Power Purchase Cost (APPC) which is growing at a CAGR of 3.5% and costs like depreciation, interest cost, employee cost and other costs are fuelling up the ACS.

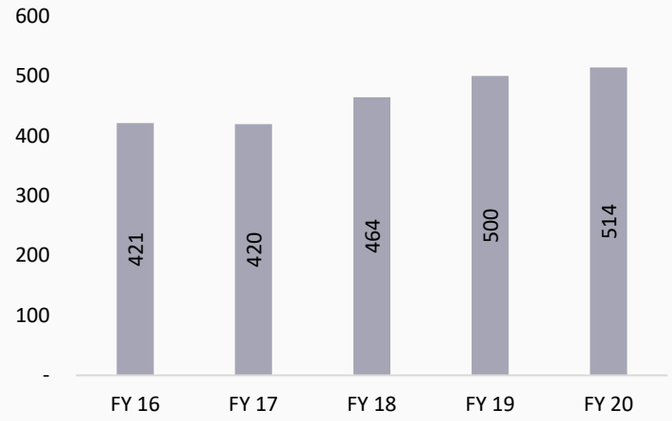
Figure 14: ACS-ARR Gap vs Loss After Tax



From the above graph, it can be observed that there is a continuous widening of ACS-ARR gap.

Further, the loss after tax (after subsidy received) is also increasing with increase in ACS-ARR gap.

Figure 15: Total Borrowings (in Rs. 000's Cr)

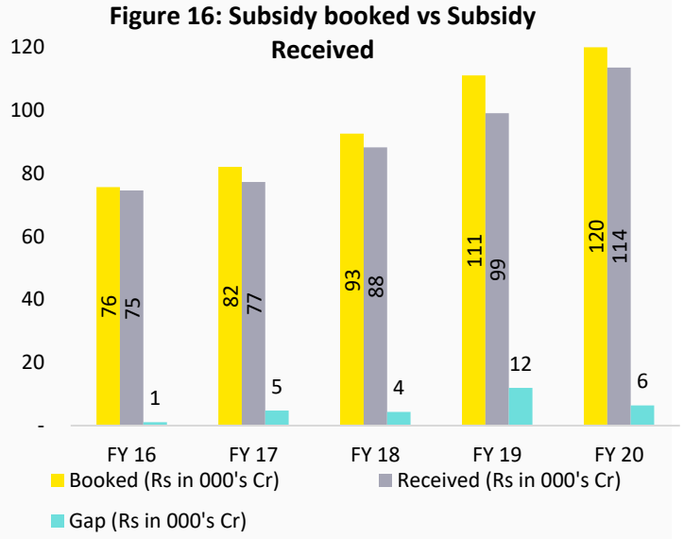


Source: PFC

From the above graph it is observed that there is a steady increase in borrowings to defer expenditure including payments to the generating companies.

The major factor which contribute to ACS-ARR gap is that periodic tariff revision is not taking place in some of the states. Even when tariff is revised, the increase is not commensurate with the legitimate costs, making DISCOMs to fall into financial trap.

Figure 16: Subsidy booked vs Subsidy Received



From the above graph it is observed that at present unpaid subsidy stands around ~Rs 6,000 Cr and ~Rs 12,000 Cr towards DISCOMs during FY 20 and FY 19 respectively.

Such huge unpaid subsidies create a cash crunch situation for the DISCOMs impacting the working capital. A significant part of the DISCOMs consumers are from rural areas and recovery of dues from such consumers has been a challenging task for DISCOMs in most of the states.

Key Takeaways:

- The Average Power Purchase Cost (APPC) is ~ Rs 4.73/kWh for FY 20 i.e., 2% hike from FY 19. With growing burden on DISCOMs, which is amounting to Rs. 90,000 crore for FY 21, this hike will further make the DISCOMs susceptible to inefficiency.
- Unlike Odisha, Uttar Pradesh's APPC is on a rise making it unsustainable while Odisha has set an example where APPC is reducing year-on-year and this has happened due to privatisation brought in the distribution sector.
- Continuous widening of ACS-ARR gap pushes DISCOMs to go for borrowings which is then reflected in the tariff, making tariff incompetent.
- Payment delays affects the whole cash flow cycle, as CERC has notified that payables days must be 45 days from the date of presentation of bills beyond which late payment surcharge is applicable.
- Untimely or partial payment of subsidy creates a challenge for the DISCOMs to pay to the GENCOs on time, leading to vicious cycle of inefficient cash flows.

02

Approach & Methodology

2.0 Approach & Methodology

Our approach and methodology is segregated into following sections:

- Understanding the objectives – We describe our understanding of context, objectives and possible outcomes for the success of this report.
- Approach and methodology – We describe our approach and detailed methods/ techniques to be deployed to execute the objectives and meet the requirements of the objective of the study.

We have segregated our understanding of objectives in following sub sections,

a. Context of Study

Indian Power Sector has witnessed plethora of reforms in the last three decades and Electricity Act,2003 has played a vital legal strategic way which resulted in unbundling of all the three verticals of power sector i.e., Generation, Transmission and Distribution.

Further, it has opened up the sector to private investors and open access provision, ensuring competition for improving efficiency and catering best consumer experience.

Though these reforms almost eradicated the supply-demand tussle, making Indian power sector from power deficit to power surplus, but it will not be out of place to mention that it has equally contributed to the overall economic growth of the country through striving hard to make it a sustainable infrastructure.

Some of the corrective measures taken up by Government of India include UDAY (Ujjwal DISCOMs Assurance Yojana), which was brought-in to bring DISCOMs out of their financial crunches, implementation of SAUBHAGYA scheme and DDUGJY (Deen Dayal Upadhyay Gram Jyoti Yojana) to ensure the electricity connection is made available till the last mile of the country.

Recently, an whopping amount of ₹ 3.03 lakh crores has been planned to be injected towards reform - based result-linked distribution reforms scheme (RDSS) is another way-out to propel the sector which in turn will help the DISCOMs to take crucial capital investment decisions to upgrade their networks and improve technological capabilities.

Reliability and quality of power supply has been directly impacting the social sector of our economy including Education, Health and Agriculture.

b. Our Understanding of Objectives

To ensure quality supply of power primarily in Agriculture, Health and Education sector, the system needs an augmentation in network strengthening through bringing in timely reforms, taking up corrective measures and technology intervention in order to make DISCOMs self-reliant or Atma Nirbhar.

In addition to it, creating conducive environment for the private investor will further push the sector to bring in more competition, transparency and efficiency making it a win-win situation for DISCOMs and the end consumers.

Hence, to analyse the self-sustainability of power distribution sector, the study comprehensively addresses the four areas:

- Analyzing the Socio-economic impact of unreliable Power
- Identifying the Regulatory Reforms for making the Sector Self-Sustainable
- Need for Promoting Private Participation in the Sector
- Technology Aspects for Reforming the Distribution segment

03

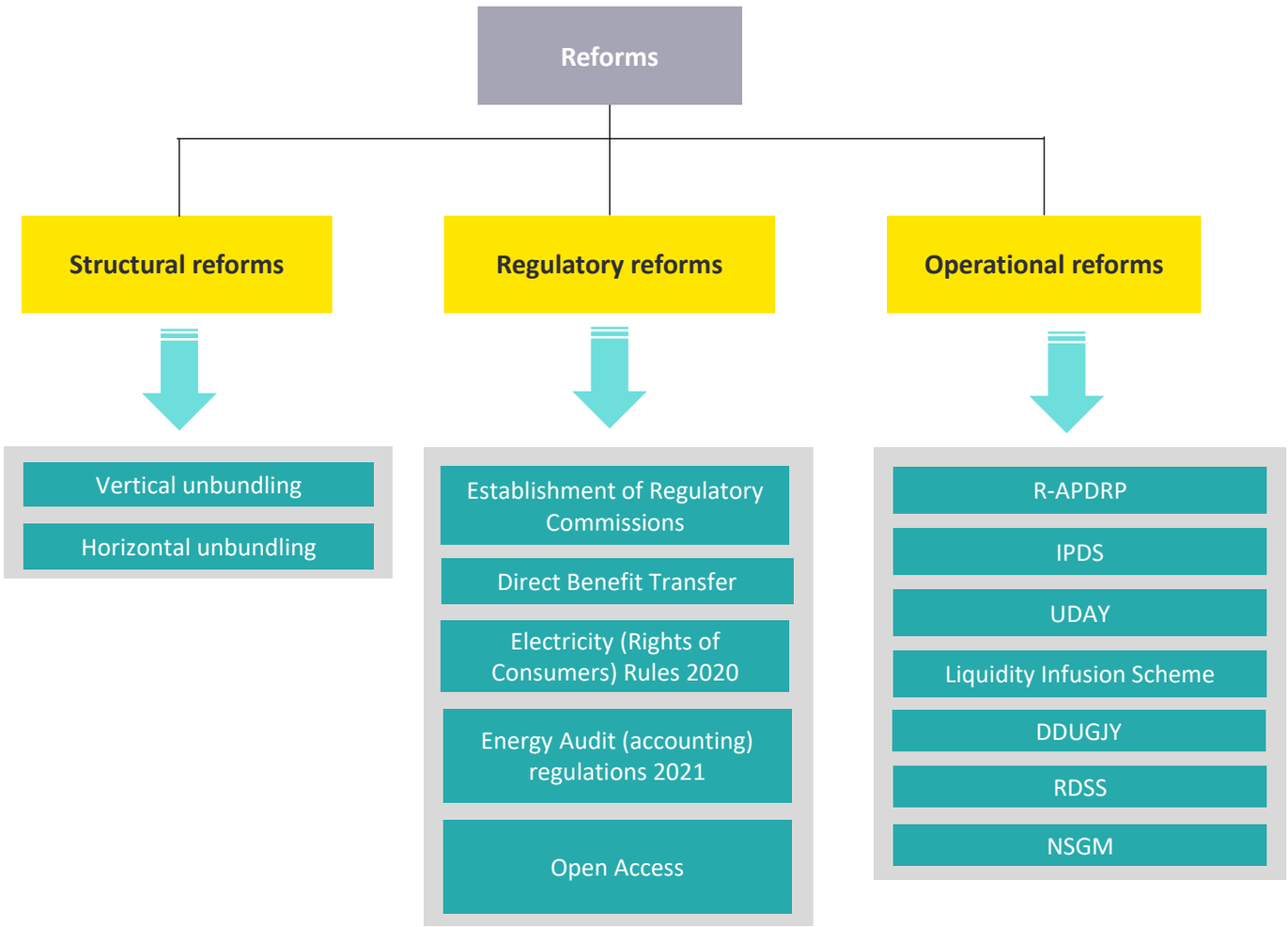
Study Contours

3.1 Regulatory Reforms and Impacts

The Indian Power Sector has been at the forefront of restructuring power business hence, various reform initiatives have been undertaken by all the successive Governments in the last three decades. With continuous reforms over the years, it is evident that that country has witnessed an installed capacity of 395 GW with a peak demand of 203 GW and peak met of around 200 GW for the year 2022. Further, the accessibility of grid electricity has reached almost 100 percent households making a remarkable achievement for Indian power sector.

This achievement was the result of timely intervention of government by bringing in Electricity Act,2003 which not only challenged the debt hit power sector but opened up the market for private players making the system more transparent and competent. This act unfolded regulation for open access, multi year tariff frameworks models, de-licensing generation, regulations on power trading, Renewable Purchase Obligations (RPOs) etc and very importantly creating independent regulatory bodies to be a watchdog of all activities within the power sector. Though, structural reforms have been taking place, yet we have witnessed underperformance of DISCOMs in terms of financial and operational activity which has subsequently turned into a weakest link in the whole value chain of power business.

So taking the above setback into account, government came up with several structural changes in the regulatory framework as proposed in draft Electricity Amendment Bill, 2021 and schemes such as UDAY, Liquidity infusion scheme and the Revamped Distribution Sector Scheme (RDSS) complimented these reforms in paving way towards making DISCOMs more viable and sustainable. Therefore to understand the impact of reform on Indian power sector it is more important to understand the reforms brought at multi levels to make the whole value chain robust and competitive. The reforms can be grouped in as:



I. Structural reforms

Table 2: Structural reforms & its Impact

Under implementation phase Implemented

Reforms	Impact
Vertical Unbundling	▪ Vertical unbundling has ensured to measure performance efficiency for GENCOs, TRANSCOs and DISCOMs. ▪ Introduction of competition in Generation, Transmission and Distribution by allowing other private participants in this segment. ▪ Scope of selling electricity at competitive rates gave choices to consumers to select their suppliers. ▪ Scope of buying electricity at competitive rates gave choices to DISCOMs. ▪ Utilities will no longer have a monopoly, small businesses will be free to sign contract for buying power from cheaper sources, and utilities will be obligated to deliver or wheel power over existing lines for a fee (non- discriminatory).
Horizontal Unbundling	▪ Reduction in AT & C losses ▪ Improvement in metering, billing and collection efficiency ▪ Improvement in financial viability ▪ Growth in retail competition through TBCB ▪ Transparency & Accountability for consumers to address grievances has been improved. ▪ Reduction in supply Outages improving the reliability and quality of power supply ensuring operational efficiency.

II. Regulatory reforms

Table 3: Regulatory reforms & its Impact

Under implementation phase | Implemented

Reforms	Impact
Establishment of Regulatory Commissions	▪ Tariff regulation for the GENCOs that are owned or controlled by the Government of India or private parties. ▪ Regulation of inter and intra state transmission of electricity. ▪ Determination of tariff for Inter and Intra state transmission of electricity ▪ Issuance of licences to transmission licensees and electricity traders ▪ Dispute resolution between the licensees and/or the generating companies ▪ Regulates power trading companies for any unprecedented spike in cost of electricity in Rs/kWh
Direct Benefit Transfer	▪ DBT would avoid pilferage in the transfer of funds from the government to the consumers or the DISCOMs, such as in the LPG scheme ▪ This will ensure subsidy reaches to the intended beneficiaries ▪ Timely transfer of subsidy to the consumers or the DISCOMs ▪ Behavioural change in consumers towards power consumption and paying tariffs. For an instance, the pilots in Punjab did to incentivise reduced power consumption ▪ Improvement of the liquidity would led to increase cashflow for DISCOMs and GENCOs
Electricity (Rights of Consumers) Rules 2020	▪ This has made the distribution companies more accountable to consumers, thus reducing their monopolies and giving consumers more alternatives. ▪ Non-compliance of quality and reliable electricity would tend to invite penalties that will be credited to the consumer's account. ▪ Strengthening the ease of doing business across the country. ▪ Time bound implementation of new electricity connections, refunds and other services.
Energy Audit (accounting) regulations 2021	▪ Energy accounting reports provides detailed information about electricity consumption by various categories of consumers and the transmission and distribution losses in various areas. ▪ It will identify areas of high losses and theft and enable corrective actions. ▪ This measure will also enable the fixation of responsibility on officers for losses and theft. The data will enable the DISCOMs to take appropriate measures for reducing their electricity losses. ▪ The DISCOMs will be able to plan for suitable infrastructure up-gradation as well as demand-side management (DSM) efforts in an effective manner.
Open Access	▪ Consumers who opt for OA can either reduce their electricity bills, increase reliability or meet their RPO obligations. ▪ It helps the industrial & commercial consumers by ensuring regular electricity supply at competitive rates but also enhances the business of power markets.

Role of Electricity Contract Enforcement Authority (Proposed)

ECEA will adjudicate on matters involving the performance of contracts regarding the purchase, sale, or transmission of electricity between a generation company and other licensees. It will not adjudicate over any matter related to regulation or determination of tariff, or any dispute involving tariff. Such matters will continue to be adjudicated by concerned SERCs and CERC.

Sanctity of PPA: A real booster to investors

The Punjab legislature recently passed the Punjab Renewable Energy Security Reform, Termination, and Redetermination of Power Tariff Bill, 2021.

The Bill proposed the renegotiation of signed power purchase agreements (PPAs) with renewable energy generators whose tariffs have been in the vicinity of Rs 7 per unit since they were signed probably between 2013 and 2016.

In contrast, current Solar tariffs may vary from Rs 2-2.5 per unit, depending upon the location and other factors.

After this bill was tabled, around 1000 MW of capacity owned by a number of independent power producers (IPPs) were likely to get affected through the passage of this Bill and this would have an adverse effect on the installation of new projects going forward.

Punjab, however, is not the first state to take this retroactive step.

Andhra Pradesh, too, has been busy reopening PPAs since 2019, a move that is now being heard before various courts of law. Andhra Pradesh, however, did not resort to the legislative route like Punjab infact went ahead of cancelling the PPAs directly.

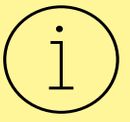
It is not only Punjab and AP, but other states like Gujarat, Rajasthan, Karnataka, and Uttar Pradesh, too, have tried to renegotiate or cancel PPAs in the past.

Certain state governments decisions to renegotiate/cancel PPAs should also be seen in the light of India's commitments made in the Paris agreement (2015) and also in the recently concluded COP26 at Glasgow.

We have given ourselves a stiff target of having a renewable generation capacity of 500 GW by 2030 and we are certain to miss the target if we continue to renegotiate PPAs because doing so, it will create a sense of investor sentiments.

Key highlights

1



Punjab Passes Bill in Legislative Assembly to Renegotiate Renewable Energy Tariffs

2

Why?

To revise the long-term PPAs between the Punjab State Power Corporation and renewable energy generators

3

Objective

The Bill seeks to reduce the tariffs for renewable energy projects approved by the state electricity regulatory commission

b. Direct Benefit Transfer

DBT is part of the Government of India's initiative to reform subsidy provision and dissemination to improve transparency and reduce leakages. Subsidies are transferred directly to a citizen's account instead of distorting the market prices for commodities or services. Transitioning to DBT will **improve revenue realisation and enable DISCOMs to implement Time of Day (TOD) and other best practices in consumer engagement.**

DBT meets Behavioural Energy Efficiency and Smart Water Pump

The Paani Bachao Paise Kamao scheme has been conceived by MIT's Abdul Latif Jameel Poverty Action Lab (J-PAL) in collaboration with the World Bank.

It is being piloted in Punjab with the DISCOMs Punjab State Power Corporation Limited (PSPCL) as the implementation agency and The Energy and Resources Institute (TERI) as the nodal body. It is supported by Punjab Agricultural University (PAU) and IT Power India (ITPI).

The pilot scheme aims to address the issue of agricultural groundwater over consumption by incentivising farmers to reduce their electricity and water use without disturbing their free electricity provision.

Farmers are positively reinforced to consume less than their free allocation by giving them rebates against their bill for lower consumption. Over consumption is not charged.

Electricity is supplied only during daytime, which allows farmers to monitor their water consumption.

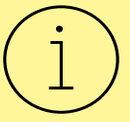
Enrolment is voluntary but once enrolled, an automated meter reading (AMR) system is installed at their agricultural pump connection. AMR enables the DISCOMs to monitor energy consumptions and calculate savings and incentives.

Consumptions and saving data are conveyed to farmers through SMS on a bimonthly basis. Any incentive amount is credited to farmers through a DBT mechanism.

Success on the first six feeders has prompted the state to extend the pilot to 250 additional feeders

Key highlights

1



Punjab has rolled out a promising scheme that pays farmers for consuming less electricity and water

2

Why?

To address the issues of agricultural groundwater overconsumption by incentivising farmers to reduce their electricity use

3

Role

The current scheme can turn out to be a game-changer, in a state where groundwater levels in many parts are depleting by 80-90 cm every year.

Reaction of DISCOMs due to frequent switching of consumers to OA

In its petition for approval of ARR for the FY 2011-12, Punjab State Power Corporation Limited (PSPCL) has described the problems caused by frequent switching by OA customers.

The following paragraphs provide a brief description of PSPCL's complaints in order to illustrate the level of difficulty caused by OA and provide an example of the experience of DISCOMs.

PSPCL stated that OA increased by four times in one year, seriously affecting the quality and cost of service for its other customers. PSPCL procures power from its own generating units, CPSUs, and short-term purchases.

Short-term purchases can come from bilateral contracts or the day-ahead market at the power exchanges.

However, PSPCL relies on bilateral contracts three months in advance because the prices at the power exchange are volatile and the availability of power is uncertain.

The tendering for these bilateral contracts has to start six months in advance based on estimates of load made by PSPCL. These short-term power contracts carry heavy penalties for cancellation.
In contrast to these constraints on PSPCL, OA customers have had the freedom to take, or not take, power from PSPCL at any time.

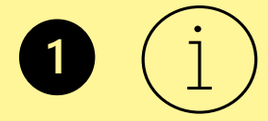
PSPCL asserted that instead of an 'assured customer supplier' relationship, this led to PSPCL being treated as 'stand by supplier'.

Summarising the situation, PSPCL stated:

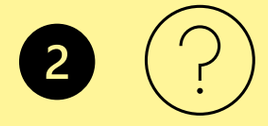
- The power scheduled by OA consumers through open access varied on an hourly basis depending on the prevailing market price, and PSPCL was required to supply the residual requirement of these consumers. This made the power demand on the PSPCL system vary unpredictably, making system operation and its associated economics 'unmanageable' or rather 'impossible'
- Frequent shifting of OA consumers between PSPCL and the market affected the quality of power provided to other consumers.
- The total Open Access quantum on day ahead basis can be known at 5PM on the previous day only. Due to this short time given to PSPCL, it has no alternative for arranging excess power or surrendering the power and thus PSPCL is financially affected.

PSPCL characterised this behaviour as, 'OA consumers are indulging in foul play for pure profiteering thus jeopardising the system reliability & economics.

Key highlights

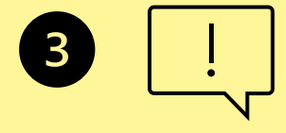


The frequent shifting of OA consumers from PSPCL to Open Access and again to PSPCL is affecting the quality of power to other consumers



Why?

At present OA consumers use PSPCL as a standby supplier and for this PSPCL must have spinning reserve.



The OA consumers being the cross subsidizing category for other consumer groups, this reduction of power off-take by them from PSPCL power pool has adverse impact on the tariff of other categories

III. Operational reforms

Table 5: Operational reforms & its Impact

Under implementation phase | Implemented

Schemes/ Initiatives	Impact
R-APDRP	Reduction in AT&C losses ▪ AT&C loss reduction reported in 85 % of 76 selected towns, ranging from 1% to 54%. This reduction in losses corresponds to annual monetary benefit of approx. Rs.185 crores p.a. in 76 towns. ▪ Extrapolated monetary benefits on total sample on the basis of energy consumption have been estimated to be more than Rs.5,000 crores p.a.
	Reliability of Power at 11KV Feeder level ▪ IT based system has enabled accurate measurement of Reliability of Power (i.e. total hours of supply). More than 85% reliability of power has been observed in 66 towns (more than 96% reliability in 60 towns).
	Improved Consumer services ▪ Single window customer care-centre has been established for all type of complaints in different states. ▪ Rate of addressing consumer grievances got increased under stipulated timelines as specified by SERCs. ▪ New connections were released within SERC time limits. ▪ Web self-service and multiple payment options have been made operational. ▪ Introduction of e-payment mode
	Mapping of physical infrastructure with consumers ▪ Mapping of Feeders and it's linkage with consumers has been achieved. ▪ 57% Feeders have started showing improvement in AT&C losses. ▪ GIS based asset mapping and consumer Indexing achieved in go-live towns.
IPDS	▪ Strengthening of sub-transmission and distribution networks in the urban areas. ▪ Metering of distribution transformers / feeders / consumers in the urban areas. ▪ IT enablement of distribution sector and strengthening of distribution network under R-APDRP for 12th and 13th Plans by carrying forward the approved outlay for R-APDRP to IPDS. ▪ Implementation of Enterprise Resource Planning (ERP) and IT enablement extension to all 4041 towns as per Census 2011. ▪ Net metering, smart metering and underground cabling got initiated under this scheme.
UDAY	Reduction in AT&C losses ▪ AT & C loss reduction came down to 18.7% in FY 18 from 26% in FY 16 which was actually below the projected loss of 15% by 2019. ▪ Reduction in ACS-ARR gap: ACS-ARR gap of Rs. 0.58/ unit in FY 16 came down to Rs. 0.17/unit in FY 18, which was more than the targeted ACS-ARR gap of zero. ▪ Energy accounting for distribution and identifying pockets of high energy losses through Feeder & DT metering, consumer indexing and GIS ▪ At pan India basis, feeder separation is 86% of which 100% feeder metering is done for rural and urban areas.

Under implementation phase Implemented

Schemes/ Initiatives	Impact
Liquidity Infusion Scheme	▪ Facilitated cashflow to clear the dues for GENCOs. ▪ Reduction in the burden of Late Payment Surcharge (LPS) to GENCOs
DDUGJY	**Feeder separation** ▪ Regrouping of consumers into agricultural and non-agricultural users ▪ Creation of high tension lines for setting up new feeders (both agricultural and non-agricultural) ▪ Installation of new transformers for distribution of electricity to agricultural and non-agricultural end users **Systems Strengthening** ▪ Creation of new substations and augmentation of the capacity of existing stations to enhance electricity distribution ▪ Modernization of existing sub-stations & power lines to improve quality of electricity distribution ▪ Installation of aerial bunch cable to prevent electricity theft **Rural Electrification** ▪ RGGVY has been subsumed under the scheme to spread rural electrification ▪ BPL households are eligible to get free electricity connection under the scheme. ▪ Villages, which cannot be part of grid connectivity, are provided electricity through off-grid solutions.
RDSS	▪ Reduction in AT&C losses to 12-15% ▪ Reduction in ACS-ARR gap to zero by 2024-25 by improving the operational efficiencies and financial sustainability of all DISCOMs/ Power Departments excluding Private Sector DISCOMs.
SAUBHAGYA	▪ Almost 2.82 crore households have been electrified till March 31, 2021, since the launch of Saubhagya scheme in 2017.
NSGM	▪ Reduction of T&D losses ▪ Peak load management, improved QoS and reliability. ▪ Reduction in power purchase cost. ▪ Better asset management. ▪ Increased grid visibility and self-healing grids. ▪ Renewable integration and accessibility to electricity. ▪ Increased options such as ToU tariff, Demand response programs, net metering. ▪ Satisfied customers and financially sound utilities etc.

3.2 Evolving Business Models in Distribution sector

The power sector, globally as well as in India, is undergoing a sea change. This is visible in the increasing deployment of clean renewables and the rising prevalence of grid connected distributed generation. While these trends create churn and disruption in the power sector, they also create opportunities for new and innovative business models.

The Indian power sector with recent commitment of installing renewable energy of 500 GW by 2030 at CoP 26 has lead to a decade of transition and transformation. Further, Government supports through policies like draft National Electricity Policy 2021, announcement of the Ancillary Services Market regulation and the Market-Based Economic Dispatch (MBED), have signalled a bright future for India's power sector. This transformation will come up with challenges like grid stability, evacuation of power, supplying quality and reliable power etc. Hence, to cope with these enormous challenges private participation in this sector will play a vital role. Therefore, Government is striving hard to bring reforms and facilitate private investors to come up with new business models in distribution business, in clean energy portfolios, grid modernisation and other areas to improve the sector's financial and operational performance.

Higher private participation in distribution holds out the possibility of greater efficiency. Franchisee models have been successfully implemented in Odisha and Bhiwandi in Maharashtra, where there have been rapid improvements in metering, billing, and collection. In Delhi, after power distribution was taken over by three private licensees, the Aggregate Technical and Commercial (AT&C) losses have come down from about 55 percent in 2002 to about 9 percent in 2019.A public-private partnership (PPP) model can be especially useful in loss-making areas, where commercial operation might not be feasible without support in the form of viability gap funding (VGF) by the government. Some of the evolving business models in the distribution sector are elaborated below:

I. Distribution Franchisee (DF) Model

The DF model's genesis in India came about in the context of improving access to electricity for the rural communities. This model was given formal recognition with the passage of the Electricity Act, 2003, as a means of encouraging private participation in the power distribution segment, besides improving electricity access.

Bhiwandi in Maharashtra, Feedback Energy Distribution Company (FEDCO) in Odisha and states like Meghalaya, Tripura, Rajasthan and Madhya Pradesh are few example of the success of this model, given the sustained improvement in performance on all fronts over its baseline.

II. Distribution Licensee/ PPP Model

In this model, the private party owns the distribution assets and performs all distribution related functions—from the purchase of power from suppliers of its own choice and supply to end users, to billing and collection.

In urban areas, where there is a high density of population and a reasonably homogenous consumer mix, private parties might be more enthusiastic about acquiring an existing state-owned utility.

Depending on the financial viability, privatisation could be complete (100 percent ownership by the private party) or partial, with the government retaining a minority stake in the utility. In either case, the management control resides with the private owner.

Need for Distribution Franchisee

Reliability of Supply: The franchise can bring in operational efficiencies to reduce supply Outages.

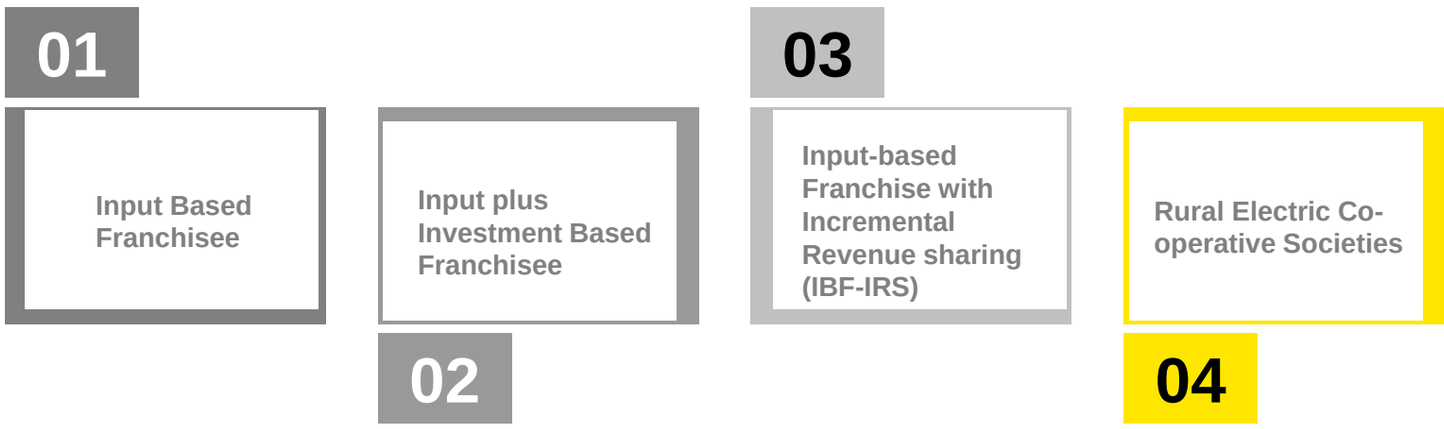
Transparency & Accountability: The relatively small size of distribution area bring the entities closer to the Consumer and thus improving the transparency.

Operational efficiency: Improvement in metering, billing and collection efficiency.

Financial viability: The franchisee can bring in financial viability to the distribution utility.

Reduction in loss levels: The franchisee can reduce the Aggregate Technical and Commercial (AT&C) loss levels for the utility.

Different types of DF models:



Key characteristics of the various DF models are explained below,

Franchisee model	Key Characteristics
Input- based	▶ Term of contract (10 – 15 years) ▶ Franchisee pays an agreed price to the utility for each unit of electricity procured and retains the collected revenue
Input-plus-investment based	▶ Long term of contract (15-20 years) to cover initial investment costs ▶ Franchisee pays the utility for each unit of electricity procured and retains the collected revenue ▶ Specified investment to be undertaken by the franchisee
IBF-IRS	▶ Short term contract (5 years) ▶ Input energy delivered to DF without payment ▶ Incremental revenue realised beyond the baseline is shared between the franchisee and the utility in the ratio as per contract ▶ Both the franchisee and licensee to incur capital expenditure as agreed
Rural Electric Cooperative Societies	▶ The ownership and maintenance of assets and provision of services are the responsibilities of the members of the cooperative ▶ Model distribution zone (MDZ) programme in Odisha is managed by Self-Help Group (SHG).

Franchisee Model in Bhiwandi

The input based franchisee, as implemented in Bhiwandi is an arrangement under which a private company Torrent Power Limited (TPL) is appointed to manage distribution business of a Bhiwandi circle of MSEDCL for a period of 10 years.
The franchisee pays to the licensee for input energy injected into the franchisee area at an agreed 'input rate'. The input rate actually implies the certain level of AT&C loss reduction that franchisee will achieve in the area.

If it succeeds in reducing losses lower than the input rate it has committed, it makes profit. If it fails to achieve the necessary loss reduction, it makes financial loss as irrespective of the actual AT&C loss levels the franchisee has to make payments to licensee based on the agreed input rate.
The selection of franchisee was made based on competitive bidding process. Being the highest bidder, Torrent Power Limited was appointed as the franchisee for Bhiwandi circle. MSEDCL signed Distribution franchisee Agreement (DFA) with Torrent in December 2006 and TPL took over operation of Bhiwandi circle from 26th January 2007.
For the term of franchisee i.e. 10 years in this case, it is responsible for all the functions of the distribution licensee within that area. These include metering, billing, repair, maintenance, consumer service, capital expenditure, giving new connections, generating bills, revenue collection etc.
The consumers in the franchisee area are charged same tariff as applicable to consumers of rest of licensee area.
Franchisee has to comply with all service and supply quality norms, rules and regulations as specified by regulatory commission and other authorities.

Post - Franchisee Performance

Both MSEDCL and Torrent power limited, (TPL), claim significant improvement in loss reduction in Bhiwandi. The metered sales after the franchisee take over have almost doubled.

As per the data on MSEDCL website, it can be seen that distribution loss in Bhiwandi circle have gone down from 40% to around 18% and collection efficiency has gone up from 61% to 99%. As a result, the aggregate technical and commercial losses have gone down from 63% to 19%

Key highlights

1

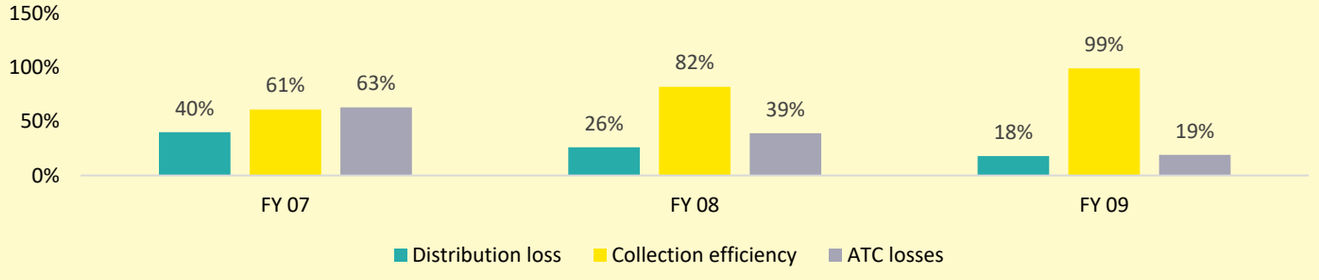
Input Based Franchisee model in Bhiwandi for improved efficiency & Financial viability

2

End- results

- ✓ **Reduction in Distribution loss levels**
- ✓ **Improved Collection efficiency**
- ✓ **Decreased AT&C loss levels**
- ✓ **Improved operational performance**
- ✓ **Improved reliability of supply**

Figure 28: Distribution loss, Collection efficiency from FY 07, FY 08 & FY 09



Source: MSEDCL website

A Distribution Franchisee Model in Odisha

The Central Electricity Supply Utility of Odisha (CESU) has adopted the input-based franchisee with incremental revenue sharing (IBF-IRS) model, where the franchisee would infuse the capital required for system upgrades and the incremental revenue generated would be shared between CESU and franchisees in a mutually agreed ratio.

In IBF-IRS, the input energy is free of cost in order to alleviate the demand and price fluctuation-related risks. The IBF-IRS is only for five years and all assets below the distribution transformer (DT) are too maintained by the IBF-IRS DF.

Also, the IBF-IRS DF mandates the installation of smart meters and partial Capex on the meters is to be recovered by 40 months through monthly meter rent.

CESU engaged FEDCO as a franchisee in four divisions in 2013. **FEDCO achieved an average 23% reduction in AT&C losses between 2013 and 2017.**

The overall collection doubled in the same period as well. FEDCO claims this to be the steepest reduction in AT&C losses achieved in a predominantly rural area.

Key highlights

1

IBF- IRS DF model in Odisha for improved efficiency & Financial viability

2

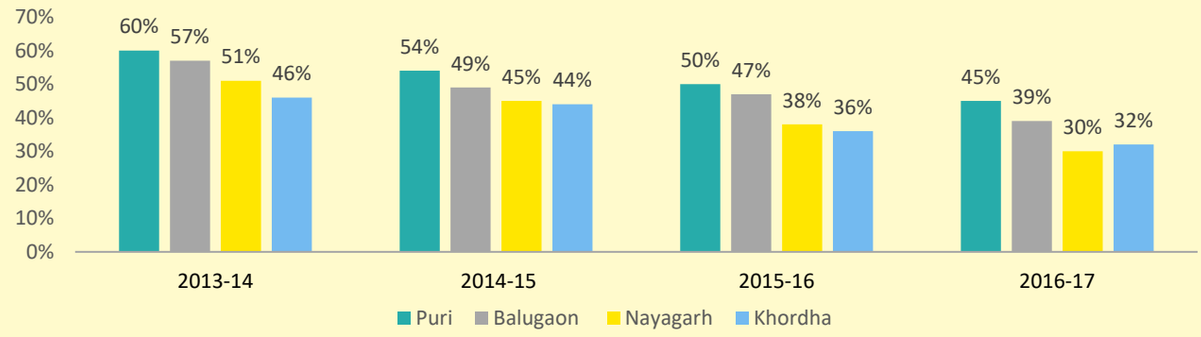
End- results

- ✓ **Improved Collection efficiency**
- ✓ **Decreased AT&C loss levels**
- ✓ **Improved operational performance**

In Feb 2013, FEDCO commenced operations as a franchisee in Puri, Khorda, Balugaon and Nayagad divisions in Odisha across an area of 9,000 sq. km. (covering 4,00,000 consumers).

The company has taken several steps to improve distribution operation and minimise AT&C losses, like setting up customer care center, spot collection, developing ERP for billing, etc. These steps resulted in increasing the billing coverage to 88% from 75%, collection coverage improved to 70% from 56%, AT&C losses reduced to 54% from 61%.

Figure 29: AT&C Loss Reduction by FEDCO in Odisha



Currently, there are 12 operational franchisees in different circles/divisions across Maharashtra, Uttar Pradesh, Odisha, Rajasthan and Meghalaya. Bhiwandi in Maharashtra was the first DF to be awarded in the country in 2006-2007. TPL took over as the DF for the Bhiwandi area from the Maharashtra State Electricity Distribution Company Limited for a period of 10 years on 2007. The Bhiwandi DF is considered hugely successful as TPL managed to bring down the AT&C losses from 58% at the time of takeover to less than 20% in five years. As of 2018-19, AT&C losses in Bhiwandi stood at 14.9%. In subsequent years, the DF model was adopted in Uttar Pradesh, Odisha and in Rajasthan. All these areas have shown improved performance compared to the baseline. Some of the distribution franchisee in India with the operational status as of 2020 are given in the table below,

State	Circle/Town	Distribution Franchisee	Type of Franchisee
Maharashtra	Bhiwandi	Torrent Power Limited	Input based
	Shil, Mumbra and Kalwa subdivisions	Torrent Power Limited	Input plus Investment Based
	Malegaon	CESC Limited	Input plus Investment Based
Uttar Pradesh	Agra	Torrent Power Limited	Input based
Odisha	Khurda, Balugaon, Puri and Nayagarh	FEDCO	IBF-IRS
	Kendrapara, Marshaghai, Jagatsinghpur, Dhenkanal, Angul and Chainpal	Enzen Global Solutions Private Limited	IBF-IRS
Rajasthan	Kota	CESC Limited	Input-plus-investment
	Bharatpur	CESC Limited	Input-plus-investment
	Bikaner	CESC Limited	Input plus Investment Based
	Ajmer City	Tata Power	Input plus Investment Based
Meghalaya	Mawkyrawat, Mawsynram, Nangalbibra and Phulbari subdivisions	FEDCO	Input plus Investment Based
	Dalu subdivision	Sai Computers	Input plus Investment Based

Some of the challenges in DF business:

- **Inadequate power supply:** Franchisee is dependent on the Licensee for electricity supply. Many states in India still face electricity shortages. DFs have to resort to load-shedding. Thus objective of improvement in customer-service is not always achieved and hence results in failure of DF
- **Rehabilitation of the existing employees of the utility:** It is not obligatory for the franchisee to take on the existing employees of the utility. Most of the staff has to be transferred to the other distribution areas under the utility
- Depending on the model, it may require huge CAPEX for network strengthening

Although DF models show promise, their impact on strengthening overall systems and in reducing losses is limited, depending on the specific DF model, the relationship with the state machinery, and the rural/urban nature of the landscape.

Given the limited control that DFs have on distribution system operations, tariffs, and cost of supply, their ultimate impact on transforming the sector is limited. DFs have minimal incentive or ability in the form of capital investments to enable innovation. Lastly, the model also faces a degree of long-term risk from grid-modernisation efforts, especially from smart grids, if its performance incentives remain tied to billing and collection only.

II. Distribution Licensee/ PPP Model

PPP Model in Delhi

The Delhi Model of Public Private Partnership (PPP) in Distribution (TPDDL – JV of Tata Power (51%) and Govt. of Delhi (49%)) is probably one of the very few PPP successes in the India.

The Delhi Distribution PPP Model, provides full functional autonomy to the Private Investors to manage the Business.

The distribution business was in very bad shape at the time when TPDDL took over as distribution license of North and Northwest circle of erstwhile DVB. TPDDL has reported loss level to be at 53%.

The high losses can be attributed to large revenue leakage, low consumer satisfaction, technological obsolescence, absence of proper monitoring and control over the operations, low level of motivation of employees, and bureaucratic nature of the management, beside other reasons.

As per TPDDL, some of the challenges faced include:

- Very high AT&C losses
- Approximately 20,000 new connection applications were pending for processing and subsequent release of connection
- One lakh metering and billing related pending complaints. Of the total bills issued, over 30 per cent were provisional bills. Complaints, related to wrong billing were very high
- Power outages were common

Initiatives undertaken by TPDDL

TPDDL carried out multiple interventions to improve electricity distribution system so as to ensure round the clock supply of quality power.

The interventions carried out by TPDDL are enumerated below,

Key highlights

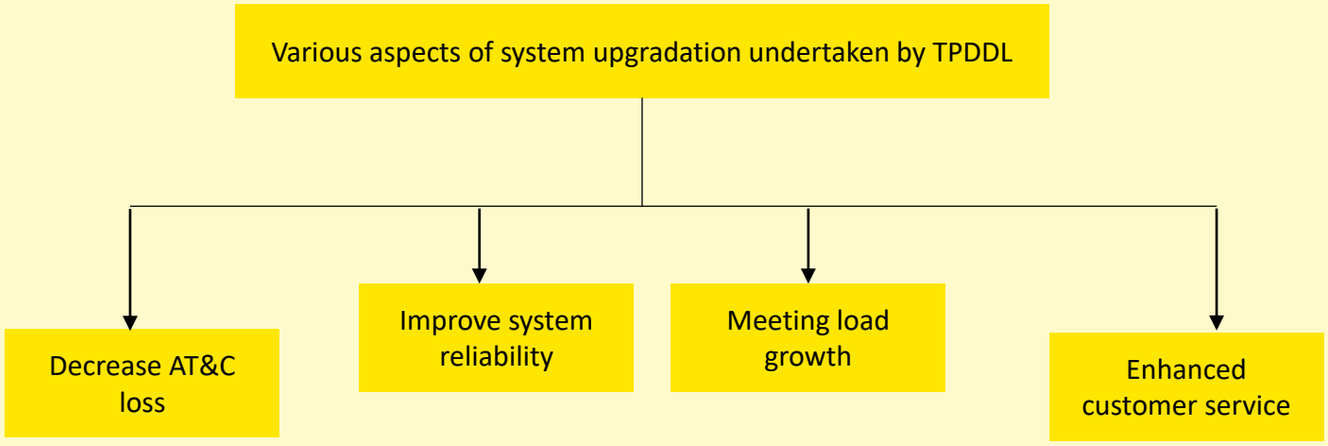
1

Public Private Partnership PPP in Delhi for improved efficiency & Financial viability

2

End- results

- ✓ **Reduction in AT&C loss levels**
- ✓ **Improved Collection efficiency**
- ✓ **Enhanced customer service**
- ✓ **Improved operational performance**
- ✓ **Improved reliability of supply**
- ✓ **Reduction in DT failure rate**
- ✓ **Improvement in the peak load**
- ✓ **Improvement in length of the network**



Decreasing AT&C loss

- In the first 10 years of its operations, the utility replaced approximately 800,000 electromechanical meters with tamper proof static meters having no accuracy change over time
- Improving the Low Tension (LT)/ High Tension (HT) ratio, especially in theft prone areas, with installation of smaller capacity transformers placed nearer to load centre
- Replacement of LT bare conductor with LT AB cable

System reliability improvement

- Introduced distribution automation in its entire operations and automation of all 66/11 kV and 33/11 kV grid sub-stations with latest technology for remote establishment of SCADA Master **Control Centre to control all connected grids**
- **GIS mapping of all the assets (transformers, buildings, poles, cables, etc.) and linking it with various processes such as Capital Expenditure Management (CEM), Asset Management (AM), and Revenue Management (RM)**

Meeting load growth

TPDDL has followed different approaches under different conditions and at different stages to meet its load growth. During first five years of operation, efforts were made to meet the peak demand of TPDDL with the establishment of new grid substations and augmentation of capacity of overloaded grid sub-stations. Between FY 2007 to FY 2011 focus was more on meeting load growth requirements through implementation of Distribution Management System (DMS), Distribution Automation (DA).

Results achieved by TPDDL

Since takeover, the TPDDL has been successful in reducing the AT&C losses. Introduction of innovative initiatives have helped the utility in reducing its losses over the years. The improvements in operational performance have been detailed below,

Parameter	Unit	July 2002	March 2013	% change
Peak load	MW	930	1,573	69%
AT&C losses	%	53.1	10.78	80%
DT failure rate	%	11	0.79	93%
Length of network	Ckt km	6,750	10,364	54%

While the private distribution licensee model provides greater ownership and control over improving the system, it is relatively more financially demanding for the private sector. The model has been successful in major cities such as Delhi and Surat where government support, consumer mix and geography helped it succeed.

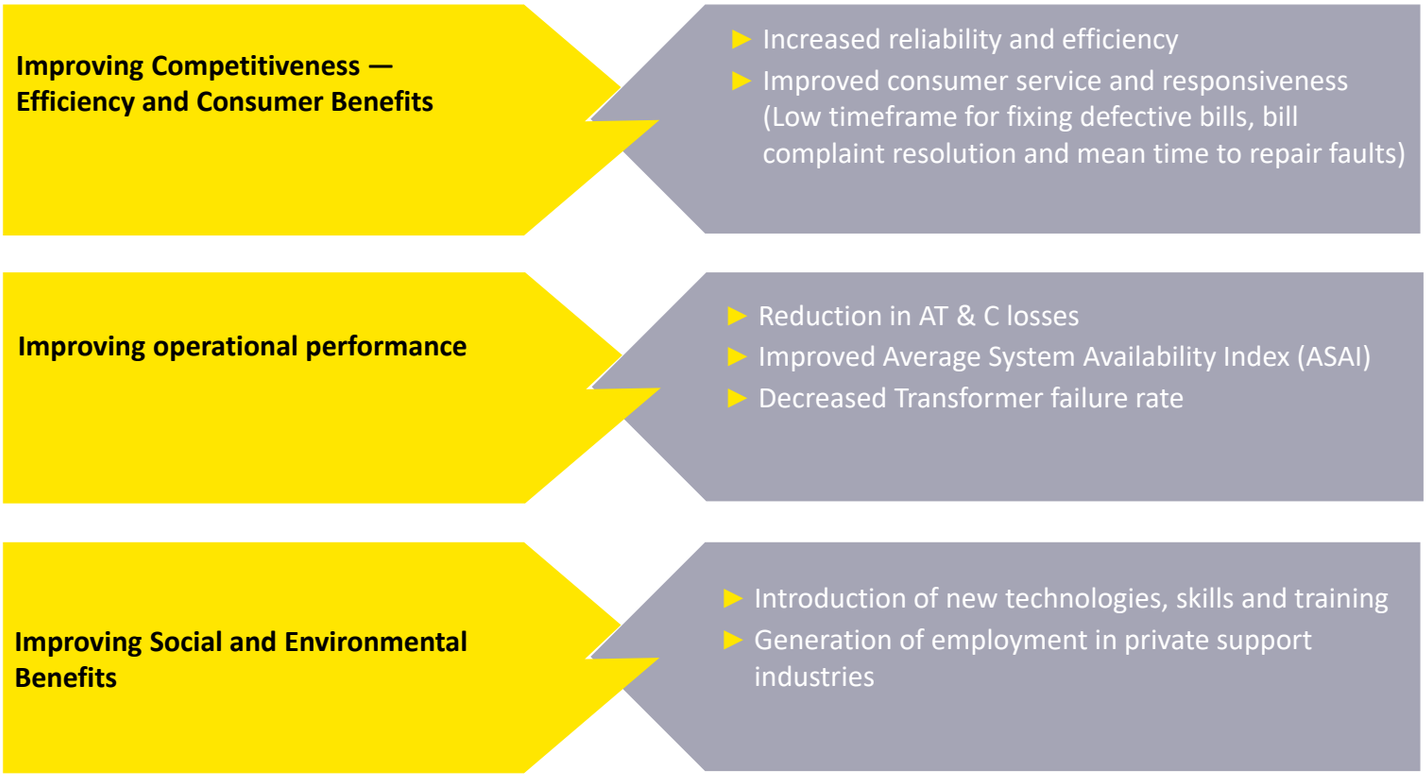
Furthermore, privatisation becomes difficult to achieve when the DISCOMs service area is more rural. Given the tariff differential and difficulty of billing, collection, and, in some cases, metering, the cost of servicing rural and agricultural consumers is commercially challenging. For full-scale privatisation, the consumer mix and geography are ultimate factors in achieving commercial viability.

The major difference in the business models are,

Distribution Franchisee Model	Distribution Licensee Model
Private party has no ownership over the distribution grid assets.	Private party holds equity and is part or complete owner of the distribution grid assets
Private party manages billing and revenue collection mainly	Private party manages the distribution of power along with billing and revenue collection services.
Example – Torrent Power, Bhiwandi, MH	Example – TATA Power, New Delhi

Need for Private participation in Power Distribution

The Need for Private Sector Participation in India's Electricity Distribution Sector explains how shifting focus to increasing private sector participation and investments in India's energy distribution business could lead to improved financial viability and sustainability. The need for promoting private participation in the power distribution sector is described below,



Draft Electricity Amendment Bill: Delicensing distribution

Another aspect to encourage the private participation is to 'delicense' the electricity distribution sector. The Delicensing of the distribution business is proposed in the latest amendment to the Electricity Act, 2003.

According to the proposed amendment, consumers would be free to choose the distribution company for their electricity supply, and the Government expects that competition between distribution companies within the same area will lead to improvement in services and breaking monopolies existing in the power distribution sector.

In the existing system, distribution companies (DISCOMs) have dual role of providing network and retail supply to end consumers where they have a universal supply obligation. This means that DISCOMs currently have the responsibilities of both Distribution Network Operators (DNOs) and Distribution System Operators (DSOs).

The separation of carriage and content means, while a DISCOMs will still be responsible for network, the supply and revenue recovery would be done by separate multiple companies. In the new proposed system, the DISCOMs would still be a monopolized and a regulated business, but retail would be open to competition thereby bringing in much needed operational efficiencies. End-consumers will have option of purchasing their power either directly from the spot market or from one or several competing power retailers.

Key facets of the proposed changes

New entrants to distribution will need to register for each area in which they want to distribute electricity. The area of supply should be at least a municipal council, or a municipal corporation, or a revenue district, or a smaller area, as and if, notified by the state government.

Registration will be done by the respective SERC, and an SERC will be required to complete the registration process within 60 days of receipt of registration request. Furthermore, SERC will be able to reject an applicant company only if it is does not meet the eligibility criteria. The eligibility criteria have not been articulated yet.

The key facets are explained below,

a. **Distribution Network:** For providing supply, a distribution company will be able use its own network or use the network of another distribution company. Moreover, all distribution companies have to allow the use of their networks by competitors in a supply area on the payment of wheeling charges.

b. **Sharing of PPAs:** The existing PPAs in a supply area will be shared by the distribution companies in an area as specified by the respective SERC, in accordance with rules developed by the Central Government. These sharing arrangements will be reviewed by the SERC periodically. A distribution company will be able to sign additional PPAs as the need arises, however, only after the existing PPAs' requirements have been met.

c. **Tariffs:** SERCs will continue to set regulated tariffs. However, it is not clear if these will be area-specific tariffs or uniform for the entire service territory of the existing distribution company in a supply area. These regulated tariffs will serve as ceiling tariffs with distribution companies free to charge their customers less.

d. **Universal Service Obligation (USO) Fund:** Whenever there will be more than one distribution company in a supply area, a USO fund will be created by the State Government which will also designate a Government company or entity to manage the fund.

The Draft EAB 2021 states, "Any surplus with a distribution company on account of cross subsidy or cross subsidy surcharge or additional surcharge shall be deposited into such fund to fund deficits in cross subsidy in the same or any other area of supply.

Rationale for Proposed Changes

One reason often given for introducing retail competition is that electricity should be like any other commodity, and consumers should be able to choose their suppliers.

Therefore, delicensing electricity distribution and reducing entry barriers is expected to remove the monopoly, mostly with state-owned companies.

While new entrants can enter and compete, the Government reportedly proposes to have ceiling tariffs, as described earlier. The benefits it expects are improved service and responsiveness, increased innovation, and improved operations, especially collection efficiency.

Multiple distribution licensee in Mumbai

Mumbai is one of the few places that has operationalised multiple distribution licensees in the same geographical area. There was a conflict between RInfra and Tata Power Company (TPC), over TPC's right to distribute electricity in RInfra's service territory. There was a string of litigation, with the Supreme Court finally ruling that TPC could supply power to customers in RInfra's service territory using RInfra's network. Then there were allegations of cherry-picking, and disputes over various components of charges.
At the end of all this turmoil, the Mumbai experience turned out to be a story of endless litigation, planning and regulatory failures, and unfortunately, significantly higher tariffs for consumers (Prayas, 2016; Singh, 2016). While all aspects of the experience from the Mumbai experiment with multiple distribution licensees may not necessarily apply to the changes being proposed by the Government, it should be a sobering reminder of the perils of such an approach

The concept of carriage-content separation has been successfully implemented in developed countries such as the UK, New Zealand and many states of the US. New Zealand has successfully demonstrated healthy competition and reduction in cost of electricity through more than 20 retail suppliers. Developing countries and manly South Asian countries are still endeavouring for the structural changes to implement carriage-content separation.

The implementation of the delicensing initiative would require amendments to the Electricity Act as well as suitable policy and regulatory measures to outline the division of the wires and supply business, including a mechanism to compensate the existing DISCOMs for the distribution infrastructure as well as a tariff determination process in the case of multiple operators.

Also, the regulations must provide a mechanism for a fair and equitable sharing of AT&C losses, subsidy payments, cross-subsidy charges and additional surcharge. While delicensing would be a positive for consumers in the long run, by providing them a choice of suppliers and improved operating efficiencies and customer service, the implementation of this initiative would require the support of the state governments.

3.3 Energy Sustainability

The energy sector plays a critical role in both meeting sustainable development objectives and reducing environmental externalities in India but at the same time, providing secure, affordable and sustainable energy to all is an important policy priority in India, and a major progress has been extended to the United Nations Sustainable Development Goals (SDGs), notably SDG 7 on energy. Sustainable energy can be referred as generation of electricity through renewable energy. All renewable energies like Wind, Solar, Tidal, Geothermal, etc. are sustainable in nature hence they are termed as source of sustainable energy.

Although the growth of India's RE sector is impressive, still more facilitation policy is expected from government to attract more private developers for renewable field with long term PPA so that a sense of confidence is built within the investors. Some of the actions required by the Government for Energy Sustainability are listed below,

Proposed Actions	Description
Easing land acquisition	Easing land acquisition through a process called "plug and play" model. Under this model land will basically be acquired by the government and would be allotted to developers after a bidding procedure
Standard power purchase agreements	Standardising of all power purchase agreements ("PPAs") in the areas of Solar and Wind power and imposing penalty in the event of breach of obligations or default by the state.
Proposed Amendments in Electricity Act 2003	Bringing amendments such as allowing paying by letter of credit and regulating direct transfer of subsidies,
Reduction in corporate tax	Reduction in corporate tax from 30 % to 22% for Indian companies and adjusting its corporate tax to the corporate tax rates applicable in other Southern Asian countries

Technology aspects for Energy Sustainability

a. Off-grid systems

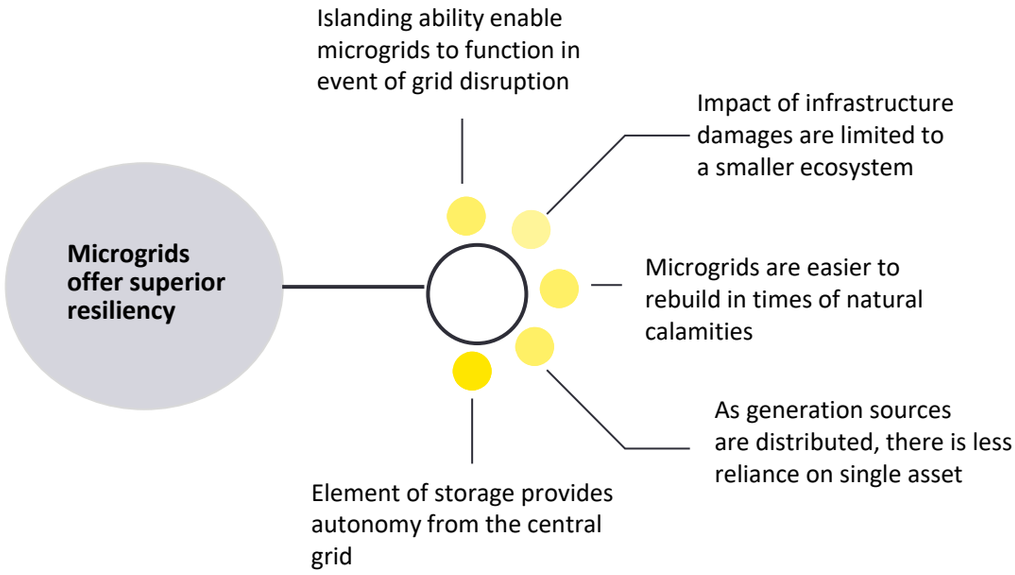
Off-grid systems, also known as stand-alone systems, provide electricity in areas where grid power is either unavailable or directly replacing expensive or unreliable grid power. Off-grid systems work independently of the grid but have batteries which can store the power generated by system. There are two main aspects to provide electrification in a competitive and effective way: mini-grids and micro grids. Both types of systems operate independently of the national electricity grid and are thus known as off-grid systems.

Mini/ Microgrids

Micro-grid typically refers to an independent grid network operating on a scale of less than 10 kW power, while the mini grids are designed to generate 10 kW or more power using renewable energy that distributes electricity to a limited number of customers. Unlike traditional grid systems, microgrids are decentralized and located close to the area they serve. Microgrids can serve as a supplement to a larger, connected grid system or as a stand-alone power source. Microgrids are seen to be an important participant in the evolution of a future transactive energy market. Emerging technologies like AI, RPA, blockchain and analytics are further enhancing microgrids value proposition for the energy ecosystem as given below,

	AI is helping to decide merit order of energy demand, supply and storage sequencing in microgrids AI is making forecasting of electricity load and associated energy costs for microgrid operations more efficient
	Automated billing and customer relationship management solutions are enabling deployment of remote microgrids
	Blockchain is enabling P2P energy trading in microgrids
	Analytics is optimizing the automatic voltage and current flow between microgrid and central grid Analytics is helping avoid peak demand by sequencing & dispatching energy efficiently
	IoT solutions are ensuring better connectivity of micro-grid' based distributed generation sources with monitoring and control platforms

Also, Microgrids offer a compelling solution to consumers rising grid resiliency concerns, especially in developed markets.



Initiatives taken for Mini/ Microgrids

Though the government has shown significant progress on rural electrification in recent years through grid extension, a large number of rural households still have no access to electricity. The India Energy Storage Alliance (IESA) had launched the Microgrid Initiative for Campus & Rural Opportunities (MICRO). The main objective of this initiative was to reduce electricity cost from microgrids in India by 20–30% within 2019.

Table 6: Microgrids: Key projects in India

Project name	Location	Rated power (kW)	Project developer/owner
Tata Power – MIT Microgrid project, Purnia, Bihar, India	Bihar	1000	Tata Power Solar, MIT
SunEdison 159 kW Solar PV Microgrid Project, MP, India	Madhya Pradesh	159	SunEdison, Rural Electrification Corp (REC), MP Urja Vikas Nigam State Agency
Chief Ministers Official Residence Microgrid project, Bihar	Bihar	125	Optimal Power Solutions
Sunderbans Village Microgrid Project, West Bengal, India	West Bengal	120	Tata Power Solar
Dharnai Microgrid Project, Bihar, India	Bihar	100	Greenpeace India
KPCL Mandya Karnataka Microgrid Project, Karnataka	Karnataka	100	KPCL
Andaman Island Indian Coast Guard Microgrid Project, Andaman, India	Andaman	75	Optimal Power Solutions
Gram Oorja Microgrid Project,Jawhar Palghar, Maharashtra	Jawhar	38	Gram Oorja
Kalkeri Sangeet Vidyalaya Microgrid Project, Karnataka, India	Karnataka	14	SELCO

Source: EY Analysis

Benefits of Microgrids

Empowering consumers with microgrids can help DISCOMs operations in multiple ways. The below table highlights the benefits of implementing microgrids to distribution utilities as well as to consumers,

Distribution utilities	Consumers
▪ Promoting such systems among a larger consumer base can potentially eliminate the need to construct new network elements like distribution lines, transformers and feeders.	▪ Microgrids can bring in considerable savings to the consumers as well. First, monthly electricity bills are lower as grid consumption is reduced.
▪ As the generation and consumption points coincide, the transmission and distribution losses are lowered, improving efficiency.	▪ By exporting the excess Solar generation back to the grid, they gain financially.
▪ The self-generation by consumers reduces the quantum of power procured by the DISCOMs from the conventional power plants. Solar energy is clean and environmentally benign.	▪ Also, microgrids lasts as long as the system life, which could be up to 20 years. Finally, in the event of a power outage, these systems would continue to serve the consumers safely, by detaching from the network.

Key challenges

- **Business Case Visibility**: Since microgrids are a relatively new platform, they do not have strong financing opportunities and metrics. Companies often find it difficult to define a business case that demonstrates monetization of energy security and reliability benefits microgrids can provide
- **Lack of regulatory framework**: There are currently little or no regulations which define interconnection standards, safety requirements, rates for power purchased from microgrid, roles of the microgrid operators and the utilities, rate basing of microgrids capital expenditure, etc.
- **Limited technical expertise**: Microgrid eco-system is still in the nascent stage. As a result, local electricians often lack technical system expertise, which makes regular maintenance and fault repair difficult. Hence, system manufacturers find it difficult to service remote/developing communities
- **Issues during start-up of island mode:** During the initial stages of island mode start-up can cause a sudden intake of current which can affect the frequency of the system and voltages. This can cause the generators to trip and go offline during the initial phase. In order to combat this, an analysis is needed on energy generation methods during island mode and specialized controls need to be developed that are suitable for microgrid operations.
- **Balancing between generation and load in island mode:** This is one of the most common challenges faced by microgrids. The balance between load and power generation needs to be constantly maintained. Sudden or large change in loads can introduce instability into the island system.
- **Feeder design for microgrids:** This is the most important challenge that needs to be overcome. Throughout the history of energy generation feeders have been engineered for typical grids which require a strong source. As microgrids are gaining popularity there seems to be lack of availability in suitable feeders that go with current microgrid designs.

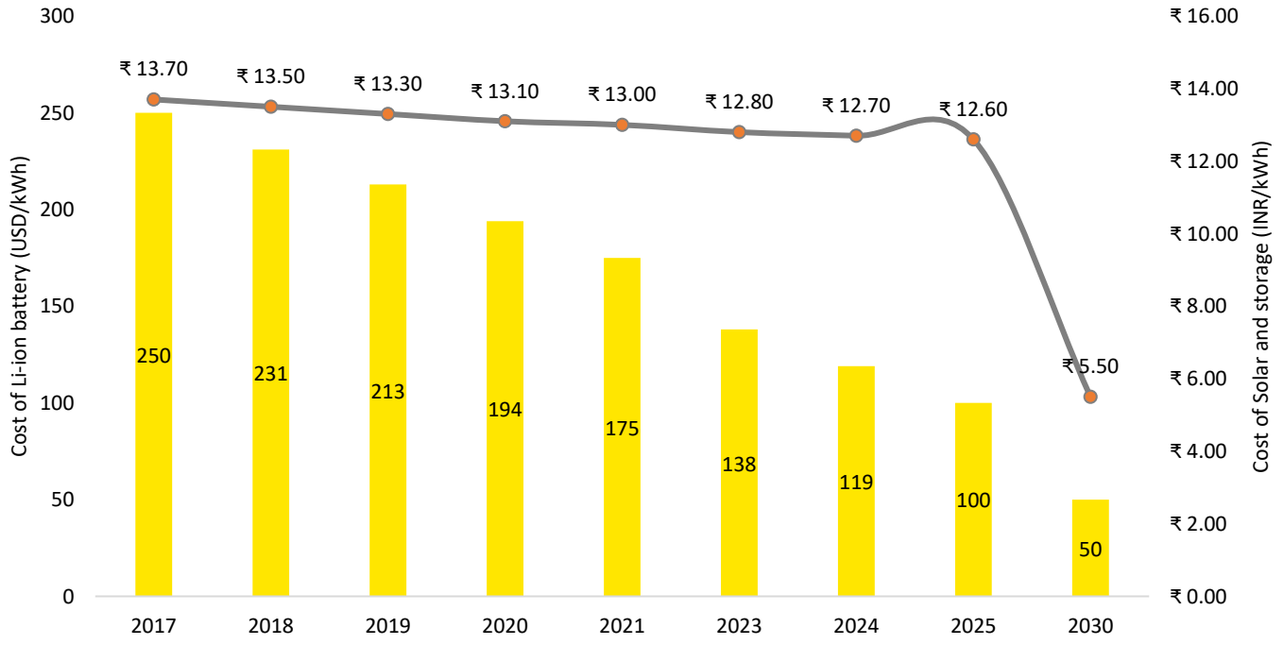
b. Energy Storage

The next phase of energy transition driven by the large-scale deployment of Variable Renewable Energy Sources (VRES) like Solar and Wind power can be fully realized by key technologies of Energy Storage. The grid integration challenges of the intermittent generation sources, ensuring quality supply on real time basis along with the capability to store electricity over different time horizons can be achieved by the storage. Many grid scale storage systems are commercially available worldwide which includes Pumped storage, Battery storage etc.

- **Battery Storage**

Battery storage is a technology that can enhance power system flexibility and enable high levels of renewable energy integration. A battery energy storage system (BESS) is an electrochemical device that charges (or collects energy) from the grid or a power plant and then discharges that energy at a later time to provide electricity or other grid services when needed. Several battery storage options are available under grid-scale applications, including lithium-ion, lead-acid etc.

The below graph represents the forecasted cost of lithium batteries and cost of solar and storage till 2030



Source: EY Analysis

- **Pumped Storage**

Pumped storage is one of the most cost-effective utility-scale options for grid energy storage, acting as a key provider of what is known as ancillary services. Ancillary services include network frequency control and reserve generation – ways of balancing electricity across a large grid system. With an ability to respond almost instantaneously to changes in the amount of electricity running through the grid, pumped storage is an essential component of the nation's electricity network.

Benefits of Pumped Storage

- **Large-scale**: This is the attribute that pumped Hydro storage which is especially suited for long discharge durations for daily or even weekly energy storage applications.
- **Cost-effectiveness**: thanks to its lifetime and scale, pumped Hydro storage brings among the lowest cost of storage that currently exist.
- **Mature technology**: for decades, pumped Hydro storage has offered a cost-effective way to provide large-scale balancing and grid services, with predictable cost and performance. New Hydro storage technologies, such as variable speed, now give plant owners even more flexibility, output, efficiency, reliability and availability.

- **Hydrogen**

Hydrogen energy storage is a process wherein the surplus of energy created by renewables during low energy demand periods is used to power electrolysis, a process in which an electrical current is passed through a chemical solution in order to separate hydrogen. Once hydrogen is created through electrolysis it can be used in stationary fuel cells, for power generation.

Hydrogen fuel cells, which generate electricity by combining hydrogen and oxygen, have appealing characteristics: they are reliable with high energy density, and release no emissions (when running on pure Hydrogen, their only byproduct is water).

Benefits of Hydrogen Storage

Hydrogen fuel can be stored for long periods of time, and in quantities only limited by the size of storage facilities.

Hydrogen energy storage has proven its merit beyond the lab through real-world projects

In Europe many hydrogen energy storage projects have been created, such as the Energiepark Mainz in Germany. The Energiepark uses excess Wind energy to create hydrogen fuel, which is later used to generate energy when Wind power cannot match demand.

In 2018 Enbridge Gas Distribution opened North America's first multi-megawatt power-to-gas facility using renewably-sourced Hydrogen, the 2.5 MW Markham Energy Storage Facility in Ontario, Canada. The facility is currently providing grid regulation services under contract to the Independent Electricity System Operator of Ontario.

Initiatives taken for Energy storage

- Mar’19: National Mission on Transformative Mobility and Battery Storage
- Mar’19: Subsidy allocation - FAME II: Faster Adoption and Manufacturing of Electric Vehicles
- Several corporates (such as Tata Chemicals Limited, BHEL, SUZUKI & Toyota, and Adani) have announced their interest publicly to enter Li-ion battery manufacturing to gain the first-mover advantage in the Indian ecosystem.
- Various state governments are providing strong support measures to encourage the battery manufacturing market such as Capex Subsidy
- Several states have also set targets for Battery Manufacturing capacity such as in UP its 2 GWh, Karnataka is 5 GWh, Andhra Pradesh is 10 GWh

Future Scope for Energy Storage

- According to IEA, global utility-scale battery storage capacity is set for a 20-fold increase between 2019 and 2030, with 130 GW of installed batteries globally projected by 2030. The largest market is India, where batteries absorb peak output from Solar during the day, store it for several hours, and then discharge it to help meet electricity evening demand peaks.
- India will become the largest market for utility-scale battery storage by 2040 as its investment in Solar PV expands rapidly.
- Though India's energy storage market is at a nascent stage, it is expected to grow upwards of 2 TWh by the year 2030.
- While battery storage poses a threat of load defection, new value-creation opportunities can outweigh the threats. Energy storage will create new market opportunities including:
    - Schedulable energy (RE) markets: Peal power, Firm power (which is schedulable and dispatchable)
    - Storage markets

Challenges

- **Demand risk:** Government schemes like FAME I & II have helped to create an emerging market for energy storage solutions, but more policy interventions are required to unlock demand across all applications.
- **Low mineral reserves:** India does not have reserves of some of the most important Li-ion components including lithium, cobalt, and nickel, nor, for that matter, of the copper used in conductors, cables, and busbars.
- **Maintenance requirements and performance of battery system:** Batteries require regular maintenance and replacement after every few years.
- **Lack of cost-effective cell manufacturing know-how:** Cell manufacturing contributes to about 30% - 40% of the cost of the battery. International partnerships will be needed for cell manufacturing
- Cost of battery technologies: Consumers and Solar installers in the Solar photovoltaic segment is highly cost-sensitive. The backup system (batteries) could increase the upfront cost of a Solar system by up to 50% along with additional maintenance and replacement cost associated with batteries.

c. Energy Efficiency

Energy efficiency simply means using less energy to perform the same task – that is, eliminating energy waste. Energy efficiency brings a variety of benefits: reducing demand for energy imports, and lowering our costs on a household and economy-wide level. The Government of India (GOI) has been taking efforts to efficiently use energy on the demand side through various innovative policy measures under the overall ambit of the Energy Conservation Act 2001.

Key Initiatives
National Mission for Enhanced Energy Efficiency (NMEEE)
Promotion of Energy Efficient LED Bulbs – UJALA scheme
Energy Conservation Building Codes (ECBC)
Energy efficiency in Small and Medium scale Industries (SME)
Demand Side Management
Energy efficiency in Small and Medium scale Industries (SME)
Demand Side Management

d. Decarbonisation

Decarbonization refers to the process of reducing carbon emissions into the atmosphere to limit global warming to below 2°C above the pre-industrialized level in response to the ambition of the 2015 Paris Agreement. Hence, many companies across all industries (e.g., in energy, transport, and consumer products) have publicly declared their intention to become carbon neutral by 2050.

Decarbonization will require a fundamentally different energy system, by using alternative energy sources based on green electricity and green molecules (such as biofuels and hydrogen). Some of the technical aspects identified to decarbonize the power sector are listed below,

Technology aspects	Description
Hydrogen	► **Initiatives taken for Hydrogen** National Hydrogen Mission : ▪ The Mission aims to aid the government in meeting its climate targets and making India a green hydrogen hub. This will help in meeting the target of production of 5 million tonnes of Green hydrogen by 2030 and the related development of renewable energy capacity. ▪ Hydrogen and Ammonia are envisaged to be the future fuels to replace fossil fuels. Production of these fuels by using power from renewable energy termed green hydrogen and green ammonia is one of the major requirements for the environmentally sustainable energy security of the nation. ▪ Government of India is taking various measures to facilitate the transition from fossil fuel/fossil fuel-based feedstocks to green Hydrogen / green ammonia. The notification of this policy is one of the major steps in this endeavour.

Technology aspects	Description
Digital Twins	► It is a digital representation of a real-world physical object, process, or service that uses real-time data flows and machine learning to evaluate a physical object not only today but also in the future. ► This technology can also be used to make construction and building operations more efficient and sustainable, in addition to reducing energy consumption. The technology could be susceptible to cyber attacks as well as data quality and interoperability issues. Its initial costs and maintenance are also high.
High-Efficiency Heat Pumps	► In a heat pump, heat is extracted from the air or ground and transferred either outdoors to cool buildings or indoors for heating. ► This decarbonization technology allows for a huge annual carbon footprint reduction. In order to properly maintain a building's temperature, installing heat pumps is one of the most important things to consider.
Smart digitisation	► In the case of smart grids, technology is used to enhance the communication, automation, and connectivity of various bits and pieces of the energy grid. ► Smart meters are used to collect data on energy use and help power plants better anticipate and respond to peak demand periods. As a result of smart grids, it is possible to integrate large-scale renewable energy systems, thereby reducing the overall CO2 emissions of the electricity grid.
Vehicle to Grid Technologies (V2G) for Electric Vehicles (EVs)	► A V2G enables EV batteries to be recharged and discharged into a power grid, thereby converting them into storage units for wider use across an energy grid. Decarbonization technologies such as V2G could create an additional revenue stream for owners of electric fleets, incentivizing them to go electric. ► Due to the increasing prevalence of renewable energy sources, balancing supply and demand has become more difficult. Some of these sources cannot be controlled by suppliers, but are dependent on weather patterns (Wind, sunshine etc.). Storage becomes more crucial in this context. At peak times when energy demand is high, energy from a fully charged cars battery could be fed into the grid to support grid balancing and reduce the grid's reliance on carbon-intensive sources of energy. Cars would be charged when there is a low demand or when green energy production exceeds demand due to excess production.

All these decarbonisation technologies or green technologies have a strong potential to reduce the carbon footprint from a large margin.

Furthermore, there are some additional benefits as well such as clean air, low energy bills, less commuting cost and new job opportunities.

All these technologies require awareness and more than that they need regulatory, policy and financial incentives.

Palli enters history as India's first 'carbon neutral panchayat', PM inaugurates 500 KV Solar plant

The nondescript hamlet of Palli in Jammu and Kashmir's border district of Samba entered into the 'modern history' of India becoming country's first "carbon neutral panchayat" with PM Narendra Modi dedicating to the nation 500 KV Solar plant & was installed in a record time of 3 weeks

In all 1,500 Solar panels put up on the total area of 6,408 square metres was provided with clean electricity to 340 houses in the model panchayat under the central government's 'Gram Urja Swaraj' programme.

The local people term this day as the “red letter day" in the India’s modern history of development and transformation.

From the macadamised roads to the recently launched electric bus service, the village located just 17 kms from the winter capital Jammu has witnessed a major transformation with an upgraded Panchayat Ghar, renovated government high school building, a new pond and improved playfields.

The project was completed at a cost of Rs 2.75 crore in a record time and the generated electricity will be distributed to the village, having a daily requirement of 2,000 units, through the local power grid station.

Key highlights

1

First carbon neutral panchayat in India. Palli has shown the way to the country for achieving carbon neutral state.

2

Outcomes

- ✓ Provision of clean electricity through Solar power
- ✓ Implementation of electric bus service
- ✓ Provision of solar stoves across 450 houses.

3.4 Technology Intervention and its Impact

With the advent of COVID19 and nation wide-lockdown, a steep fall in consumption of electricity was observed in Commercial and Industrial power consumption. Gradually with easing of lockdown the Government of India ensured to bring back the economy and this was evident from its increase in peak demand from 183 GW in 2019-20 to 189 GW in 2020-21 and it is expected that it will reach to 200GW by 2021-22 (MoP).

Though such surge in peak demand is a good indicator of any economy, but the fact cannot be denied that to avail quality and reliable electricity it is very important to amalgamate the technologies which can revolutionize the whole power sector or overhaul the whole power sector in terms of supplying reliable power, in terms of improving metering and collection efficiency, reducing Aggregate Technical & Commercial Loss (AT&C) ,imparting better experience to consumer.

Further with government's policy on renewable energy wherein our future goals of RE integrating of 500 GW discussed in Glasgow Conference would drive the energy mix target of India's power sector. In this existing scenario a timely intervention of latest technologies would really help the sector in manoeuvring its success.

Technologies which can create difference in DISCOMs performance:

Supervisory Control and Data Acquisition (SCADA)	**About:** With the advent of Smart Grid, integration of SCADA systems will allow the utility to remotely monitor, supervise and control the electric network equipment's as a means of fulfilling reliability and desire efficiencies for the whole utility.	**Impact:** ▶ Automation through SCADA systems directly leads to increased reliability of power for the consumers and lower operating costs for the utility. ▶ Identifying any faults on the network ▶ Faster restoration of power in case of a breakdown.
Information and Communication Technology (ICT)	**About:** ICT has globally contributed significantly in the power reforms process, particularly in the areas of business process automation (BPA), revenue and commercial management, distribution system automation, consumer relationship management (CRM) and loss reduction measures	**Impact:** ▶ ICT will lead to capacity building, improving operational efficiency, AT&C loss reduction, improving metering, billing and commercial efficiency, energy accounting and to foster customer relations

Advance Metering Infrastructure (AMI)	**About:** AMI enables two-way communication meters reading electrical consumption at a higher frequency. This information can be processed in real-time and signals sent to manage demand and to understand the load patterns	**Impact:** ▶ Allows two-way communication ▶ Data collection & recording in an interval of 15/30/60 minutes ▶ Consumer payment option, ease in billing operation, ease in managing DSM ▶ Consumer Billing, consumer information system. Consumer data display, outage management, emergency demand response
Blockchain	**About:** Blockchain technology works on peer-to-peer networking wherein transactions is authorised by buyer and seller digital signature which authenticates the transaction and safeguards any information from getting tampered.	**Impact:** ▶ Eases the trading of renewable energy credit or certificates based on actual energy consumption. ▶ Easing of wholesale power trading by bypassing third party agencies. ▶ Enabling energy accounting, energy efficiency, real time grid integration, fast payments.
Artificial Intelligence /Machine Learning (AI/ML)	**About:** AI analyse data generated through IT/OT devices such as system metres, demand forecasting, Time of Day (ToD) tariff, renewable energy (RE) integration, and other predictive analyses., enabling DISCOMs to make informed decisions on loss reduction	**Impact:** AI/ML can help utilities by: ▶ Forecasting the energy load ▶ Optimizing Energy accounting efficiency ▶ Improving transmission and distribution processes ▶ Supporting demand management ▶ Enhancing maintenance tasks ▶ Transforming the customer experience ▶ Asset Health Condition

Cyber Security	**About:** Cyber Security is the practice of safeguarding network ,server, electronic system and data from malicious attack. Categories: a) Network Security b) Application Security c) Information Security d) Operational Security e) Disaster Recovery and business continuity	**Impact:** ▶ Secures complex system like SCADA, PLC and other control systems of power plant. ▶ Robustness of grid security ▶ Secures communication system ▶ Securing controlling devices ▶ Securing Data Management Devices
Data Analytics	**About:** Cyber Security is the practice of safeguarding network ,server, electronic system and data from malicious attack. Categories: a) Network Security b) Application Security c) Information Security d) Operational Security e) Disaster Recovery and business continuity	**Impact:** ▶ Analytics for strategic &planning ▶ Optimising operations & managing assets. ▶ Reducing operational costs and improving the customer experience ▶ Demand Forecasting and Power portfolio analytics ▶ Consumer data insights (peer-to-peer comparison, consumption & optimization in TOD billing regime)

Past incident of Cyber Attack

- The incident of 'Sandworm' cyber attack conducted by the Russian intelligence in Pennsylvania in October 2020, and the malicious Stuxnet computer worm that was a malicious enough to target SCADA, PLC and other control systems of power plant operations due to the prevalence of an open system in the plant.
- Attack on Ukraine's electricity grid in the year 2015, which was a major security breach in the power and utility sector. As a result of this attack, a total of 30 electricity substations were deactivated and nearly 230,000 people were left with no supply of electricity for up to six hours. Such events rarely illustrate the scale and extent of the problem of cyberattacks in the power and utility sector.
- As per the International Energy Agency (IEA), due to the security concerns, details of other threats and cybersecurity breaches are rarely made public by the grid operators. In reality, as per the research conducted by Hornet Security, a German cloud security company, a total of 16% of all cyber attacks are being conducted on the power and utility sector all over the world.

Case Study: Power ledger

The Uttar Pradesh government has introduced blockchain technology to its rooftop Solar power segment and is the only state that has amended its regulatory framework to enable controlled peer-to-peer (P2P) energy trading in India.

The pilot project was implemented by India Smart Grid Forum (ISGF) and Power ledger, and hosted by state power utility Uttar Pradesh Power Corporation Limited (UPPCL) and Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA)

The pilot project has demonstrated the feasibility of Power ledger's platform to trade energy from rooftops with Solar power to neighbouring households/buildings.

Findings

- Power ledger's blockchain-enabled platform was utilized to record transactions.

The implementation of Power ledger's xGrid technology has led to the energy market buy price to be 43% lower than the retail tariff, further incentivizing the uptake of distributed energy resources.

- With the national aim to increase Solar energy by 1,000% until 2022,Powerledger worked to provide valuable opportunities to UPPCL to learn how best to implement all aspects of our blockchain-enabled P2P electricity trading platform

- Through this pilot project, Power ledger has been able to define the network tariff that will support the wider rollout of P2P electricity trading across the state.

As a result, UPPCL was able to understand the impacts that P2P trading has on the electricity distribution network.

- Following the successful pilot led by Power ledger, the Uttar Pradesh Electricity Regulatory Commission (UPERC) issued a tariff order, directing all the utilities in the state of UP to implement P2P energy trading.

In achieving this, affordable electricity can be distributed to the unelectrified population, usually rural parts of the state, improving the economic welfare for the citizens of UP.

Key highlights

1

First Peer to peer blockchain trial in India, in the state of Uttar Pradesh

2

43 % lower than the retail tariff for peer to peer market buy price

3

Why?

To demonstrate the feasibility of Power ledger's platform to trade energy from rooftops with solar power to neighbouring households/buildings

Case Study: Anti-Theft Technology in Brazil

Ampla, an electric power distribution subsidiary of Brazil's Enel Group, an IFC client, operates in 66 municipalities of the State of Rio de Janeiro and serves nearly seven million inhabitants and 2.5 million customers.

It is one of the largest power distributors in Brazil, responsible for 2.5 percent of the nation's energy turnover and 27.8 percent of the state's.

It serves an area of 32,608 square kilometres, some 73.3 percent of the state territory.

The Ampla market has a residential profile, with 80 percent of its clients in low-density, high-complexity areas.

Ampla has long been plagued by loss of power due to fraud and theft, with more than half of it concentrated in five municipalities, all of which are populous favelas with high rates of urban violence and drug trafficking.

The high rate of non-technical losses (i.e., via theft) damages the quality of Ampla's services, the safety of the population, and also pushes national energy production above levels needed by the market and the formal economy, causing waste.

To address these theft and power-loss issues, Ampla deployed an Anti-Theft Machine Project for medium voltage customers.

The system gathers all the elements of power use measurement through digital meters into a single device that connects to Ampla through a remote management system using cellular communication networks.

The devices are intelligent modules with diverse functionalities, and once a day, they transmit accurate consumption information to Ampla for efficient remote management of supplies, disruptions, and reactivations.

Artificial intelligence is used in the control centre to identify unusual patterns relative to customer profiles located in similar areas.

This data is also used to anticipate consumer behaviour and predict which customers are likely to have informal connections to the power grid.

This information can then be used to curb such connections and cut waste. Brazilian business magazine Exame named Ampla's antitheft system one of the top ten innovations of the last decade in Brazilian industry.

Key highlights

1

Ampla, one of the largest power distributors in Brazil, has long been plagued by loss of power due to fraud and theft

2

How?

- ✓ Ampla deployed an Anti-Theft Machine Project for medium voltage customers, to gather information through digital meters
- ✓ AI is used in the control center to identify unusual patterns relative to customer profiles

3

One of the top ten innovations of the last decade in Brazilian industry.

3.5 Effect of the reliable power sector on economic growth

A reliable power supply is essential for the growth of industries and businesses, which in turn drives economic growth. States that have surplus power need to ensure that this power is being utilized effectively to encourage industrial investments and create employment opportunities

Linking 24 x 7 power supply can have a significant impact on industrial investments and employment opportunities. With uninterrupted electricity supply, industries can operate round-the-clock, leading to increased production and higher profits. This, in turn, attracts more investments as industries become more profitable and attractive to investors. Additionally, the availability of continuous power supply ensures that there are no delays or disruptions in the production process, which could lead to missed deadlines and loss of contracts for local communities and contributes towards economic growth.

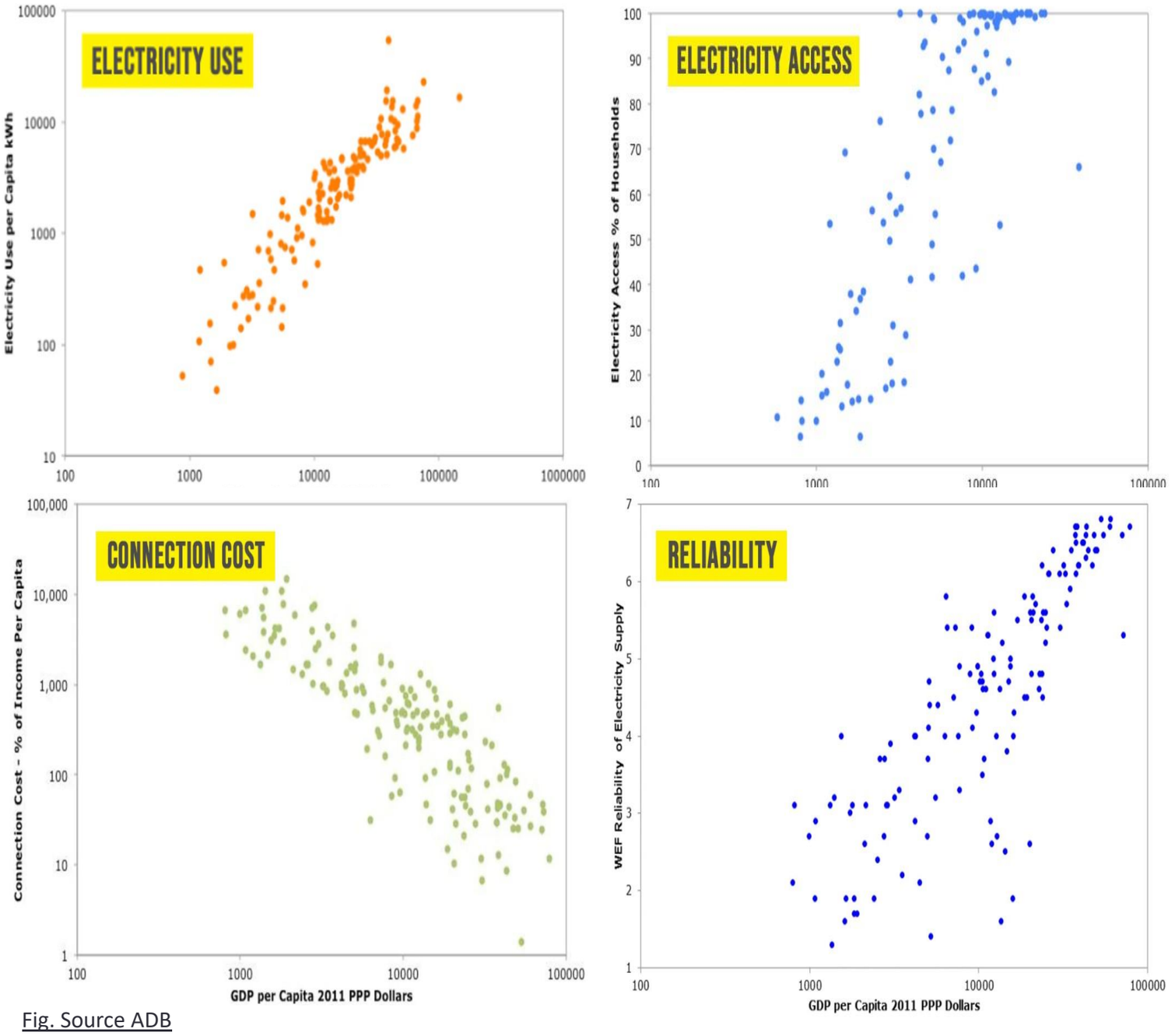


Fig. Source ADB

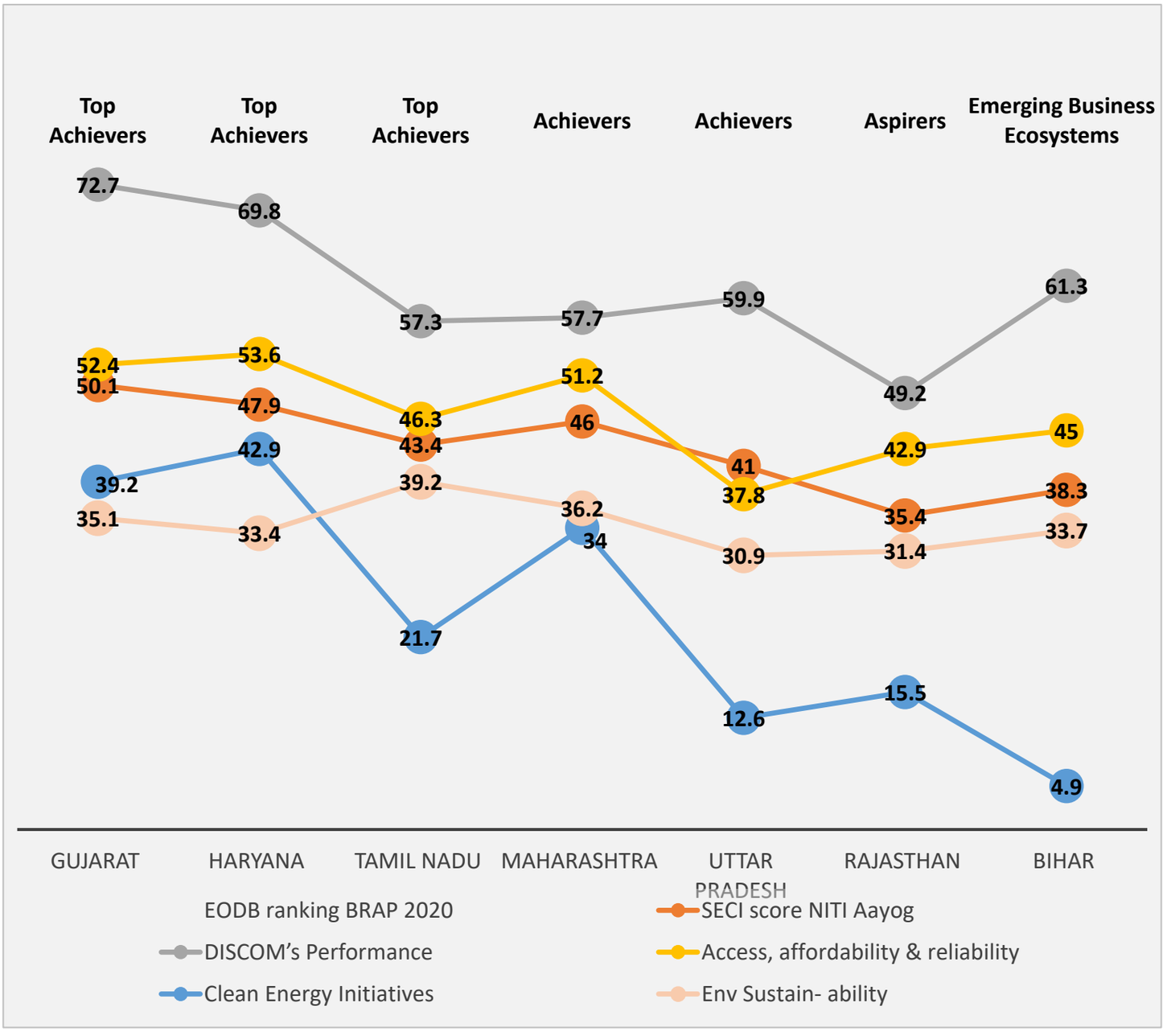
The above regression graph is from the research paper "The Impact of Electricity on Economic Development: A Macroeconomic Perspective" David I. Stern, Paul J. Burke & Stephan B. Bruns." shows the relationship between GDP vs Electricity consumption, electricity access, reliability of power & cost of connection. It is clear that higher levels of GDP are correlated with greater electricity use, access, reliability, and affordability

Relationship between EoDB ranking & reliable power sector

The ease of doing business and reliable power sectorare two important factors that affect the economic development of Indian states.

The ease of doing business refers to the regulatory environment for businesses in a particular state. It includes factors such as the number of procedures required to start a business, the time it takes to get a construction permit, and the cost of doing business.

There is a positive correlation between the ease of doing business and reliable power in Indian states. States with a better business environment tend to have higher rates of electricity access. This is likely because businesses are more likely to invest in states where it is easy to do business, and this investment can lead to increased electricity demand



The above graph shows the EoDB ranking of states with various aspect of the reliable power sector & it is very clear that EoDB ranking have a correlation between DISCOMs performance, access, affordability & reliability of electricity.

3.6 Performance of leading DISCOMs

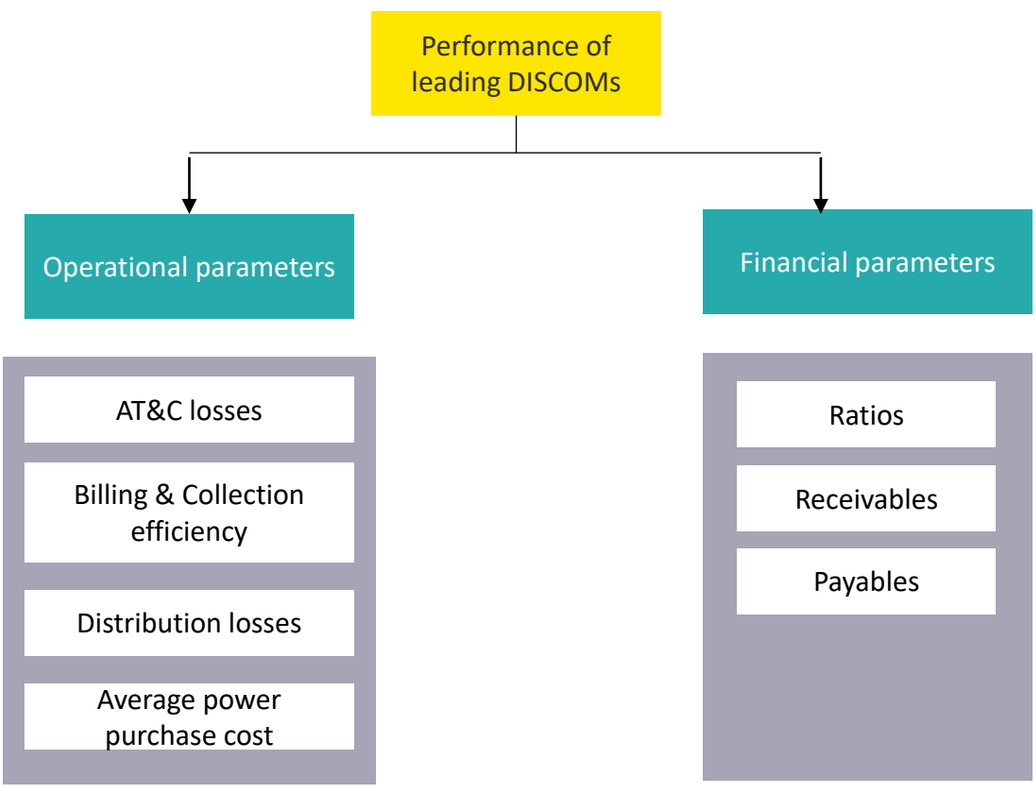
The Ministry of Power in its Ninth Annual Integrated Ratings of State Power Distribution Utilities report FY 20, released in July 2021 provides the details of operational and financial health of the distribution Utilities. This rating exercise was done on an annual basis covering all State owned distribution utilities. The rating covered 41 State owned distribution utilities spread across 22 States.

The objective of the integrated rating is to rate all utilities in power distribution sector on the basis of their performance and their ability to sustain the performance level. In our study, to analyse the performance of DISCOMs, we are considering the top five performers as mentioned below,

Rank	Name of Utility	State
1	Uttar Gujarat Vij Company Limited	Gujarat
2	Madhya Gujarat Vij Company Limited	Gujarat
3	Dakshin Gujarat Vij Company Limited	Gujarat
4	Paschim Gujarat Vij Company Limited	Gujarat
5	Dakshin Haryana Bijli Vitran Nigam Limited	Haryana

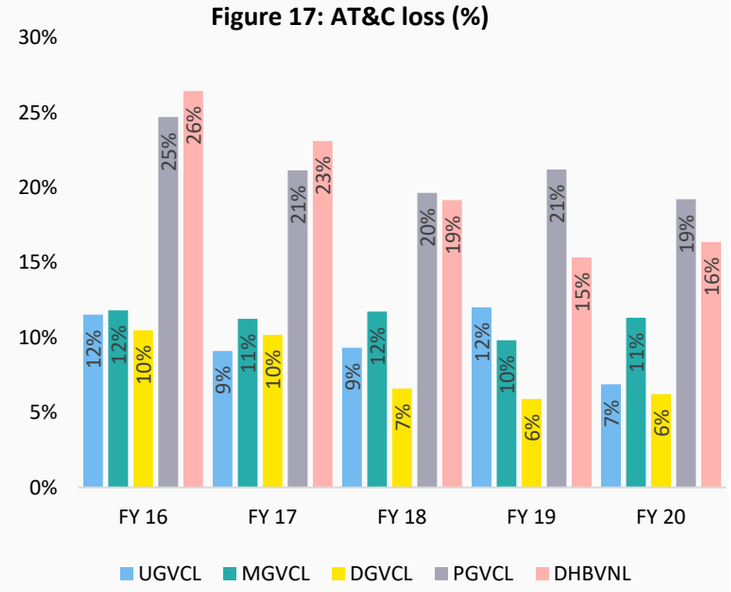
Source : PFC

The performance of the DISCOMs are assessed based on three different parameters as mentioned below,



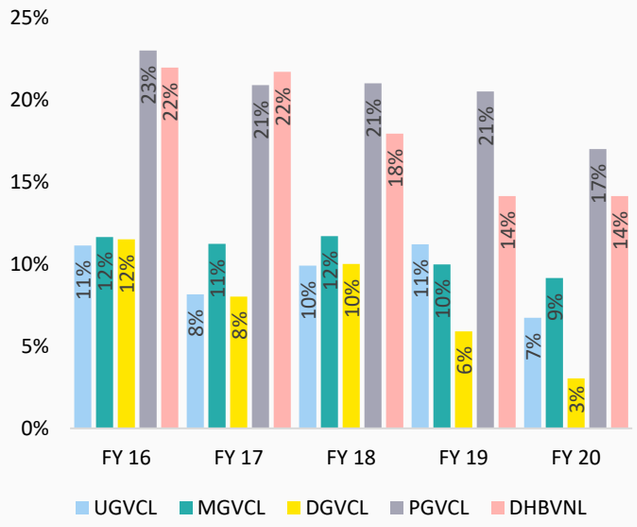
1. Operational parameters

Figure 17: AT&C loss (%)



From the above graph, it can be inferred that the DISCOMs have successfully lowered their AT&C losses since FY 16. Especially, PGVCL and DHBVNL have drastically reduced their loss level from 25% and 26% to 19% and 16% respectively since FY 16. This level of AT&C losses can be compared with the national average AT&C loss of ~21% for FY 20 (PFC).

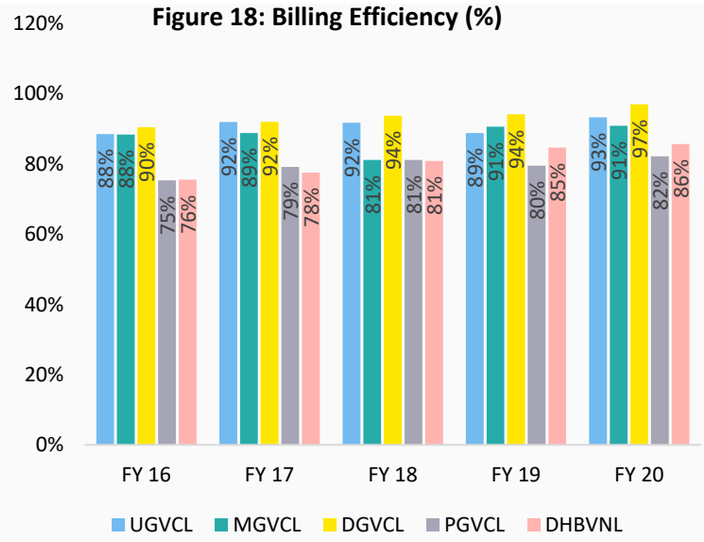
Figure 18: Distribution Losses (%)



From the above graph, it can be inferred that the DISCOMs have successfully lowered their T&D losses since FY 16. Especially, PGVCL and DHBVNL have drastically reduced their loss level from 23% and 22% to 17% and 14% respectively since FY 16. This level of T&D losses can be compared with the national average T&D loss of ~18% for FY 20 (19th EPS).

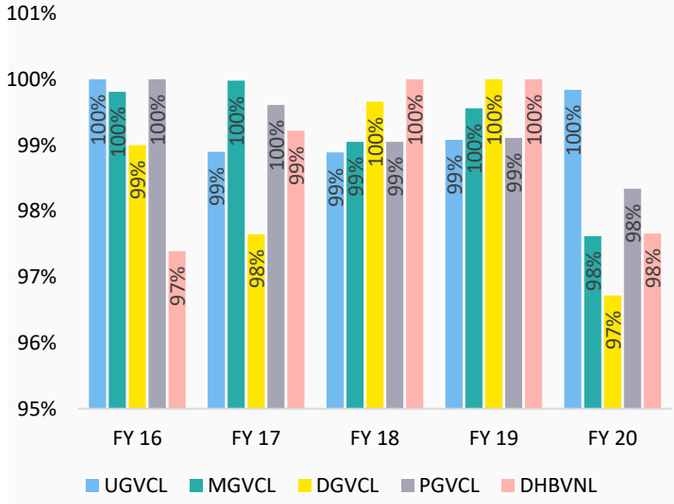
Source: PFC

Figure 18: Billing Efficiency (%)



From the above graph, it can be inferred that the billing efficiency for these five DISCOMs is increasing on a year-on-year basis. If we consider UGVCL and MGVCL, both DISCOMs have maintained a billing efficiency of ~92%. Similarly, we consider DGVCL, it shows a linear growth from 90% to 97% since FY 16. Similarly, for DHBVNL, the billing efficiency has reached 86% from 76% in FY 16. If we compare the performance of these DISCOMs, it is found that they are way ahead of the national average billing efficiency of ~85%.

Figure 19: Collection Efficiency (%)

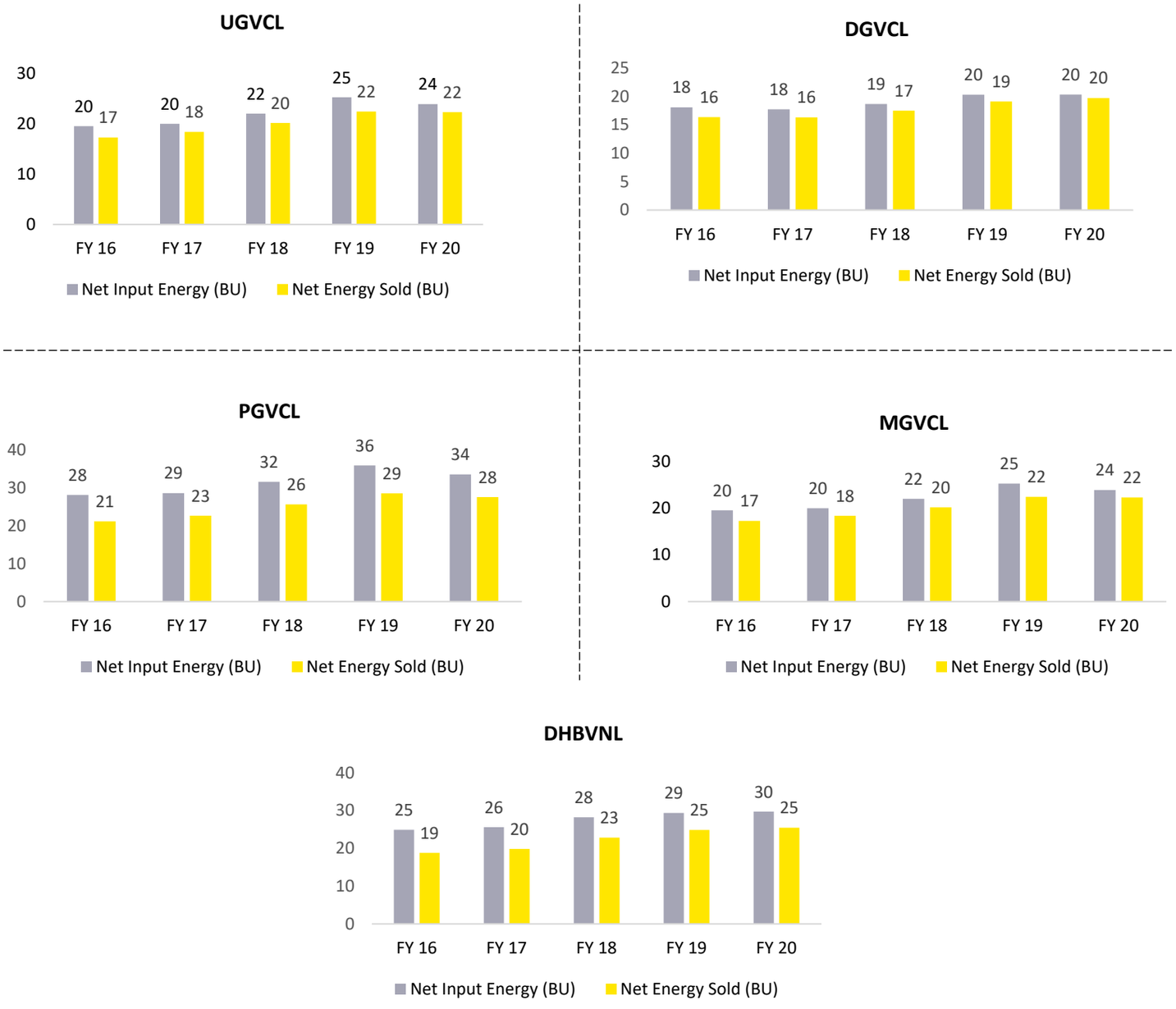


From the above graph, it can be inferred that the collection efficiency for these five DISCOMs has reached almost 100% efficiency.

If we compare the performance of these DISCOMs, it is found that they are way ahead of the national average collection efficiency of ~93%.

Source: PFC

Figure 20: Net Input Energy (BU) vs Net Energy Sold (BU)



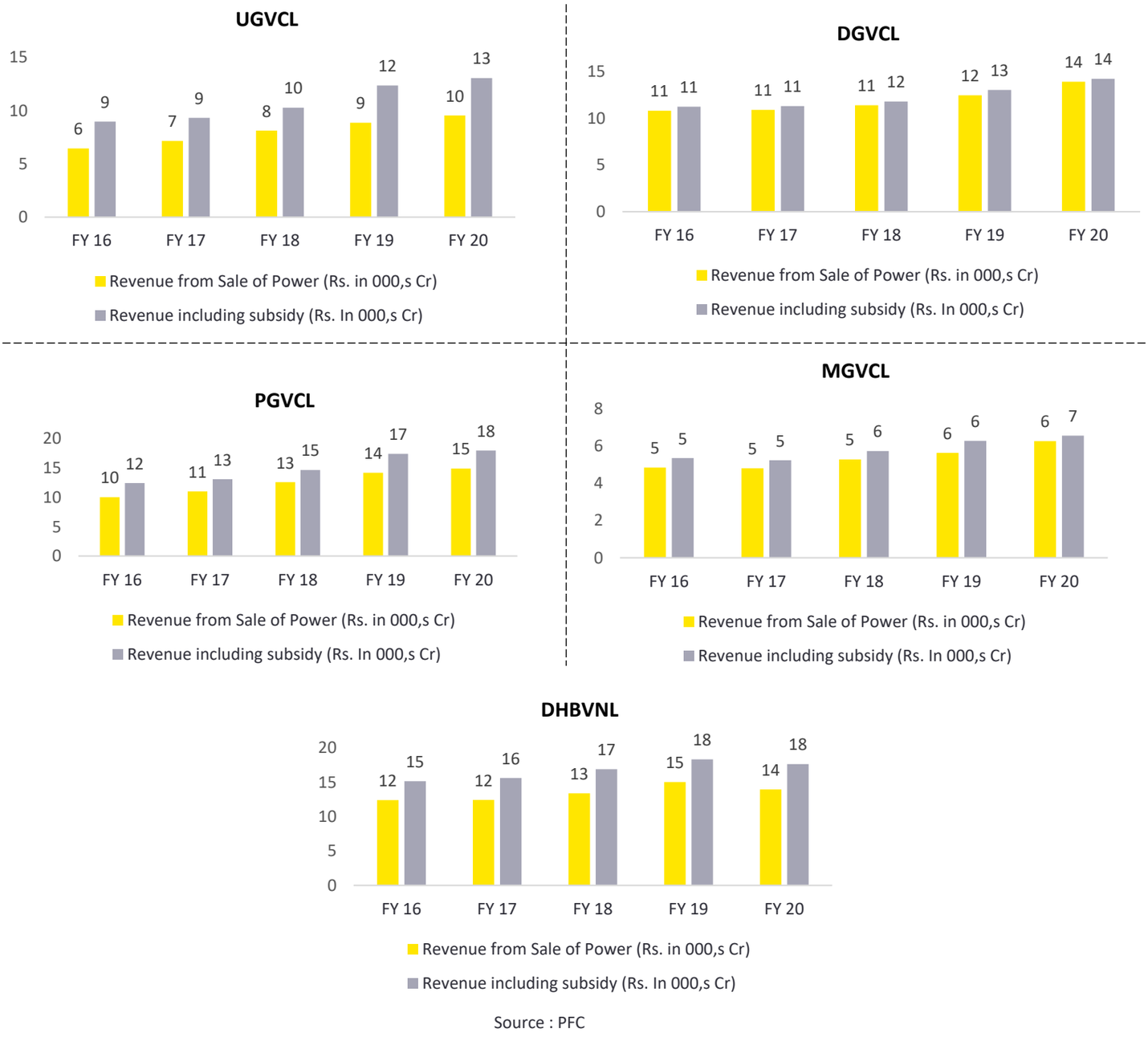
Source : PFC

From the above cumulative graph, it can be inferred that there is a disparity in net energy input and net energy sold to the consumers from FY 16 to FY 20. This disparity is basically an overview of the transmission loss and to a marginal extent of AT&C losses. This inference can be directly linked to our analyzation on AT&C and Distribution loss plus the rate of billing and collection efficiency.

As all operational parameters mentioned above, are under the limits set by different schemes and policies, hence these DISCOMs are performing well even after incurring minimal losses.

2. Financial parameters

Figure 21: Revenue from Sale of Power vs Revenue including subsidy (Rs. in 000's Cr)



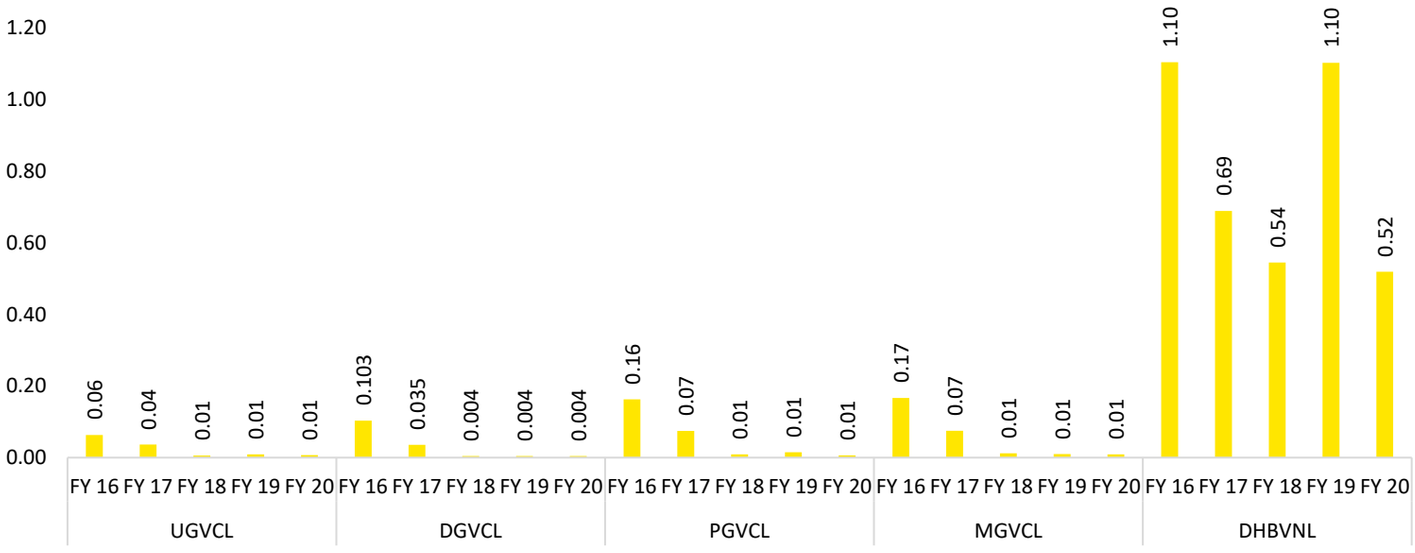
Source : PFC

From the above cumulative graphs for all the DISCOMs mentioned above, it can be inferred that the there is a continuous rise in the revenue from the Sale of power and subsidy is also increasing with minimal gap between revenue from sale and revenue from subsidy. Hence, it clearly indicates that the cash flow to GENCOs and DISCOMs are realised and it is successfully offsetting any payment delays which we can infer from the payment and receivables graph.

Debt Equity Ratio

The debt-to-equity (D/E) ratio can be used to evaluate a DISCOMs's financial leverage and is calculated by dividing a DISCOMs's total borrowings by its net worth. The D/E ratio is an important metric used in power finance.

Figure 22: Debt Equity Ratio



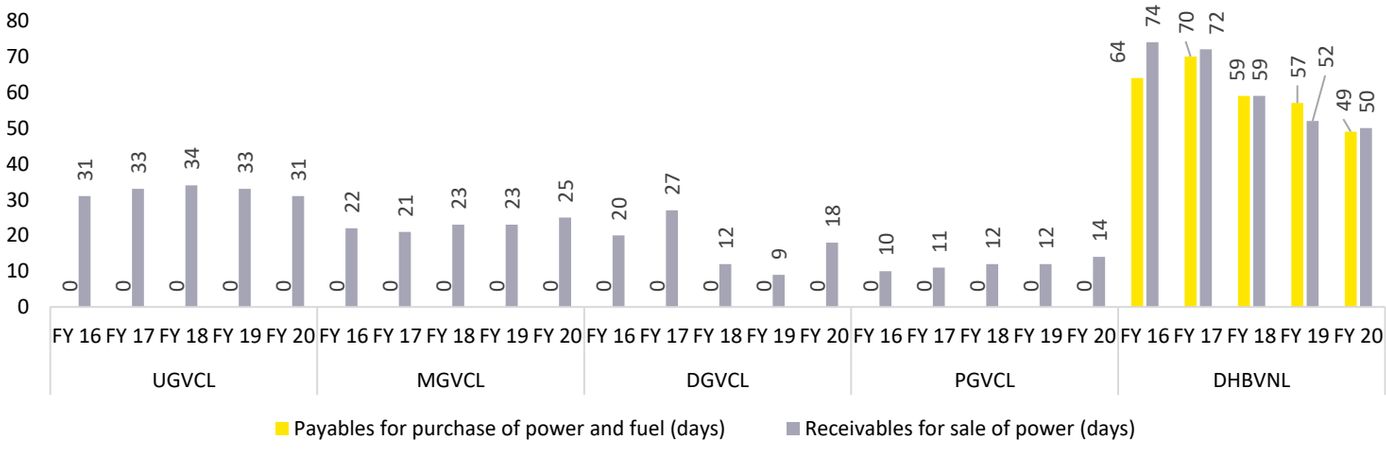
Source : PFC

From the above graph, it can be inferred that the top 5 DISCOMs have maintained low debt equity ratio which indicates these DISCOMs are subjected to low potential risk.

Payables vs Receivables

Payable days indicates the average time that a DISCOMs takes to pay for its purchase of power to GENCOs. Receivable days indicates the average time that a DISCOMs takes to receive payment for sale of power from consumers. Payables and Receivable days are very crucial for timely cashflow within the value chain of power sector.

Figure 23: Payables vs Receivables



Source : PFC

As we can see from the graph, that the payables and receivable days for these five DISCOMs are much below than the average payable and receivable days of 165 and 148 respectively for FY 20.

Due to this, working capital and capital investment is smoothly channelized.

Key highlights

- According to PFC report, Five out of the 41 DISCOMs under study secured the highest possible "A+" grade with an overall score of between 80 and 100 (on a scale of 100).
- The below table shows the top 5 leading performers in the distribution segment.

S No.	Name of the Utility	State	9 IR Grade	Billing Efficiency	AT&C loss	Collection Efficiency	Receivable days
1	Uttar Gujarat Vij Company Limited	Gujarat	A+	↑	↓	↑	↓
2	Madhya Gujarat Vij Company Limited	Gujarat	A+	↑	↓	↑	↓
3	Dakshin Gujarat Vij Company Limited	Gujarat	A+	↑	↓	↑	↓
4	Paschim Gujarat Vij Company Limited	Gujarat	A+	↑	↓	↑	↓
5	Dakshin Haryana Bijli Vitran Nigam Limited	Haryana	A+	↑	↓	↑	↓

- The "A+" grade indicates "very high operational and financial performance capability"
- All the four state DISCOMs of Gujarat secured "A+" grade. The only other DISCOMs to score this maximum grade was Dakshin Haryana Bijli Vitran Nigam Ltd.
- Uttar Gujarat Vij Company Ltd (UGVCL), the best-rated DISCOMs, had satisfactory AT&C losses of 6.88% in FY20.
- Payable days for all the four DISCOMs of Gujarat and DHBVNL are found to be zero and 49 respectively, which is quiet less than the average payable days of 148 (According to PFC report)
- Among key concerns included in the rating report was: "absolute subsidy dependence for the state remains high, given the subsidized nature of tariff particularly towards agricultural consumers."

3.7 Tariff Rationalization

As the Government of India seeks to transform the power sector, one crucial step that must be taken is tariff rationalisation. Tariff rationalisation refers to the process of restructuring electricity tariffs to ensure fairness, efficiency, and sustainability in the power sector. By aligning tariffs with the cost of generation, distribution, and transmission, tariff rationalisation can address the challenges faced by the power sector and promote its overall growth.

The Importance of Tariff Rationalisation in the Power Sector

Tariff rationalisation plays a vital role in ensuring the financial viability of the power sector. With a rationalised tariff structure, electricity consumers pay a fair price for the electricity they consume, while power companies receive adequate revenue to cover their costs and invest in infrastructure development. This balance is crucial to attract investments in the power sector, improve operational efficiency, and ensure a reliable power supply for consumers.

Moreover, tariff rationalisation encourages the efficient use of electricity. When tariffs are aligned with the cost of generation, consumers are incentivised to adopt energy-efficient practices and technologies. This not only reduces the overall demand for electricity but also contributes to environmental sustainability by lowering carbon emissions. Tariff rationalisation, therefore, promotes both economic and environmental benefits in the power sector.

Challenges Faced by the Power Sector regarding Tariff

The power sector in India faces several challenges that hinder its growth and efficiency. The current consumer tariff structure in India is extremely complex, with numerous categories and tariff slabs distributed across various states. Further, there is irregularity in the categorisation of certain consumer sections across states.One of the primary challenges is the issue of cross-subsidisation. Currently, industries and commercial consumers pay higher tariffs compared to residential consumers, which leads to a burden on their operational costs. This imbalance discourages industrial growth and investment, impacting the overall development of the power sector.

Possible Solutions

1

There is a need to conduct a comprehensive tariff study to assess the cost of generation, distribution, and transmission accurately. This study will provide the necessary data to determine the appropriate tariff structure that aligns with the actual costs incurred by power companies.

The government should consider phasing out cross-subsidisation gradually. By reducing the burden on industries and commercial consumers, it will encourage investment and promote industrial growth. This can be achieved by introducing time-of-day tariffs or demand-based tariffs that reflect the actual cost of supplying electricity during different periods of the day.

2

3

Feeder separation of Agriculture feeder-

As feeder separation activity is already in progress across India, the government should monitor the electricity consumption of Agriculture feeder precisely. As the agriculture sector are getting power at a supportive rate and State governments/ Discoms may rationalise their power procurement cost by resorting to Demand Side Management (DSM)

Benefits of Tariff Rationalization

Tariff rationalisation offers numerous benefits for both consumers and the power sector. For consumers, it ensures fair and transparent pricing, encouraging responsible consumption and reducing electricity bills. Additionally, tariff rationalisation promotes the adoption of energy-efficient technologies, enabling consumers to save on their energy costs in the long run.

For the power sector, tariff rationalisation ensures financial viability and promotes investment. With a rationalised tariff structure, power companies can cover their costs and generate profits, which can be reinvested in infrastructure development and capacity expansion. This leads to a more reliable power supply for consumers and creates opportunities for economic growth.

Case Studies of Other Countries that Have Implemented Successful Tariff Rationalisation Strategies

Several countries have successfully implemented tariff rationalisation strategies in their power sectors, providing valuable lessons for India. One such example is Germany, which introduced a feed-in tariff system to promote renewable energy generation. This system guarantees a fixed payment for electricity generated from renewable sources, incentivising investors and contributing to Germany's transition to a clean energy future.

Another case study is South Africa, which implemented tariff rationalisation to address the financial challenges faced by its power sector. By restructuring its tariff structure and implementing cost-reflective tariffs, South Africa improved the financial health of its power companies and attracted investments, leading to an expansion of its power generation capacity.

These case studies highlight the positive impact of tariff rationalisation on the power sector and provide valuable insights for the Government of India as it seeks to transform its own power sector.

Understanding The Tariff Affordability Ratio And Its Importance For Economically Weaker Cross-Sections In India's Electricity Sector

In India, providing affordable electricity to economically weaker sections of society is a key challenge for policymakers. One solution that has been proposed is the use of Direct Benefit Transfer (DBT) to mobilize subsidy administration. By working out a tariff affordability ratio in electricity, policymakers can quantify the level of subsidy needed to provide affordable electricity to low-income households. This can then be transferred directly to consumers via DBT, reducing leakages and ensuring that subsidies reach their intended beneficiaries

The use of DBT for electricity subsidies has already been implemented in some states in India with promising results, including reduced corruption and increased transparency. However, there are also concerns about the feasibility and accessibility of DBT for all households, particularly those in remote or marginalized areas. Policymakers must carefully consider these issues as they work towards making affordable electricity accessible to all in India

3.8 Understanding of cost reflective Tariff & linking it with LPS Rule

Cost reflective tariffs are a pricing structure used by utility companies to ensure that the cost of producing and distributing energy is reflected in the price charged to customers. The idea behind this system is that it provides an accurate reflection of the true costs, including generation, transmission, and distribution costs, as competition was introduced into these markets, there became a need for clearer pricing structures that accurately reflected the true costs involved.

The government has been subsidizing power tariffs for consumers in a bid to provide affordable electricity across the country. However, this approach has resulted in mounting losses for power distribution companies. To address this issue, it is essential to introduce cost-reflective tariffs that take into account the actual costs involved in generating and distributing electricity. This will help ensure that investors receive fair returns on their investments while also allowing distribution companies to operate profitably. While cost-reflective tariffs have helped provide more transparency in energy pricing structures, they still fall short in reflecting actual production costs if not properly implemented or linked with other regulations like Late Payment Surcharge rules.

How would linking cost reflective tariffs to Late Payment Surcharge rules work?

Linking cost-reflective tariffs to Late Payment Surcharge rules is a system that would work by ensuring that customers who pay their bills on time are rewarded with lower electricity rates than those who don't. The concept of cost reflective tariffs means setting the prices for electricity based on the actual costs of production, transmission, distribution, and supply.

By linking late payment surcharges to these tariffs, companies can encourage prompt payments while also discouraging wasteful energy practices which increase operating costs. This system benefits both parties since it encourages responsible usage behaviors and ensures timely bill payments.

This approach creates an ecosystem where consumers are incentivized to conserve energy while being assured of fair pricing based on actual costs incurred by utilities companies

What are the benefits of this system?

Linking cost reflective tariffs to late payment surcharge rules can have numerous benefits.

It incentivizes timely payments by customers. This would help in building willingness to pay in consumers & ultimately lead to a reduction in outstanding debts owed by customers and an increase in revenue for the service provider.

This system ensures that costs are allocated fairly among all customers based on their usage. It eliminates the possibility of some customers subsidizing others who fail to pay on time. Linking cost reflective tariffs to late payment surcharge rules promotes transparency and accountability. Customers are able to clearly see how their bills are calculated and understand why they may be subject to additional charges if they don't pay on time.

This system can also reduce administrative costs associated with managing overdue accounts as well as legal fees incurred when pursuing unpaid debts. Linking cost reflective tariffs to late payment surcharge rules can benefit both service providers and customers alike by promoting fairness, accountability, transparency and financial discipline.

LPS rule between DISCOMs & Generators.

Discoms are required to pay generators a late payment surcharge if they fail to make timely payments for the power supplied. This has led to an improvement in the payment cycle, ensuring that generators receive their dues on time.

Financial Burden Of New Infrastructure On Discoms

The introduction of new infrastructure has placed a significant financial burden on Discoms, and this is expected to have an impact on tariffs. The Discoms are required to pay for the new infrastructure that is being implemented, in addition to paying the generators due to LPS rules. This means that either state governments will have to raise tariffs massively or find a way to provide subsidies every time

Possible Solutions

1

One possible solution is for state governments to provide subsidies that can help discoms pay their dues to generators, as required by LPS rules, without having to raise tariffs drastically

Another option is for the government to fund new infrastructure projects that will help improve the efficiency of power transmission and distribution systems

2

3

Power procurement mix optimisation: There is considerable scope for a reduction in PPC if merit order despatch is followed strictly and the power market is used for optimisation of power procurement.

Aligning Investment With Cost Reflective Tariff

Aligning investment with cost reflective tariff is a crucial step towards achieving sustainable energy. The investment required for new coal, grid strengthening, or new renewables should reflect in the cost of electricity. This will ensure that consumers pay the true cost of generating and transmitting electricity, which will encourage efficient energy use.

A cost-reflective tariff will also provide a clear signal to investors about the economic viability of different energy projects.

Furthermore, aligning investment with cost-reflective tariffs can help reduce government subsidies for energy production and distribution as it will recover from tariff.

Overall, aligning investment with cost-reflective tariffs is an essential component of transitioning towards a sustainable energy future.

04

Linking sustainability to social benefit

AGRICULTURE

4.1 Analysing the Socio-economic impact of unreliable Power

Access to adequate as well as affordable power services is a necessity for the socio-economic development of any country. In a country like India where the major economic activity is agriculture, the supply of power, particularly to rural areas, is of great significance in accelerating growth. Agriculture plays a vital role in India's economic growth as ~54.6% of the total workforce is engaged in agricultural and allied sector activities and accounts for ~17.8% of the country's Gross Value Added (GVA) for the year FY 20 at current prices.

Electricity consumption is one of the most important indicators to achieve rapid economic growth and socio-economic development for any nation. The figure below provides the electricity consumption data for the Indian agriculture sector.

Figure 24: Electricity Consumption for Agricultural Purposes (in 000's GWh)

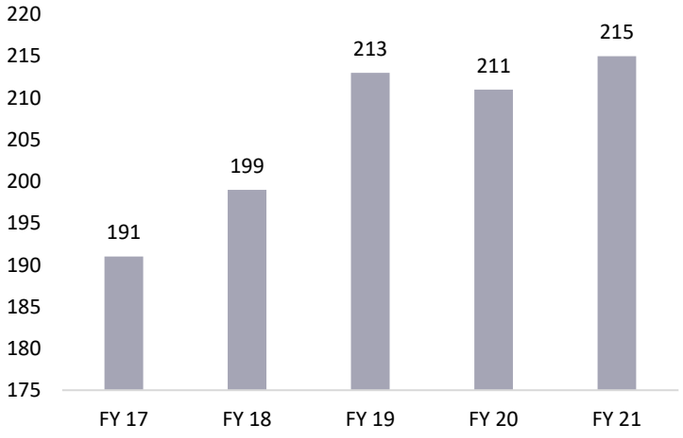
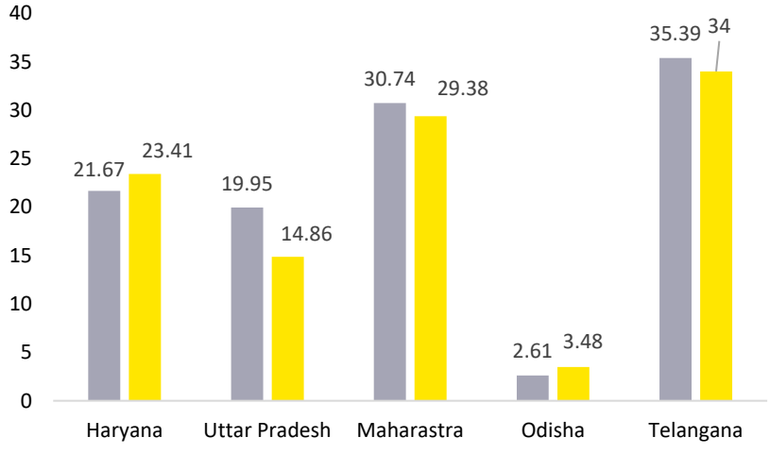


Figure 25: State-wise Consumption of Electricity for Agricultural Purposes (%)



Source: PFC

Electricity Consumption has been steadily growing since FY 17, but it can be observed from the above graph that there is a sudden slump during FY 20 due to the outbreak of COVID-19 which affected the primary sector of the Indian economy and the whole economy at large.

From Figure 39, it can be seen that agriculture consumption increased over the period of years, due to the reduction in the use of diesel pump sets, the rise in the agriculture connections, and also the increase in hours of supply to agriculture.

States with a large rural or agricultural consumer base such as Gujarat, Karnataka, and Maharashtra—have resorted to separating feeders for agricultural use from non-agricultural use. This measure has been adopted to regulate agricultural consumption and manage peak loads. It can be noticed that the states such as Haryana and Odisha have increased their electricity consumption due to the increase in the connected load.

a. Reliability of power supply help farmers in investing in electric pump sets thereby reducing the usage of diesel pump sets

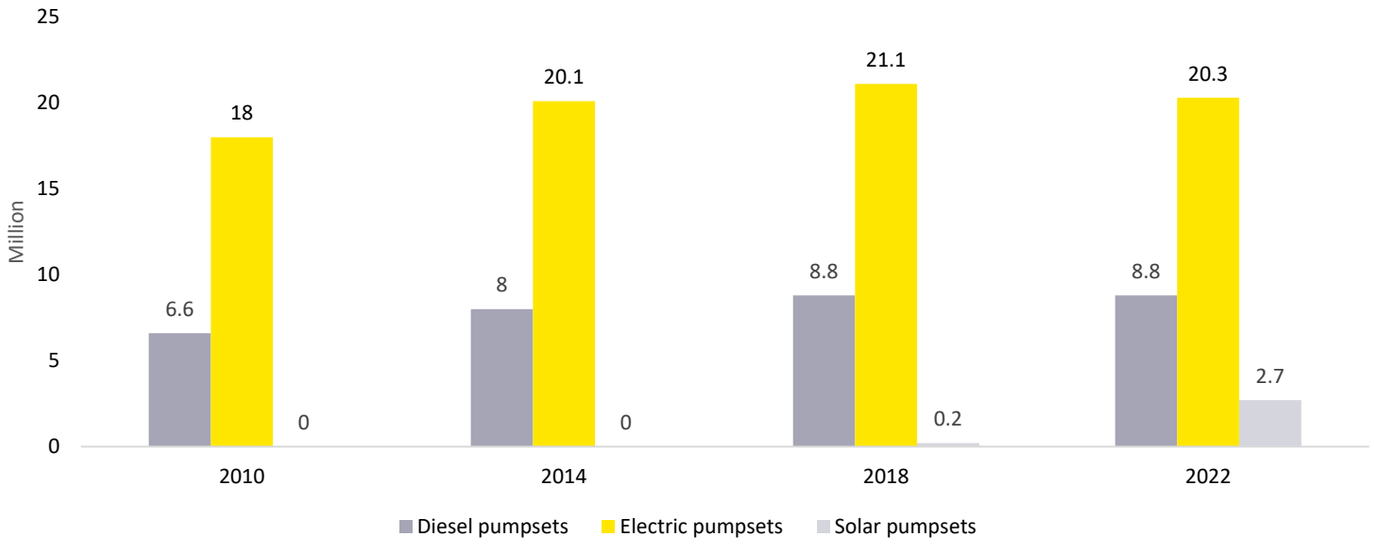
With the growing penetration of electric pumps, agricultural electricity consumption has doubled from 107 billion units (BU) in FY 09 to 215 billion units in 2021. Irrigation pumps account for a major share of electricity consumption in the agriculture sector in India.

As electricity networks extended to rural areas, irrigation pumps started running on electricity, along with diesel. As per the data released by MNRE, among the 3 crore agricultural pumps in India, about 80 lakh (26.5%) are diesel pumps and the remaining share is through electric and Solar pump sets.

Out of the total electric-powered wells and tube wells in states where electricity is the dominant source of irrigation, 4% use electricity and diesel conjunctively. The proportion is higher in states such as Haryana, Punjab, and Telangana. Owning and running both diesel and electricity pumps can be expensive because running diesel pumps is costlier than running electric pumps.

An overview of the Irrigation pump sets in India including the pump sets powered by diesel, electric, and Solar is described below.

Figure 26: Irrigation pumpsets in Agriculture



Source: IEA World Energy Outlook

At present, over 30 million agricultural pumps are installed in India, out of which nearly 8 million pumps are diesel-based and over 20 million grid-connected agriculture water pumps have been installed in the country with an annual addition of 0.25 to 0.5 million pump sets.

The number of farmers using diesel-powered pumps is high in villages located remotely or having minimal access to electricity. It can be observed that there is an increase in the use of Solar pumps among all agricultural irrigation pumps used in India since 2018. Further, it can also be observed that there is a minimal decrease in the use of electric pumps, while the share of diesel pumps has remained steady since 2010. The reasons for the slow uptake of Solar pumps in India are high capital costs as compared to traditional pumps and lack of awareness among farmers.

Farmers who had previously used diesel pumps no longer have to travel long distances to obtain and transport diesel fuel and are more insulated from market fluctuations. This has benefited farmers from respiratory health risks and reduced air pollution resulting from diesel pump operations.

Solar pumping systems are increasingly becoming a reliable, environmentally sustainable, and affordable alternative for irrigation to replace conventional diesel pumps.

Replacement of conventional diesel pumps with electric-powered pumps contributes to environmental conservation by reducing CO2 emissions (25.3 million tons from the replacement of 1 million diesel pumps, respectively).

Transitioning to electric pumps increased farmers' income due to the reduction in irrigation costs for diesel pump owners.

Other benefits of using electrical pumps include lower labor and maintenance requirements; ease of integration with digital control systems; and reduced environmental impact, such as emitting less noise.

For the government and the country as a whole, the economic impacts include subsidy savings on diesel and farm electricity, forex savings that can release the current account deficit, agricultural output increase, and development of relevant industry that brings job creation. Farmers can enjoy increased income at a minimum cost, through enhanced crop productivity, higher-value crops, and multiple cropping cycles.

Table 7: Understanding the Socio-economic impact of reliable supply of power in Agriculture

Benefits from replacing 1 million diesel pumps with Solar pumps		**Impacts**
Reduction of diesel use	9.4 billion litres of diesel use over life cycle of Solar pumps	Economic
Subsidy savings	USD 1.26 billion (INR 84 billion) in diesel subsidy savings over life cycle of Solar pumps	Economic
Emission reductions	25.3 million tons of CO2 emission abatement over life cycle of Solar pumps	Environmental
Foreign exchange savings and relief of current-account deficit	By reducing diesel imports, USD 300 million savings annually, USD 4.5 billion over pump life	Economic
Benefits from replacing 1 million electric pumps with Solar pumps		**Impacts**
Reduction of electricity use	Up to 2,600 million units of electricity, to relieve the overburdened old power grid	Economic & Environmental
Subsidy savings	USD 450-525 million (INR 30-35 billion) savings in farm power subsidies	Economic

Benefits to agricultural output from installing 1 million Solar pumps		Impacts
Improvement in crop yields	10% increase in crop yields or USD 300 million (INR 20 billion) annually, USD 4.5 billion (INR 300 billion) over the pump lifetimes	Economic
Other impacts of Solar pumps		**Impacts**
Boosting relevant industry	Development of Solar pump market and technology advancement	Economic
Job creation	Creation of small businesses/employment across the value chain	Economic

Understanding the socio-economic benefits through PM KUSUM scheme

Solar feeders provide quality daytime supply for agriculture. Ministry of New and Renewable Energy (MNRE) has launched the Pradhan Mantri Kisan Urja Suraksha evem Utthan Mahabhiyan (PM KUSUM) Scheme for farmers to install of Solar pumps and grid-connected Solar and other renewable power plants in the country. Under this scheme, Solar pump sets are being promoted by the central government and many state governments.

- Component B: Installation of 17.50 Lakh Stand-alone Solar Pumps

- Under Component B, individual farmers will be supported to install standalone Solar Agriculture pumps of capacity up to 7.5 HP for replacement of existing diesel agriculture pumps/irrigation systems in off-grid areas, where grid supply is not available.
- Pumps of capacity higher than 7.5 HP may be allowed, however, the CFA will be limited to the CFA applicable for pumps of 7.5 HP.
- The State Government provides a subsidy of 30%; and the remaining 40% will be provided by the farmer. Bank finance may be made available for the farmer's contribution, so the farmer has to initially pay only 10% of the cost and the remaining 30% of the cost as a loan.
- In the North-Eastern States including Sikkim, Jammu & Kashmir, Himachal Pradesh, and Uttarakhand, Lakshadweep, and A&N Islands, the State Government provides a subsidy of 30%; and the remaining 20% will be provided by the farmer. Bank finance may be made available for the farmer's contribution, so the farmer has to initially pay only 10% of the cost and the remaining 10% of the cost as a loan.

The below table provides the details of the sanctions and State implementing agencies for 2019-2020.

State	Implementation Agency	Sanctioned Quantity (Nos)
Uttar Pradesh	Agricultural Department, Government of Uttar Pradesh	8,000
Madhya Pradesh	Madhya Pradesh Urja Vikas Nigam Limited (MPUVNL)	25,000
Maharashtra	Maharashtra Energy Development Agency (MEDA)	30,000
Jharkhand	Jharkhand Renewable Energy Development Agency (JREDA)	10,000
Odisha	Orissa Renewable Energy Development Agency (OREDA)	2,500
Tamil Nadu	Agricultural Engineering Department (AED), Government of TN	17,500

Source : MNRE

Component C: Solarisation of 10 Lakh Grid Connected Agriculture Pumps

- Under Component-C for solarisation of 10 lakh grid-connected agriculture pumps, individual farmers having grid-connected agriculture pumps will be supported to solarise pumps.
- The farmer will be able to use the generated Solar power to meet the irrigation needs and the excess Solar power will be sold to DISCOMs at a pre-fixed tariff. The State Government will give a subsidy of 30%, and the remaining 40% will be provided by the farmer.
- In the North Eastern States, Sikkim, Jammu & Kashmir, Himachal Pradesh and Uttarakhand, Lakshadweep, and A&N Islands, The State Government will give a subsidy of 30%; and the remaining 20% will be provided by the farmer. Bank finance may be made available for the farmer's contribution, so that farmer has to initially pay only 10% of the cost and the remaining up to 10% of the cost as a loan. The below table provides the details of the sanctions and State implementing agencies for 2019-2020.

State	Implementation Agency	Sanctioned Quantity (Nos)
Uttar Pradesh	Uttar Pradesh Power Corporation Limited (UPPCL)	1,000
Madhya Pradesh	Madhya Pradesh Urja Vikas Nigam Limited (MPUVNL)	15,000
Maharashtra	Maharashtra State Electricity Distribution Company Limited (MSEDCL)	9,000
Jharkhand	Jharkhand Renewable Energy Development Agency (JREDA)	500
Tamil Nadu	Tamil Nadu Energy Development Agency (TEDA)	20,000

Source : MNRE

Some of the benefits under this scheme are listed below,

Day-time reliable power for irrigation: Farmers generally get power for irrigation at night. This not only causes them a great deal of inconvenience but also results in a waste of water as pumps are left running once switched on. Providing Solar panels for irrigation under PM-KUSUM would result in day-time reliable power to farmers making irrigation easier for them and also avoiding over-use of water and power.

De-Dieselization of Farm Sector By Replacing Diesel Pumps With Solar Pumps: Farmers have been demanding the replacement of diesel pumps with electric pumps as the former is costly to run. By replacing diesel pumps with Solar pumps, the farmers will get cheaper and more reliable power for irrigation resulting in savings in diesel costs.

Enhancing Farmer's Income: Enhancing farmers' income is one of the most important policy priorities of the Government. PM-KUSUM will serve this objective by replacing high-cost diesel with less expensive Solar energy under Component-B and by enabling farmers to sell surplus Solar power at a pre-determined rate to DISCOMs under Component-C.

Curbing Climate Change: Nearly 80 lakh pumps out of approximately 3 crore agricultural pumps installed in India are diesel pumps. The total diesel consumption of these pumps in a year works out to 5.52 billion litres per annum along with equivalent CO2 emission of 15.4 million tonnes. When implemented fully, PM-KUSUM will lead to reducing carbon emissions by as much as 32 million tonnes of CO2 per annum. Moreover, farmers whose diesel pumps are replaced will be able to work on their farms in a pollution-free environment.

Deriving the benefits to DISCOMs as well as to farmers through Feeder separation/ segregation

Inadequate power supply in rural areas is one of the major obstacles affecting economic growth and development. At present, rural power feeders feed mixed agriculture and domestic/village loads approximately for 8-10 hours. Agricultural pumps are provided with a three-phase supply for 6-8 hours. During the rest of the period, single-phase supply on the HV line is made available, intended for use in households and small businesses.

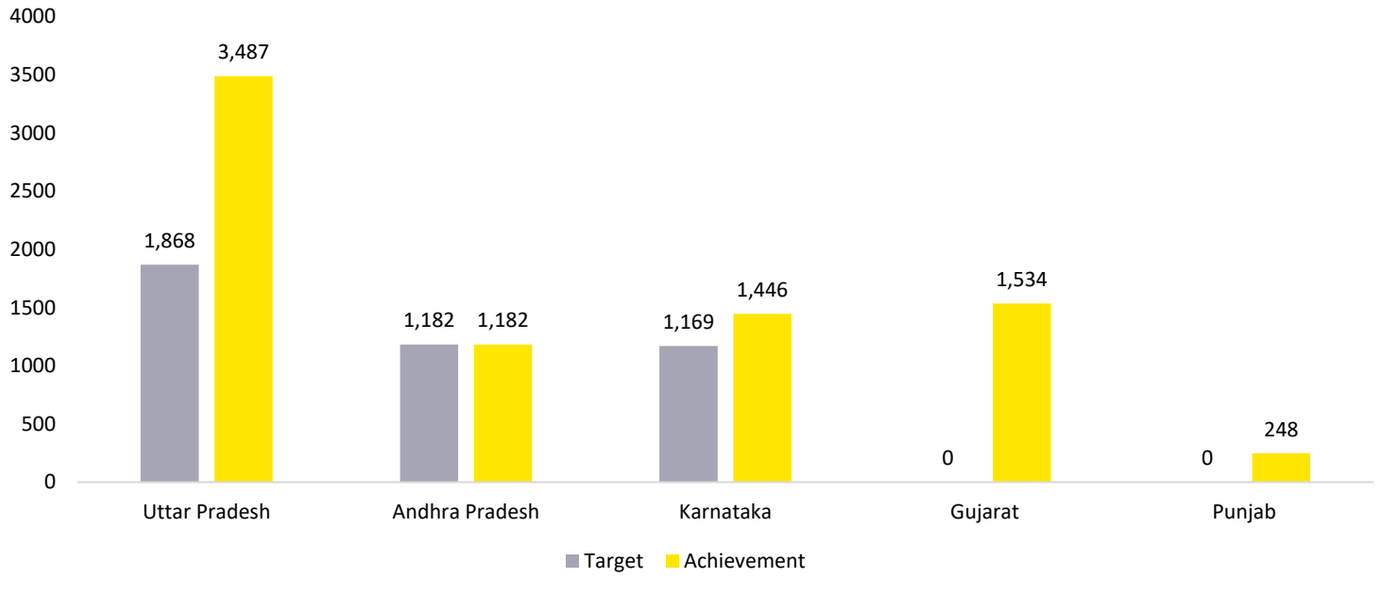
Earlier, before feeder separation, farmers were using phase splitters to run their water pumps for extended hours resulting in power interruptions, abnormal loading of feeders, and failures of distribution transformers. This resulted in the inefficient supply of power round the clock and inefficiency in controlling commercial losses.

Hence, the Government undertook initiatives like feeder separation programs to resolve these issues and the key aspect of the feeder separation program was to separate the irrigation and residential/commercial loads in rural areas so as to adopt measures to check pilferage of electricity.

The main objectives of feeder separation are listed below,

- Improvement in quality and reliability of power supply.
- Prevention of theft/direct hooking from LT network catering to non-agricultural load.
- Reduction in technical and commercial losses
- Reduction in equipment/plant failures
- Flexible load management for DISCOMs
- Also, Feeder separation helps in the reduction of supply downtime for high-billing consumers. For instance, if a feeder is catering to a consumer mix of high billing and low billing domestic/ commercial consumers and if a fault occurs due to low billing consumers, still it will affect the entire consumer mix whether high or low billing. This grim situation can be avoided through feeder separation.

Figure 27: Post UDAY top performers - Feeder segregation (Dec 2021)



Source : UDAY

According to UDAY, the states of Odisha, West Bengal, and Nagaland are yet to join UDAY. States under the UDAY scheme of DISCOMs debt restructuring have put up a separate power feeder for agriculture load which resulted in better energy accounting and mitigating AT&C loss.

In addition to UDAY for feeder segregation, the Government of India has approved Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY) with a total cost of Rs. 43,033 crores in December 2014 for separation of agriculture and non-agriculture feeders facilitating judicious rostering of supply to agricultural & non-agricultural consumers in the rural areas, strengthening and augmentation of sub-transmission & distribution infrastructure in rural areas, including metering at distribution transformers/feeders/consumers.

As of December 2021, 1.22 Lakh ckms of 11 kV Feeders have been segregated under this scheme.

Case study: Gujarat

The rural electricity sector in Gujarat was grappling with issues such as erratic power supply, low voltage, load-shedding in domestic supply, unreliable metering, high failure rate of DTs, submersible pumps, improper energy accounting and high aggregate technical and commercial (AT&C) losses.

To address these issues, the state government launched the Jyoti Gram Yojana in 2003 to provide 24×7 three-phase power supply to 18,000 villages for non-agricultural activities.

Under the scheme, the government separated electricity feeder lines for agricultural and non-agricultural users to make farm power rationing effective and tamper-proof.

The scheme helped the utilities ensure **flexible load management, improve quality and reliable power supply, reduce transformation system failure and ensure speedy restoration of power supply.**

Over the years, feeder separation has played a key role in augmenting electricity penetration in the state.

Under this scheme, a parallel rural distribution network was laid to cover the entire state, which separated agricultural consumers from non-agriculture consumers to facilitate load management and regulate agricultural consumption without affecting power supply to other consumers.

It also helped in DSM through various measures such as switching to agriculture feeders, proper grouping of feeders, reducing the gap between maximum and minimum demand, facilitating better load forecasting, and encouraging the use of efficient pumps.

In June 2014, the Ministry of Power announced its plan to replicate the Jyoti gram Yojana in other states with necessary modifications.

Key highlights

1

How?

Scheme for implementation of feeder separation

- ✓ Defining objective (loss reduction, 24*7 supply to non-agricultural consumers)
- ✓ Selection of best and appropriate approach to achieve the objective (load segregation, energy audit)
- ✓ Prioritising the geographical areas for feeder separation based on their agricultural load
- ✓ Establishment of baseline data
- ✓ Implementation of feeder separation programme

b. Rationing hours of supply and connections

The hours of supply to agriculture in rural areas are significantly lesser than that for urban consumers. Many states now have a system of rostering of supply, where power supply alternates between daytime on a few days and night time on others. Agriculture does not receive more than 10 hours of electricity supply a day in a majority of the states.

The limitations in hours of supply have often been met by farmers installing higher capacity pumps and/or more pumps.
Farmers receive fewer than scheduled hours of supply which are often erratic and with frequent interruptions and voltage fluctuations, causing farmers to incur avoidable expenditure on pump repairs due to motor burnouts. Transformer burnouts are a common occurrence, and there are long delays in getting the transformers repaired.

Average Hours of Power Supply to the Agricultural Sector in some of the Indian states such as Uttar Pradesh Odisha etc during March 2021 are described below,

State	Average Hours of Power Supply to Agricultural Sector during March 2021
Uttar Pradesh	18:08 hours/day
Chhattisgarh	24 hours/day
Maharashtra	9 hours/day
Andhra Pradesh	07 hours/day
Telangana	24 hours/day
Bihar	More than 22 hours/day
Jharkhand	About 20 hours/day
Odisha	About 20 hours/day
West Bengal	About 23 hours/day
Tamil Nadu	9 hours/day (6 hours during day time and 3 hours during night time)

Source : CEA

24 x 7 agriculture supply - Telangana's unique initiative

In 2018, Telangana became the only state in India with a high proportion of agriculture power consumption to implement 24x7 free power supply to all farmers.

Telangana was providing 7 hours of free power supply to its unmetered farmers in 2014 and the hours of supply was increased to 9 hours in 2016. After a pilot project of 24 x 7 supply in a few distribution circles in 2017, it was extended to the whole state from January 01, 2018.

24 x 7 power supply to agriculture is being projected as a success story in Telangana. The government has also been claiming that this initiative will result in 24 x 7 three-phase power supply to rural areas, catalysing rural development.

Data from load dispatch centre indicates that there was a 34% increase in Telangana peak demand between 2016 and 2017 (when agriculture supply was increased from 7 to 9 hours and power shortages reduced) and 12% increase between 2017 and 2018 (when 24 x 7 supply was introduced).

AP has been installing Solar pump sets and in 2017, AP DISCOMs had taken up projects to replace about 1 lakh pump sets with 5-star pump sets. From 2017, Maharashtra has initiated projects for mini-Solar plants (few MW capacity) to supply Solar power to 11 kV feeders supplying agriculture pump sets.

Before introduction of 24 x 7 supply, there were many challenges in power supply to agriculture – supply at odd hours, frequent outages and long time to restore supply. 24 x 7 supply is convenient for farmers, since they can choose the time for irrigation, and could reduce distribution transformer burnouts. This is because the overloading of distribution transformers could reduce, since all farmers may not operate the pump-sets at the same time.

In most areas in Telangana for most part of the year, groundwater is sufficient for only a few hours of continuous pumping, after which it is necessary to wait for a few hours for groundwater to recharge. Since power supply was not reliable, most of the agriculture pumps had employed auto-starters, which ensure that the pump motor is turned ON whenever power is available.

There were appeals to the farmers to remove or bypass auto-starters when 24 x 7 power supply was announced, but it is not clear how many have actually done so. It is quite likely that the pumps are continuing to operate even when there is no water, thus increasing electricity consumption and reducing the life of pump.

Key highlights

1

Telangana's initiative catalyse rural development through 24*7 agriculture supply

2

Challenges due to unreliable power supply in Telangana

- ✓ Power supply at odd hours
- ✓ Frequent outages
- ✓ Long time to restore supply
- ✓ Distribution transformer burnouts

Announcement of 24 x 7 power supply claimed that investment of Rs. 12,610 Cr was made in the past three years to strengthen the transmission and distribution infrastructure, and around Rs. 2,800 Cr was specifically for 24 x 7 supply.

As in most Indian states, majority of farmers in Telangana are marginal (62% with less than 1-hectare land) and small (24% with 1-2-hectare land). 24 x 7 electricity supply can indeed be blessing for them.

Since there is a demand for quality supply during the day time and tail-end Solar power supply cost is lower than average power purchase cost, Solar based options, especially solarising feeders which have significant agriculture pump set load, would be a good option.

Along with power supply options, efforts should be made to improve irrigation efficiency, regulate ground water use, recharge bore-wells, promote suitable cropping patterns, and extend the required market and credit support to farmers.

Energy Saving for Uttar Pradesh if pumps are solarised

Average solar irradiation in UTTAR PRADESH state is 1156.39 W / sq.m
1 kWp solar rooftop plant will generate on an average over the year 4.6 kWh of electricity per day (considering 5.5 sunshine hours).

1. Size of Power Plant	
Feasible Plant size as per your Capacity :	6 KW
2. Cost of the Plant :	
MNRE current Benchmark Cost (without GST) :	Rs. 40,991 Rs/ KW
Without subsidy (Based on current MNRE benchmark without GST) :	Rs. 2,45,946
With subsidy 0 (Based on current MNRE benchmark without GST) :	Rs. 2,45,946
3. Total Electricity Generation from Solar Plant :	
Annual :	8,280 kWh
Life-Time (25 years):	2,07,000 kWh
4) Financial Savings :	
a) Tariff @ Rs.4.5/ kWh (for top slab of traffic) - No increase assumed over 25 years :	
Monthly :	Rs. 3,105
Annually :	Rs. 37,260
Life-Time (25 years) :	Rs. 9,31,500
Carbon dioxide emissions mitigated is	170 tonnes.
This installation will be equivalent to planting	272 Teak trees over the life time. (Data from IISc)

Source : National Portal for Roof top Solar

Energy Saving for Uttar Pradesh for solarised energy efficient pump

According to Tariff Order of Uttar Pradesh using energy efficient pump would cost Rs 1.65/unit

Total energy Sold (MU)		14,836.94
Total Connected Load (KW)		77,05,742
Total Agriculture consumer		12,73,131
Connected load per Agriculture Consumer (KW)		6.1
Energy Consumption per Agriculture Consumer/Year		11,654
Annual generation through Solar (kWh)		8,280.00
Units to be billed (kWh)		3,373.90
Components	**Solarised**	**DISCOM Supply**
Fixed Charge/Year (Rs/Year)	6,888.00	6,888.00
Energy Charges/Year (Rs/Year) @ Rs 1.65/Unit	13,662.00	19,228.93
Total cost (Rs)	**A:**20,550.00	**B:**26,116.93
Total Bill to be payed (Rs) (A-B)		5,566.93
Total energy saved by state (MU)		4,295.42
Total Savings of State (in Cr) **708.74**		

Source : Tariff Order Uttar Pradesh 2021

Therefore, to get reliable and quality power supply gradual shifting to solar pumps under the PM-KUSUM scheme would not only be beneficial to farmers as farmers can earn secondary income through net metering but also this source of power generation would be environmental friendly.

EDUCATION

4.2 Analysing the Socio-economic impact of unreliable Power

Universal access to energy became one of the 17 Millennium Development Goals of the United Nations in 2015. Energy access was recognized as a key element for improving socioeconomic conditions in developing countries. Access to energy services is expected to have a multi-dimensional impact on the potential of the socio-economic development of a region, improving productivity, education, and health. Accessibility of Electricity in schools is a basic infrastructure required to provide quality education. It has been observed that basic infrastructure like electricity and separate toilets for girls and boys in schools create a healthy and positive environment at schools (UNDESA, 2014). In this era of technology wherein, the learning process has expanded to online sessions, the non-availability of electricity can be a big hindrance in school dropouts. It is observed that with electricity, the schools' access to modern methods and techniques of teaching helps the holistic development of students and increases their attraction towards learning.

Indian education is in dire need of reforms, particularly from an infrastructural point of view. Although under the Suabhagya scheme 99.9% of villages have been electrified still the lack of access to reliable electricity is posing a big challenge. In such cases, a lack of unreliable electricity can affect multiple educational parameters, such as attendance, dropout rates, and learning outcomes. Electrification efforts thus have the capacity to transform the state of rural education.

The below graph shows the details of the number of schools at the national level and electricity availability in the form of percentages for different form of categories since 2015 at the national level

Figure 28: Total No. of Schools (in lakhs)

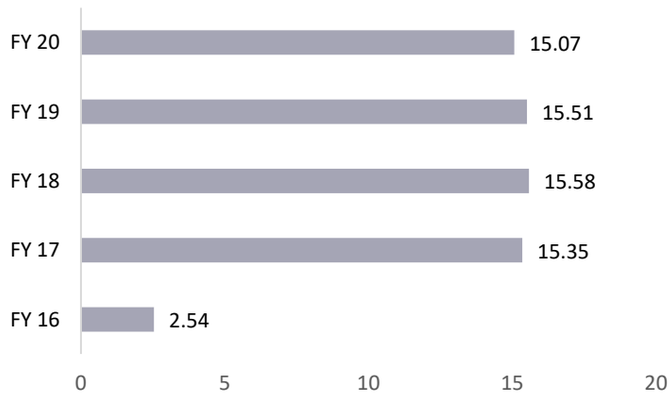
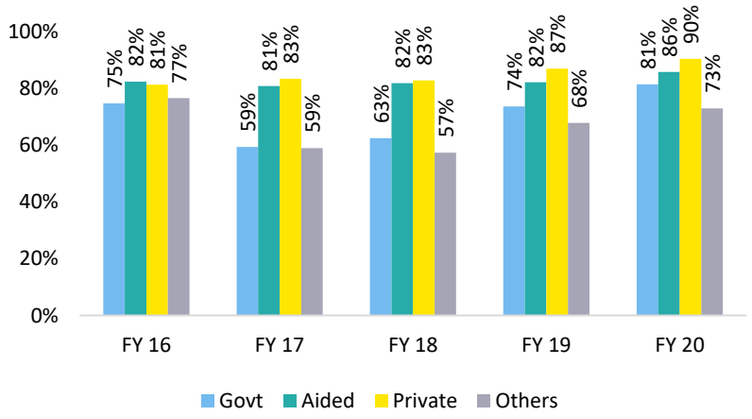


Figure 29: Electricity Availability-National Level



Source: Ministry of Education, UDISE-Dashboard

From the above graph, it can be observed that the number of schools at the National level has been increasing since FY 16. But, a small slump can be seen during FY19 due to the COVID-19 pandemic, wherein ~50,000 schools were not functioning.

According to the UDISE dashboard, at present, ~87% of the schools are electrified and at the National level, it can be observed that there is a continuous rise in the electrification of schools.

Figure 30: Total No. of Schools - UP (in lakhs)

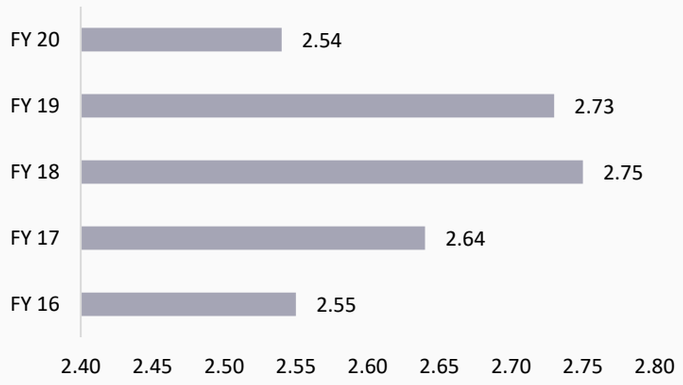
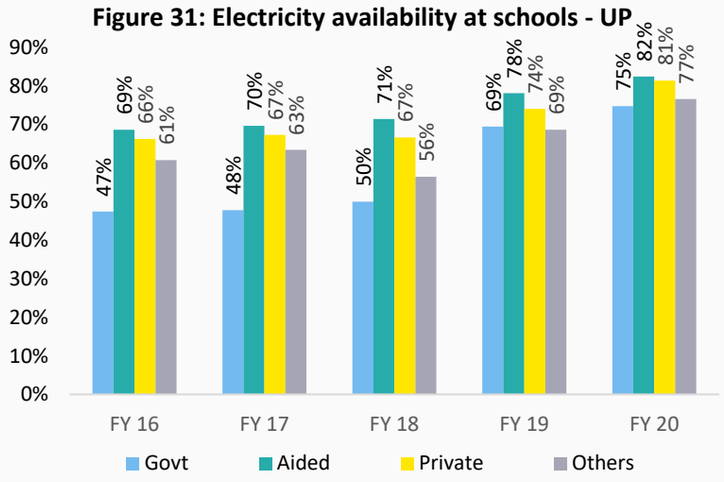


Figure 31: Electricity availability at schools - UP



Source: Ministry of Education, UDISE-Dashboard

From the above graph, it can be observed that the number of schools at UP has been increasing since FY 16. But, a small slump can be seen during FY19 due to the COVID-19 pandemic, wherein ~1 lakh schools were not functioning.

Also, the availability of electricity at schools in UP are seen increasing over the years since FY 16. The electricity availability rate at UP Government schools rose from 47% in FY 16 to a higher share of 75% in FY 20. Similarly, the growth of electricity rates at private institutions can be seen increasing from the above graph.

Figure 32: Total No. of Schools - Odisha

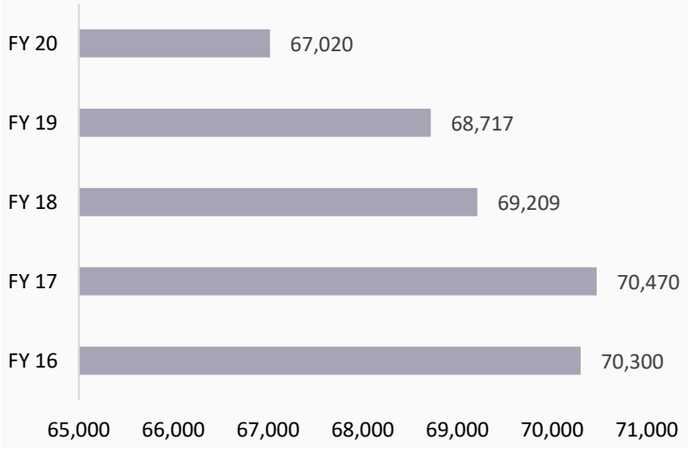
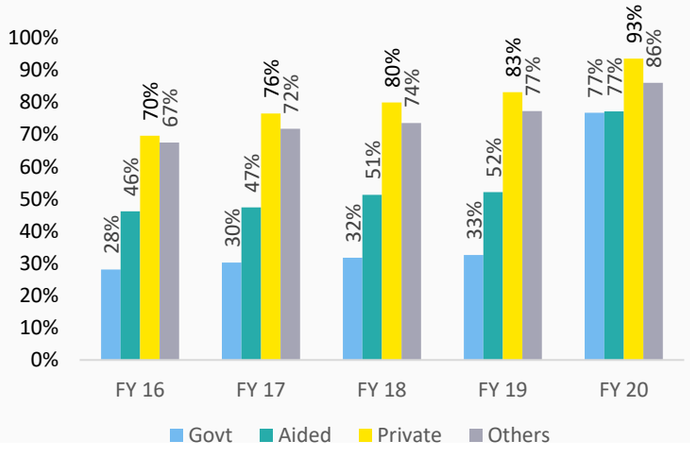


Figure 33: Electricity Availability-Odisha



From the above graph, it can be observed that the number of schools in Odisha has been increasing since FY 16. But, a small slump can be seen during FY19 due to the COVID-19 pandemic, wherein ~1,700 schools were not functioning.

Also, the availability of electricity at schools in Odisha are seen increasing over the years since FY 16. The electricity availability rate at Odisha Government schools rose from 28% in FY 16 to a higher share of 77% in FY 20. Similarly, the growth of electricity rates at private institutions can be seen increasing from the above graph.

Though from the overall analysis, it can be seen that the connectivity of electricity to the schools has increased at both the National and State level, this report will focus more on the Quality and reliability of electricity at the school level.

Electricity is driving todays innovative education:

With the growing technology, Digital technologies have time and again shown their profound impact on economies and societies in the way we communicate, and engage in any social activities. These technologies are even responsible to drive our inquisition across different dimensions of the education system. But the foundation of these technologies lies in 24X7 quality and reliable supply of electricity so that this innovative learning can go beyond learning to skill development. Despite the huge potential of digitalization for fostering and enhancing learning in India, the impact of digital technologies on education is yet to be tapped. Though investments in ICT (Information and Communication Technology) in schools have taken place in the past yet, a large bunch of schools are still untouched by the transformation of educational practices we are expecting.

According to Sustainable Development Goals Report 2021, reconstructing basic school infrastructure, in many countries should be considered the first step on the road to recovery from COVID-19. Historical data from 2016 to 2019 show that, globally, one in four did not have electricity. Internet service and computers in schools are even more scarce. Schools in LDCs face the biggest challenges. More than two-thirds of the primary schools in LDCs are without electricity. The pandemic is spotlighting the importance of adequate sanitation facilities in keeping children safe at school and the need for ICT infrastructure to support remote learning. It is also highlighting additional infrastructure considerations, such as adequate classroom space, air filtration in school buildings, and access to the Internet and computers at home. The economic fallout of the crisis on education budgets and capital spending is likely to affect the ability of countries to make progress toward these ends, especially in the poorest countries.

Table 8: Understanding the Socio-economic impact of reliable supply of power in Education

Factors	Benefits	Impact
Lighting and extended studying hours	▶ Quality supply of electricity would result into retaining students for longer hours at school. ▶ Access to modern lighting technologies can yield better understanding amongst the students. ▶ According to National Education Policy 2020, attractive spaces, computing devices, Internet can ensure effective learning environment for students. ▶ According to UNDESA 2014 report, a study conducted for the Millennium Villages Project in Malawi indicated that when households, hospitals, or schools switched from kerosene lamps to Solar lamps, their annual expenditures on lighting dropped by almost $50 per building, excluding the cost of the lantern (about $30).	Social and Economical
Facilitation of ICT in the classrooms	▶ The quality and reliability of power supply would facilitate Information and Communication technologies in the classroom. Some of the benefits are listed below, ▪ Enhanced the modes of communication ▪ Minimize cost and save time ▪ Interactive and collaborative teaching and learning methods ▪ Direct classroom teaching and spread awareness of the social impact of technological change in education ▪ Teachers can teach better with images, videos and graphics while delivering lessons ▪ Improve the administration and enhance the quality and efficiency of education ▪ Promote and improve the digital culture in schools, colleges, and universities	Social and Technological

Factors	Benefits	Impacts
School performance	▶ Better school performance based on attendance, completion rates, and test scores ▶ According to UNDESA 2014, In Sudan and Tanzania, the introduction of Solar electricity at schools allowed a jump in completion rates at primary and secondary schools from less than 50 percent to close to 100 percent.	Governance
Complimentary benefits	▶ Co-benefits such as improved sanitation and health, gender empowerment, and community resilience. ▶ A hybrid Wind-Solar thermal-Solar-PV energy system deployed on a school can provide a multi-community services. It can pump, purify, and treat drinking water, prepare and preserve food and medical supplies, and circulate air to maintain a comfortable indoor climate.	Environmental and Social
Dropout rate	▶ Reliable power supply to schools would reduce the dropout rates and create an environment friendly zone for students	Social

Economic Survey-2019-20

According to the Economic Survey 2019-20, Electricity in schools is stated to be a basic infrastructure required to provide quality education. It has been observed that basic infrastructure like electricity and separate toilets for girls and boys in schools create a healthy and positive environment at schools (UNDESA, 2014).

According to the survey it is found that with electricity, the schools have access to modern methods and techniques of teaching which helps in the holistic development of students and increases their attraction towards learning. As it is a known fact that access to Information and Communication Technologies (ICTs) methods and imparting knowledge of computers at schools requires reliable electricity connections, hence it is quite obvious that schools having quality and reliable power would generally tend to have the facilities that the Government provides under its Sarva Shiksha Abhiyan program. At the Global level, it is also observed that schools with electricity have outperformed non-electrified schools in terms of staff retention, drop-outs, and other educational indicators. Further, It is observed that States with lower literacy rates have low electricity rates at the schools and vice-versa.

Table 9: Barriers and Solutions to Accelerating School Electrification

Barrier to school electrification	Solution that overcomes this barrier
Capital cost, lack of financing	Innovative revenue schemes such as public private partnerships, bundling projects, carbon finance, community-interest companies, low-profit limited liability corporations, and for-benefit corporations
Technical problems, theft or destruction of equipment	Stable and consistent policy frameworks and technical standards and certification
Lack of household access, indoor air pollution arising from cooking practices	Bundling household access and modern cooking programs with school electrification efforts
Urban bias in electrification and education investments, inability to address poverty	Coupling electricity with community training and capacity building so that standards of living are raised and villages become more self-sufficient and autonomous

Understanding the socio-economic benefits through Solarisation in Education sector

Introducing Solar energy would make the schools secure clean energy and in return, it will benefit the environment and human health. The use of diesel-run generators produces particulate matter and air pollutants that significantly contribute to serious health hazards. The Solar installations would provide new learning opportunities for the students and promote the habit of energy conservation, and environmental sustainability among school children.

The cost savings accrued from solarisation would contribute to the financial stability of schools. Thus, renewable electricity, especially Solar electricity, is a viable and sustainable alternative source of electricity to ensure an uninterrupted energy supply. Framing the policy for installing rooftop Solar systems for non-residential schools as well, will improve the learning environment along with the environmental benefits.

Impact of solarisation in schools: Learnings from Jharkhand

The NITI Aayog SDG report 2020-21 placed Jharkhand under the aspirant category for SDG 4: Quality Education, with index score of less than 50. Access to reliable energy acts as an enabler to progress towards education.

Evidence suggests that **states with lower literacy rates also have low electricity rates at the schools and vice-versa** (GoI, 2020). The UDISE (2019) report highlights that 93% of the total schools in the state have grid connections. However, access to electricity alone does not fulfil the daily energy demand of schools. Attributes such as **quality of the power supply, legality, reliability, affordability, etc., play a pivotal role in enhancing energy-related education outcomes.**

To improve the energy access status at schools, it is imperative to understand the present scenario of electricity supply. IRADe evaluated the status of energy access in 15 schools across three districts of Jharkhand, namely, Ranchi, Deoghar, and East Singhbhum.

Among these 15 schools, 12 were non-residential, and 3 were residential. The study included identifying the different indicators to assess the quality of the current power supply and mapping them into different tiers based on the multi-tier framework developed by World Bank-ESMAP. Interviews and discussions with the staff and students revealed the school activities affected by the power supply.

Key highlights

1

Access to uninterrupted quality electricity provides creates conducive environment for learning

2

Schools with rooftop solar installations have witnessed improvement in the daily power supply, both during the daytime and evening hours

The survey result highlights that majority of surveyed schools face **power outages** from the primary source, i.e., the grid, which may range from **3- 5 hours during the working hours**. Power availability also has the seasonal dimension, as power cut duration exceeds the above range during monsoons (for line maintenance) or increased load shedding during the summer season.

During the group discussion with teachers, access to uninterrupted quality electricity emerged as significant factor for effective cooling and lighting; it creates conducive environment for learning.

A reliable power supply is much needed to run computers, internet, audio-visual classes which primarily focus on the modern technological advances to improve and strengthen the knowledge imparted to the students.

The computer-aided learning process by introducing the Information and Communication Technologies (ICT) in schools has provided the students with opportunities to build up their knowledge in an interactive way.

However, erratic supply of grid electricity during school working hours necessitates the availability of a secondary electricity source, to improve the reliability of the power supply.

The residential schools operate 24x7 with hostel facilities for students and working staff. Traditionally, diesel-operated generator sets or battery-inverters have supported the schools in maintaining the electricity supply during power cuts.

Owing to the expensive fuel and limited budgets, the schools cannot operate the generator sets every time the power goes off. In the past few years, the Government of Jharkhand launched a scheme to solarise government residential schools with battery storage.

Jharkhand Renewable Development Agency (JREDA) has installed rooftop Solar power plants for self-consumption in government-run residential schools. The vacant roofs and terraces of the school buildings and hostels are utilised to install the rooftop Solar panels.

JREDA has installed a 10kW rooftop Solar system at residential schools with battery storage. Schools with rooftop Solar installations have witnessed improvement in the daily power supply, both during the daytime and evening hours.

The solarisation of schools has helped run the smart classes and ICT labs smoothly, even in the absence of grid electricity. Students and staffs feel much safer due to the availability of uninterrupted electricity during the evening and night.

The budget required for purchasing the fuel for generators has been reduced by introducing Solar energy as secondary power in these schools.

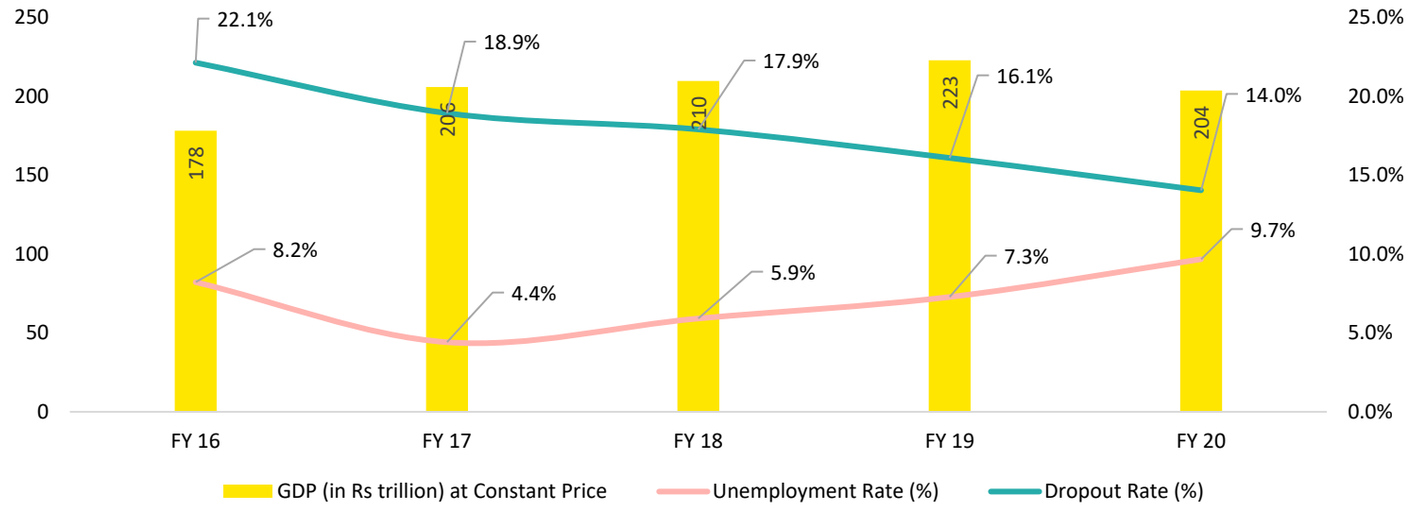
The rooftop Solar scheme had eased the staff's life in these residential schools enormously. Operating generators during power cuts in evening hours or night-time was difficult for the staff.

Understanding opportunity cost for unreliable power

Education is vital for any economy to grow. It is one of the key components of economic growth and has a direct influence on increasing our skilled workforce, entrepreneurship, productivity growth, and increases better employment opportunities and women empowerment. Education helps in making potential youth enhancement of ability, creativity, and systematic skills contest with the fast-changing global inclination.

According to a report by OECD-G20-Skills-Strategy, "basic education gives each individual a basis for the development of their potential, laying the foundation for employability. Initial training provides the core work skills, general knowledge, and industry-based and professional competencies that facilitate the transition from education into the world of work.

Figure 34: National level: GDP-Dropout Rate-Unemployment Rate



Source: World Bank / macrotrends / UDISE / CMIE

The above figure depicts the relationship between GDP-Unemployment Rate and Dropout Rate at the national level for secondary schools.

It can be observed that as GDP is growing, the dropout rate shows a declining trend.

With GDP growth, the unemployment rate showed a declining trend for FY 16 and FY 17 but an anomaly can be observed in the unemployment rate possibly due to post Demonetization and COVID-19 respectively.

Figure 35: Uttar Pradesh: GDP-Dropout rate-Unemployment Rate

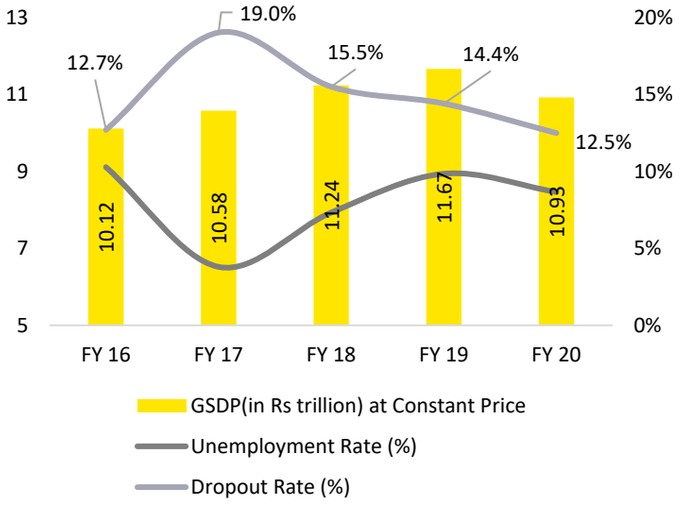
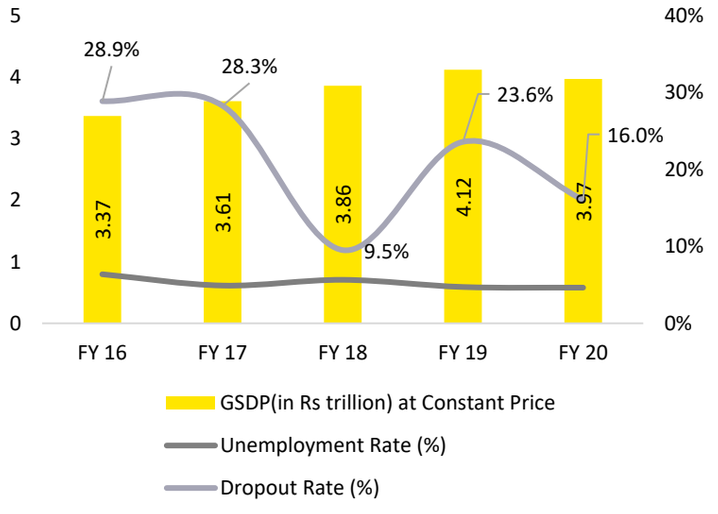


Figure 36: Odisha: GDP-Dropout Rate-Unemployment Rate



Source: RBI/ UDISE / CMIE

The above figure depicts the relationship between the GSDP-Unemployment Rate and Dropout Rate for the state of Uttar Pradesh and Odisha.

It can be observed that GSDP is rising for both states leaving the FY 20 because of the second wave of COVID 19 which affected the whole economy.

In the case of Uttar Pradesh, the unemployment rate can be seen decreasing between FY 16 and FY 17, further it is noticed that there was a rise in the unemployment rate because of the post-demonetization effect but the post-COVID-19 revival of the economy helped in reducing employment rate. Similarly, a decrease in the dropout rate was also observed since FY 17.

In the case of Odisha, the unemployment rate was continuously decreasing and meanwhile, the school dropout rate was decreasing but a sudden rise can be seen after FY 18, and further, the slump in the dropout rate can be observed after FY 19.

Table 10:Reflecccts the elasticity of GDP and dropout at national level

Financial Years	GDP (In Rs Trillion) at Constant Price	Dropout rate (%)
FY 16	178	22.1%
FY 17	206	18.9%
FY 18	210	17.9%
FY 19	223	16.1%
FY 20	204	14.0%

	Change in GDP (%)	Change in dropout rate (%)	Elasticity
From FY 16-FY 19	15.7%	-14.5%	-1.1
	1.9%	-5.4%	-0.4
	6.2%	-10.1%	-0.6
Average	**8.0%**	-10.0%	**-0.8**

The elasticity between GDP and dropout rates at the national level is negative 0.8, which reflects both GDP and dropouts are inversely proportional. Therefore, it can be observed that with the decrease in the dropout rate there is an increase in GDP growth.

National Education Policy,2020

According to National Education Policy Part-I, Chapter -3, initiatives would be taken to bring back children who have dropped out of school so that future dropping out can be decreased. Some of the initiatives are mentioned below:

- The first is to provide effective and sufficient infrastructure so that all students have access to safe and engaging school education at all levels from pre-primary school to Grade 12.

- Special care shall be taken to ensure that no school remains deficient in infrastructure support.

- The credibility of Government schools shall be re-established and this will be attained by upgrading and enlarging the schools that already exist and building additional quality schools in areas where they do not exist.

Observation: Though National Education Policy,2020 talks about improving infrastructure in schools but it nowhere mentions the reliable supply of electricity as one of the basic needs to improve the whole learning process. With growing ICT, coming up of smart classrooms, well-equipped labs, and smart libraries, quality, and reliable supply to schools are musts.

Hence providing electricity through rooftop Solar would be a good option to ensure that unreliable supply doesn't create a hindrance for the schools in the future, this initiative would really contribute to slashing dropouts rate in the near future

Therefore to understand the need for a reliable supply of electricity, we have assessed the potential capacity of establishing rooftop Solar and we have identified around 2.50 lakh schools where electricity is not available and what possible cost would be incurred to establish rooftop Solar on these schools.

Table 11: Number of students at Rural and Urban areas at National Level

Level	Rural	Urban
Primary	8,92,16,178	3,24,70,525
Upper Primary	4,57,42,530	1,91,30,857
Secondary	2,56,47,138	1,28,17,295
Higher Secondary	1,47,24,352	1,12,22,808
Total	17,53,30,198	7,56,41,485
Total Villages (Census-2011)	6,64,369	NA
Students in each village (Approx.)	264	NA
Number of schools to be electrified	2,49,811	NA
Area of each school as per the students capacity (as per CPWD Guidelines)-Page 25	1344 Sq. metre	NA

Note: The area considered here is only for secondary and higher secondary schools as more dropout is found under this level of category.

Solar Rooftop Calculator

Average Solar irradiation in Uttar Pradesh is 1156.39 W / Sq. metre. 1 kWp Solar rooftop plant will generate on an average ~4.6 kWh of electricity per day over an year (considering 5.5 sunshine hours).

1. Size of Power Plant	
Feasible Plant size as per your Roof Top Area :	94.1kW
2. Cost of the Plant :	
MNRE current Benchmark Cost (without GST) :	Rs. 38,236 Rs. / kW
Without subsidy (Based on current MNRE benchmark without GST) :	Rs. 35,98,008
With subsidy 0 (Based on current MNRE benchmark without GST) :	Rs. 35,98,008
3. Total Electricity Generation from Solar Plant :	
Annual :	1,29,858 kWh
Life-Time (25 years):	32,46,450 kWh
4) Financial Savings :	
a) Tariff @ Rs.3.5/ kWh (for top slab of traffic) - No increase assumed over 25 years :	
Monthly :	Rs. 37,875
Annually :	Rs. 4,54,503
Life-Time (25 years) :	Rs. 11,36,2575
Carbon dioxide emissions mitigated is	2,662 tonnes.
This installation will be equivalent to planting	4,259 Teak trees over the life time

Source: National Portal for Solar Rooftop-Grid Connected

Approximating total number of schools for secondary and higher secondary schools is 9,000 for which the Uttar Pradesh government has to spend around: Rs 3,238 Cr

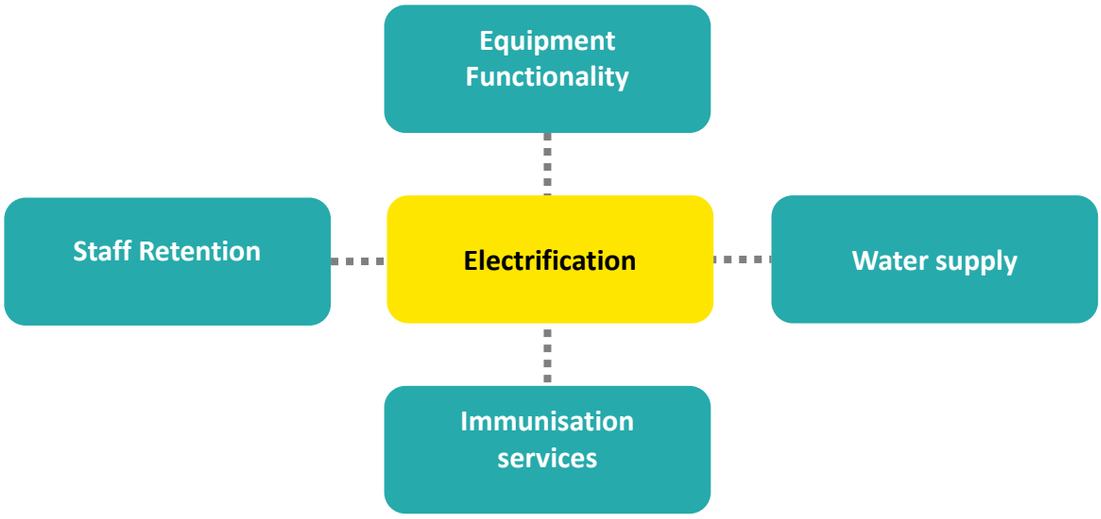
HEALTH

4.3 Analysing the Socio-economic impact of unreliable Power

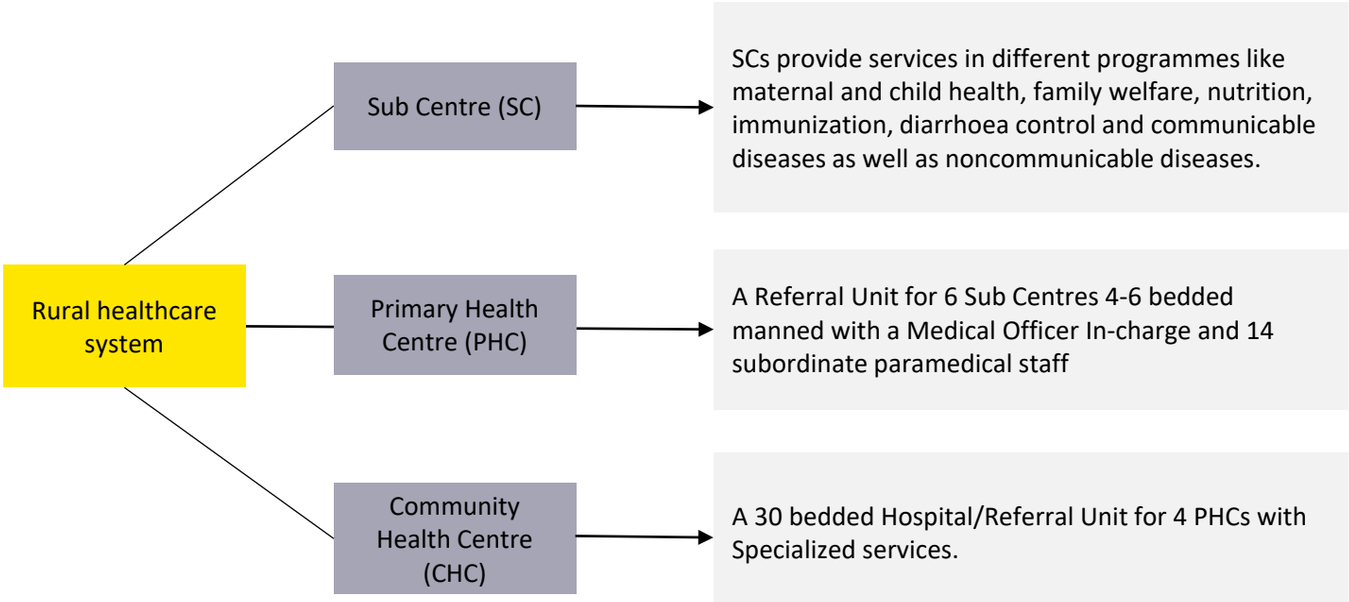
Reliable basic infrastructure, particularly electricity, is a critical enabling factor in improving health systems and consequently achieving the health sustainable development goals (SDGs). Irrespective of social, economic, religious, cultural, or any such factors, proper healthcare facilities are needed by everyone. Access to electricity in healthcare facilities is an important determinant of the efficient operation of the system.

Electricity as an enabler of health service delivery

Health system infrastructure has conventionally focused on the availability of tangible physical spaces, furniture, and equipment essential for the delivery of healthcare services. Along with the building and equipment, the availability of utility services such as electricity and water is imperative for the functioning of a health facility and is an important determinant of the effective delivery of essential health services. For instance, the use of radiant warmers for newborn care, cold chain storage for vaccines, and nighttime deliveries are all dependent on the availability of reliable power.

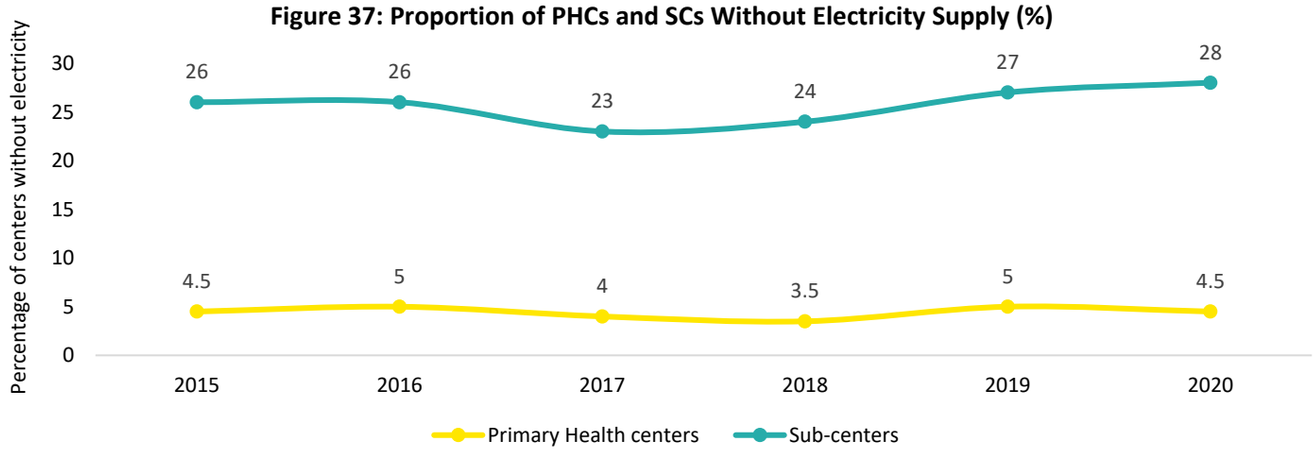


Overview of Rural Healthcare system



The health care infrastructure in rural areas has been developed as a three tier system. As on 31st March, 2020, there are 1,55,404 Sub Centres (SC), 24,918 Primary Health Centres (PHCs) and 5,183 Community Health Centres (CHCs) which are functioning in rural areas of the country.

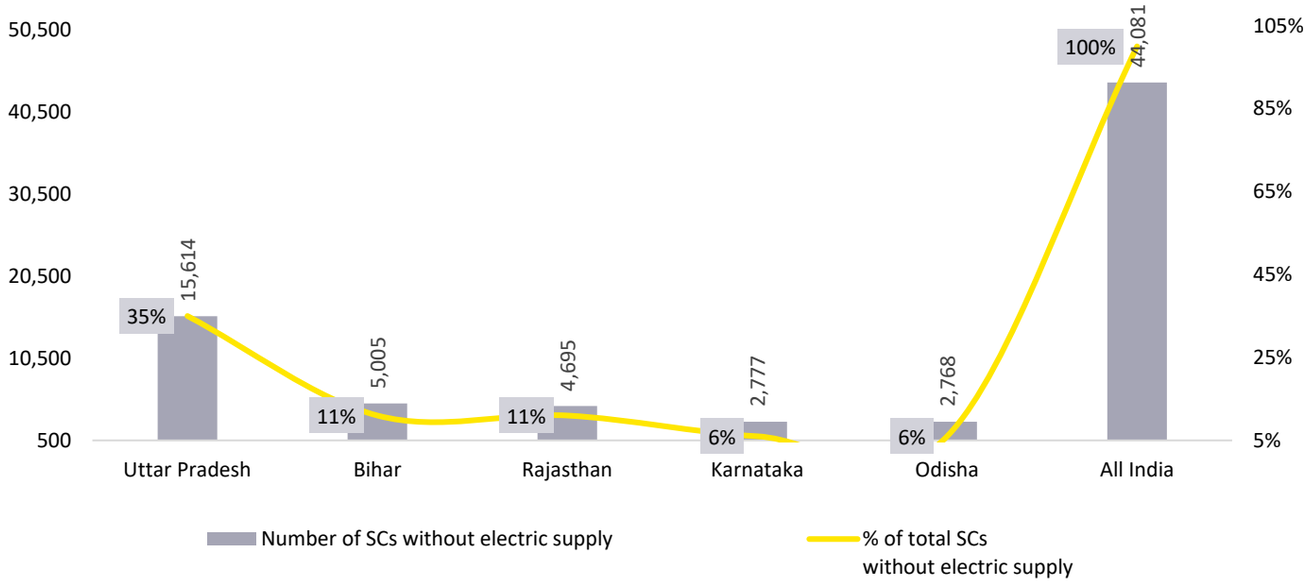
Figure 37: Proportion of PHCs and SCs Without Electricity Supply (%)



Source: Prayas Energy group, power perspectives

The above figure shows that significantly more SCs are without electricity access compared to PHCs and the share of SCs without access has also slightly increased over the last decade. As of March 2020, ~28.4% of SCs and ~4.3% of PHCs are without electricity supply.

Figure 38: Share of SCs in rural areas without electric supply (March 2020)



Source: Rural Health Statistics, 2019-20

It can be observed from the above graph that the Sub Centers (SCs) without electricity supply are concentrated more in the states of Uttar Pradesh with a major share of ~35%, which is followed by Bihar and Rajasthan with a subsequent share of 11%.

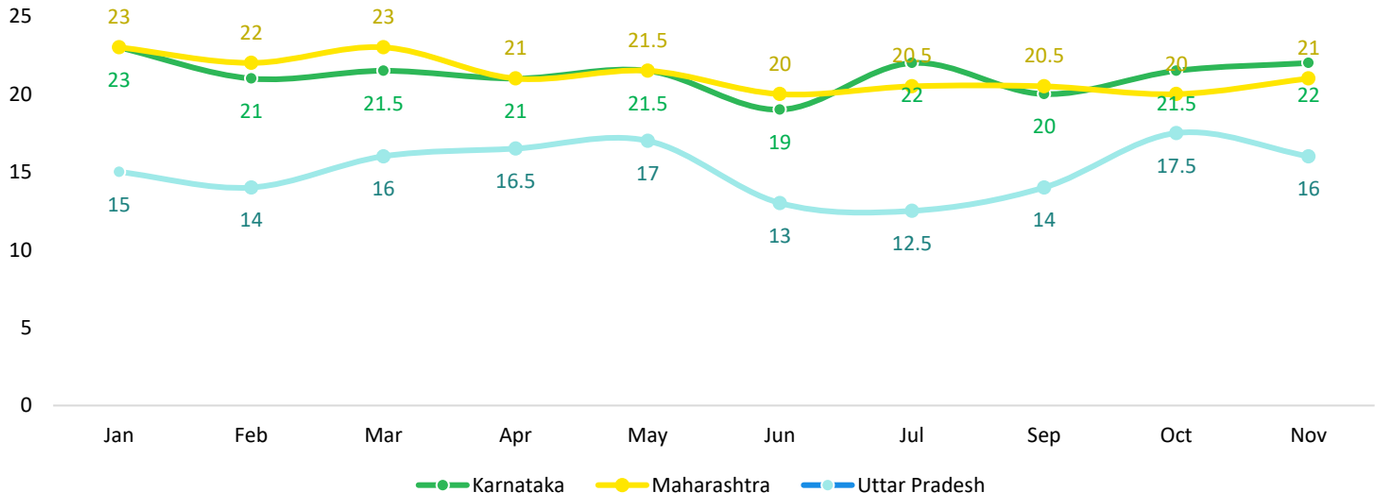
A number of services offered by these centres including operatives (caesarean section, medical termination of pregnancy, sterilization, minor surgeries) in some PHCs and all levels above PHC, vaccine storage facilities, normal deliveries in PHCs, and some sub-centres, etc. depend critically on the reliable power supply. SCs are mainly entrusted with services catering to women and children (delivery, vaccination). Thus just the expanded health care availability (increasing number of PHCs and SCs) may not necessarily translate to better health outcomes if there is no access to the reliable power supply. The outcomes due to the reliable power supply are explained in the subsequent slides in this report.

Lack of reliable electricity supply to Healthcare facilities

Under the Saubhagya scheme, though 99.9% of villages have been electrified, reliability and quality of power supply have not been achieved. To ensure a better healthcare facility in rural areas, unreliable power supply has to be phased out gradually.

Health facilities often face poor quality supply in the form of frequent interruptions, load shedding/ blackouts, and low voltage levels. Hours of supply and reliability in rural health centres are likely to be very similar to residential locations. Hence, longer duration cuts can break the cold chain and affect the storage of vaccines amongst other things.

Figure 39: Average hours of electricity supply to rural healthcare facilities (2019)



Source: Prayas Energy group, power perspectives

The above figure shows the hours of supply for rural locations in a few states in 2019. It was observed that for no state 24X7 reliable supply was available, which is a basic requisite for healthcare facilities. It can be inferred from the graph that the range of daily hours of supply was quite varied across states and months.

The case of Uttar Pradesh, which covers almost one-third population of India, has more disparity with respect to the reliable power supply as compared to Karnataka and Maharashtra.

Table 10: Understanding the Socio-economic impact of reliable supply of power in Health

Factors		Impact
Emission reductions	Benefits of replacing diesel generator sets with Solar Rooftop As per PHC guidelines, the plinth area should be in the range of 375 to 450 sq. meters. Considering the above guidelines, ~891 tonnes of CO2 emission can be mitigated over the life cycle of a Solar rooftop i.e.., 25 years (As per the National portal for Solar rooftops)	Environmental
Improving reliability	Benefits of Shifting from diesel generator sets to battery storage Battery storage pack prices, especially those based on Li-ion chemistries have fallen dramatically in the last decade, from $1,100/kWh in 2010 to $137/kWh in 2020, a drop of 89% in real terms (BloombergNEF 2020) Apart from increasing cost advantage, battery storage has very low land/space requirements and has quick response times (on the order of milliseconds) and can thus be a valuable contributor to providing reliable, uninterrupted, and quality 24X7 supply, especially in critical social and economic applications such as healthcare.	Environmental & Economic

Factors	Benefits	Impact
Cost savings	Considering the present cost of generation through diesel generators, the cost of electricity is ~Rs 14 to 15/ kWh for 2020. So, it is feasible to shift to a Solar rooftop which is cost-effective. The cost of generating electricity through Solar rooftops is ~Rs 2/ kWh (2020).	Economic
Better health services	The use of radiant warmers for new-born care, cold chain storage for vaccines, and night-time deliveries are all dependent on the availability of reliable power, thus facilitating in reducing of the Maternal Mortality rate (MMR) and Infant Mortality rate (IMR) (Note: According to NHM Portal, it can be seen that the rate of MMR decrease in UP is inconsistent when it is compared with Odisha's linear rate of decrease in MMR)	Social
Operating Cost	An unreliable power supply can damage appliances, pose safety risks, and prompt investments in protective equipment such as voltage stabilizers and surge protectors. Poor quality of electricity supply results in restricted use of appliances as well as increased costs of running the appliances.	Economic

The Solar PHC programme in Chhattisgarh: The genesis

Primary Health Centres (PHCs) in remote areas of Chhattisgarh faced serious difficulties in gaining access to reliable electricity which significantly affected their ability to provide quality healthcare services to the dependent population.

While officials at the National Health Mission (NHM) in Chhattisgarh were grappling with these challenges, the Chhattisgarh Renewable Energy Development Agency (CREDA) was already addressing the issues of access to electricity in tribal ashrams, hostels, and schools in remote areas of the state.

Various interactions during state-level meetings or events allowed both the State NHM and CREDA to learn about each other's work and the challenges they faced, leading to the genesis of the idea of installing Solar PV systems at PHCs that lacked access to reliable electricity.

The initial objective of NHM was to install Solar PV systems to provide power for basic lighting at PHCs.

However, CREDA returned with a comprehensive proposal for a system design that could support cold chain and other basic equipment along with lighting. This was welcomed by NHM, and in consultation with district-level NHM officials, PHCs that could benefit the most from such an intervention were identified.

The service conditions of the proposal specified that CREDA would be responsible for the operation and maintenance of the systems and the Solar systems would have a guaranteed warranty period of five years.

These conditions were instrumental in influencing the decision to install Solar PV systems at PHCs. The first installations took place in 2011–12, followed by further consultations leading to the subsequent expansion and installation of Solar PV systems in PHCs across all districts of Chhattisgarh.

Funds for this intervention were allocated under the Program Implementation Plan (PIP) of the State NHM between 2011 and 2013.

This initiative has been included among NHM's best practices and innovations, and has been recognised for improving the quality of healthcare service provided at PHCs through better access to electricity.

It is also a noteworthy example of interdepartmental collaboration enabling optimal outcomes, thereby ensuring significant benefits for citizens.

Key highlights

1

Powering Primary Healthcare through Solar to ensure reliable electricity supply

2

How?

Various interactions during state-level meetings or events lead to the idea of installing solar PV systems at PHCs

3

Outcomes

- ✓ Installation of solar PV systems to provide power for basic lighting at PHCs
- ✓ Reliable power supply cold chain and other basic equipment along with lighting

Building a Robust Healthcare Infrastructure with Access to Reliable Electricity

Energy access is crucial for maternal and child health. Global data suggests that over 289,000 women die every year from pregnancy-related complications. Reliable energy access for lighting and key medical equipment function, however, can avert such life-threatening complications that are impacting pregnant women and newborns in India and around the world. It is therefore imperative to equip the healthcare facilities in rural areas with reliable power to enable effective service delivery.

The two critical areas that could further strengthen India's healthcare sector are as follows,

a. Off-grid Energy solutions for Rural Healthcare

The GOI has already recognized the role of off-grid energy solutions in providing reliable power to rural households. The efforts in this direction helped India in achieving 100 percent household electrification recently. A similar approach needs to be taken up to extend electricity access to rural healthcare facilities in India. Renewable energy can provide a sustainable solution to the age-old problem of unreliable electricity supply. Off-grid (standalone/mini-grid) RE solutions are increasingly becoming cost-effective and sustainable, that is rapidly deployable and reliable to electrify healthcare centres while strengthening global efforts to achieve SDG 3 – Good health and well-being for all.

b. Increased policy support

Though India has achieved significant progress in household electrification in recent years, electrification of healthcare facilities continues to remain a major challenge, due to poor infrastructure, high maintenance costs, and inadequate policy support. There are well-defined central and state government policies for off-grid and grid-interactive Solar power plants. But there is no such policy or guiding document that exists on the installation and maintenance of off-grid Solar PV power plants for rural health centres. While the MNRE and State governments have laid out guidelines for the procurement and installation of off-grid PV power plants, there is still no policy directive on the maintenance of these off-grid PV plants in rural health centres. The maintenance of these off-grid power plants still remains with the state-level National Health Mission (NHM) offices / Health department/ Medical officers in PHCs or CHCs. As a result, the absence of a clear policy directive often leads to indefinite delays in maintenance work, depriving the health centres of reliable electricity access.

In such a scenario, it is important to have well defined guiding document for the stakeholders on procurement, installation, and especially for maintenance of the off-grid Solar PV power plants for PHCs and CHCs for effective healthcare service delivery.

As India emerges from the devastating impact of the pandemic, the health center needs a major overhaul and increased resource allocation to be future-ready, and reliable access to electricity should be at the center of our interventions.

As per the Draft Electricity (Rights of Consumers) Amendment Rules, 2021, the MoP has proposed a new rule 10(3) which notes that 'In view of the increasing pollution level particularly in the metros and the large cities, Distribution Licensee shall ensure 24x7 uninterrupted power supply to all the consumers so that there is no requirement of running the Diesel Generating sets.'

It further notes that 'Consumers, who are using the Diesel Generating sets as essential back up power, shall endeavor to shift to cleaner technology such as RE with battery storage, etc in five years from the date of the publication of this amendment or as per the timelines given by the State Commission for such replacement based on the reliability of supply by the distribution company in that city

Guidelines for electricity infrastructure for healthcare facilities

As per the Clinical Establishment Act Standards for Hospital 2010 (LEVEL 1A &1B hospitals) 'shall have 24 hr supply of electricity, either through direct supply or from other sources.

The Indian Public Health Standards (IPHS) lays down guidelines for District/Sub-District/Sub-Divisional Hospitals as well as for Sub-Centres, PHCs, and Community Centres. Guidelines related to electricity are noted in the table below and it clearly shows the critical need for a reliable electricity supply.

Type of Health Care Centre/Hospital	Guidelines related to electricity
Sub-Centres	Wherever facility exists, uninterrupted power supply has to be ensured for which inverter facility/Solar power facility is to be provided.
PHCs	The area chosen should have facilities for electricity; Requirements for a fully equipped and operational labour room: Electricity supply with back-up facility
Community Centres	The area chosen should have facilities for electricity; Blood storage facilities-Electricity: 24 x 7 hours supply is essential. Provision of back-up generator is required.

Understanding opportunity cost for unreliable power

It is widely recognized that health and well-being play a vital role in development and poverty reduction. Good health also represents instrumental values through the enhancement of opportunities to participate in education, training, and the labor market. Regular electricity access is necessary for deliveries, storage of vaccines, provision of emergency services, supply of clean water, and retention of skilled staff. It is quite self-evident that reliable electricity is paramount for the delivery of effective healthcare services. As per Rural Health Statistics 2018-19, the number of rural Health and Wellness Centres (upgraded SCs) have electricity along with power backup. Of the 7,821 HWCs in rural India, only 3,496 (45%) have an electricity backup facility.

The **Indian Public Health Standards, 2022 (IPHS)** lays down guidelines for District/Sub-District/Sub-Divisional Hospitals as well as for Sub-Centres, PHCs, and Community Centres which are tabulated below:

Type of Health Care centre/Hospital	Mandates as per the Guidelines
Sub-Centres	• The public health facilities should have access to adequate, and reliable electricity supply. (Page 17) • Appropriate power backup/inverter should be in place to ensure that there is no disruption of services, and the cold chain for vaccine and diagnostics is properly maintained (Page 17)
PHCs	• Ensuring it is adequately serviced by public utilities such as water, electricity and telephone connectivity, sewage, and storm-water disposal (Page 13) • Adequate power backup with another source such as DG, Photovoltaic, etc. should be there in synchronization with the first source (Annexure-4)
Community Centres	• The public health facilities should have access to the adequate, affordable, and reliable electricity supply (Page 17) • Ensuring it is adequately serviced by public utilities such as water, **electricity** and telephone connectivity, sewage, and storm-water disposal. In areas where these are not available, appropriate substitutes should be identified such as a deep well for water, **generators for electricity,** and radio communication for telephony. (Page 13) • Adequate powers back up with another source such as DG, Photovoltaic, etc. should be there in synchronization with the first source (Annexure-5)
Sub District Hospital and district Hospital	• Public health facilities should have access to the adequate, affordable, and reliable electricity supply (Page 19) • Adequate powers back up with another source such as DG, Photovoltaic, etc should be there in synchronization with the first source (page 105)

The healthcare sector has a high share of diesel Genset for backup power. This is due to poor quality of supply and the need for reliable 24X7 power in health services. Recently the Ministry of Power proposed Draft Electricity (Rights of Consumers) Amendment Rules, 2021 provided that:

"In view of the increasing pollution level particularly in the metros and the large cities, Distribution Licensee shall ensure 24x7 uninterrupted power supply to all the consumers, so that there is no requirement of running the Diesel Generating sets."

Solar +Storage for providing electricity access in Hilly/remote/rural Health centres

Solar + energy storage may be considered for health centres that are in hilly/remote/rural areas. This will not only reduce the CAPEX requirement of distribution companies as well as helps in providing a reliable power supply to the health centres.

Solar+ Storage for Providing reliable electricity in existing Health centres with access to electricity

Existing Health Centres with access to electricity can replace Diesel Generating Sets with Solar Rooftop with battery storage. As per the CEA Report on optimal generation capacity mix for FY 30, the cost of battery energy storage will reduce Rs. 7 Cr/MW in FY 22 to Rs. 4.3 Cr/MW for FY 30. The cost may be reduced in case of more adoption of energy storage systems and economies of scale. The comparison of the diesel set with the renewable battery storage is shown in the table below:

Particular	Battery Energy Storage	Diesel Generator Set
Current Rate/Tariff	4.04/kWh	89.66/Litres
Set Up Cost	7 Crore/MW	9 Crore/MW
Auxiliary Power Consumption	0% for Solar Plants, Only the battery dissipation happens	1.3 to 2.1%
Construction Time	0.5 Months	12-15 Months
Can CDM Benefit be Availed	Yes	No
Start up time from cold	Few Minutes	15-20 Minutes

Source: CEA and BEE Report

From the above table, it can be observed that there is a large number of benefits to the installation of renewable battery storage power Plants. Considering the poor reliability of electricity at health centres, it is advisable to go for the installation of renewable battery energy storage plants.

This technology will not only help in improving supply reliability and resiliency but it will also be cost-effective and can be deployed on a large. Implementation of such technology can be very critical in transforming rural health services

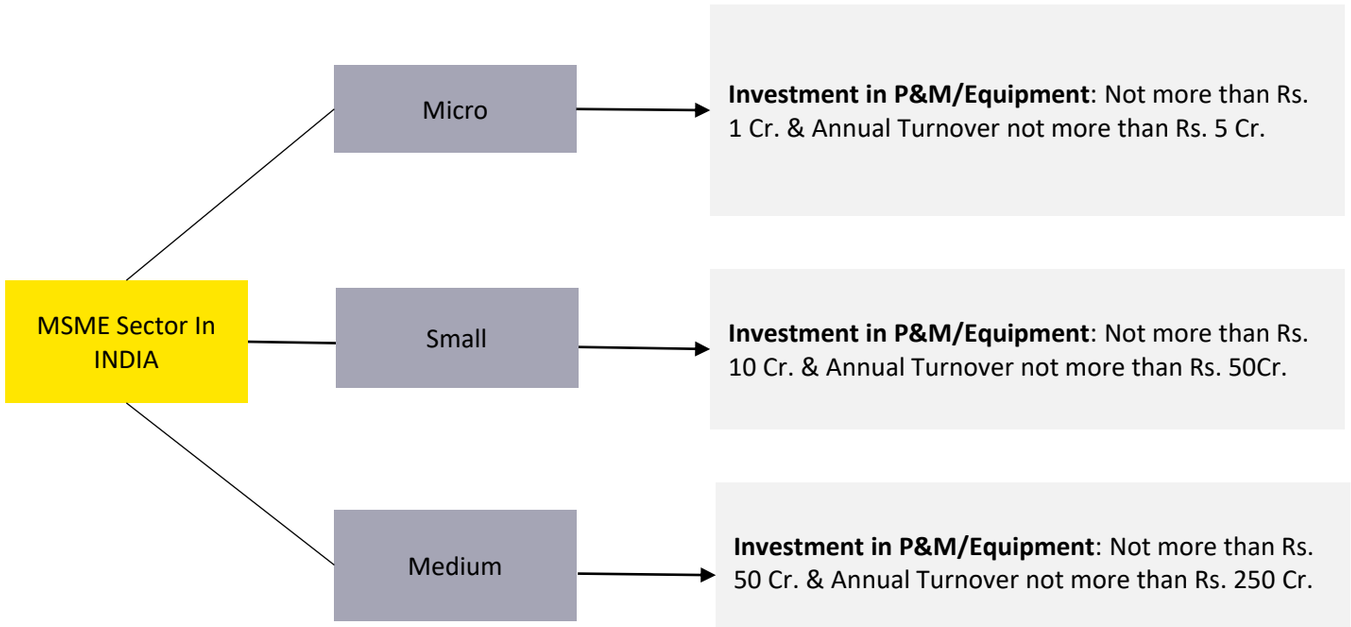
MSME

4.4 Analysing the Socio-economic impact of unreliable Power

Non-reliable power supply has been a major hurdle in the growth of micro, small and medium enterprises (MSMEs) in India. The problem of inadequate and erratic power supply is a long-standing issue that has continued to plague the sector, hindering its growth and development. MSMEs are particularly vulnerable to power outages as they do not have the financial resources to invest in costly backup systems

Power cuts not only disrupt production but also result in loss of revenue, affecting their competitiveness in the market. Moreover, a non-reliable power supply affects the quality of products manufactured by MSMEs. Lack of proper equipment maintenance due to frequent power cuts can lead to lower quality output, which can further erode their market share. The Indian government has initiated various schemes to address this issue, including subsidies for renewable energy sources and investment in infrastructure development.

The growth of Micro, Small and Medium Enterprises (MSMEs) in India has been hindered by the lack of reliable electricity. The unreliable power supply has resulted in high operating costs, reduced productivity and profitability, and limited expansion opportunities for these businesses. MSMEs account for a significant portion of India's economy, contributing to job creation and poverty reduction. However, without reliable electricity, their potential for growth is severely limited



Overview of MSME Sector

In a number of ways, the Micro, Small, and Medium Enterprises (MSME) sector benefits greatly from a dependable power supply:

Factors	Benefits	Impact
Productivity	With dependable power, MSMEs can work at their full limit without interferences or free time. Smooth production processes, minimal machinery breakdowns, and fewer production delays are guaranteed by a consistent power supply. MSMEs are able to meet market demand more effectively and increase their competitiveness as a result of this increase in output and productivity.	Economic
Enhanced Efficiency in the Operation	MSMEs can streamline their processes and optimize their operations with reliable power. It makes it possible for businesses to use technology, automated equipment, and electronic devices without being interrupted. MSMEs can adopt digital solutions for inventory management, sales, and customer relationship management with a stable power supply, resulting in increased operational efficiency and cost-effectiveness.	Social
Operating Cost	MSMEs may be able to save money by having reliable power. It is possible to significantly reduce reliance on alternative power sources, such as diesel generators, resulting in lower operational costs. Additionally, power fluctuations can help businesses avoid losses caused by equipment damage or product quality issues. MSMEs are able to allocate resources to other important aspects of business development, like marketing, talent acquisition, or technology upgrades, thanks to cost savings	Economic
Opportunities for Growth and Expansion	MSMEs are encouraged to pursue opportunities for expansion and growth when they have access to reliable power. Scaling up operations, increasing production capacity, and exploring new markets can all be planned and invested in with confidence by businesses. In regions with a robust energy supply, reliable power infrastructure encourages the establishment of micro, small, and medium-sized enterprises (MSMEs), which in turn fosters economic expansion	Economic
Economic Impact and the Creation of Jobs	The development of the economy and the creation of new jobs are directly impacted by the expansion of the MSME sector. An environment that encourages MSMEs to flourish, grow, and hire more employees is one that is supported by a dependable power supply. Not only are individuals and their families benefited by increased employment opportunities, but they also support local economies, contribute to economic stability, and lower unemployment rates	Socio-Econimic

In a number of ways, the Micro, Small, and Medium Enterprises (MSME) sector benefits greatly from a dependable power supply:

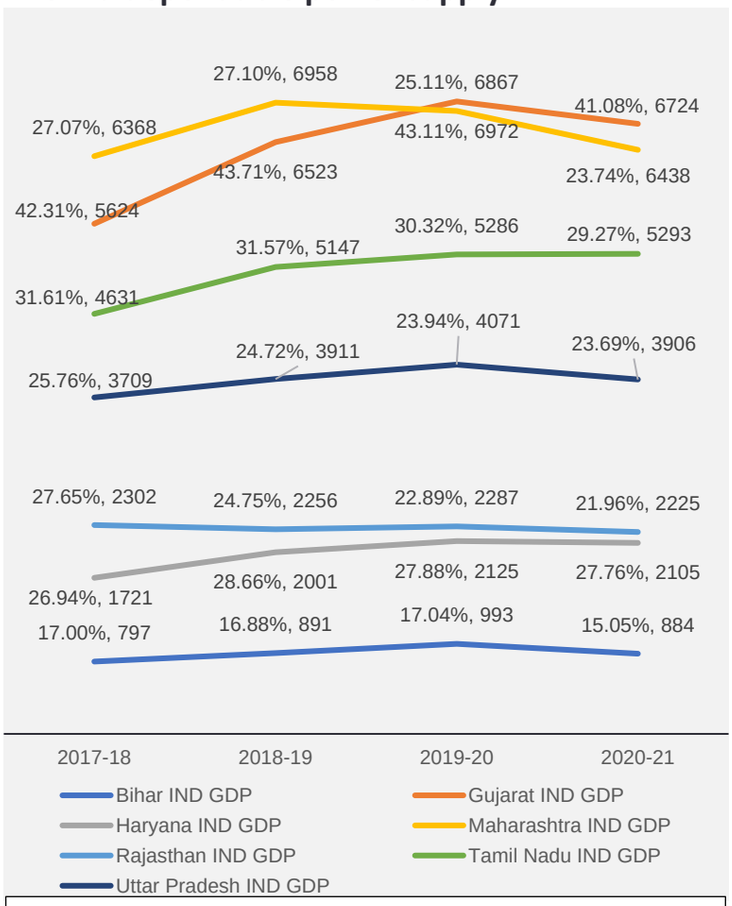


Fig.1 State Wise Industrial GDP in '00s Crore

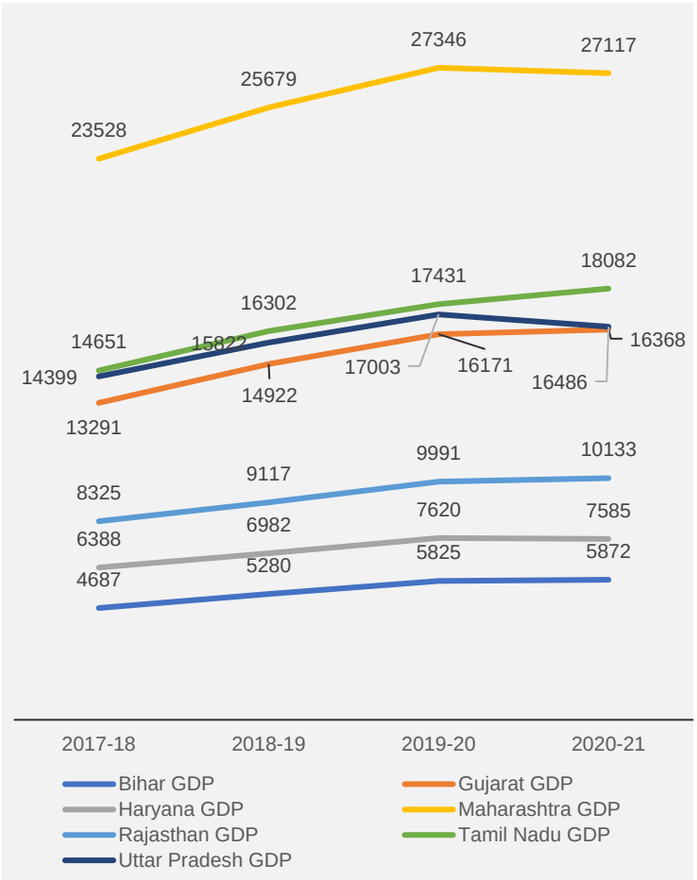


Fig.2 State wise GDP in '00s Crore

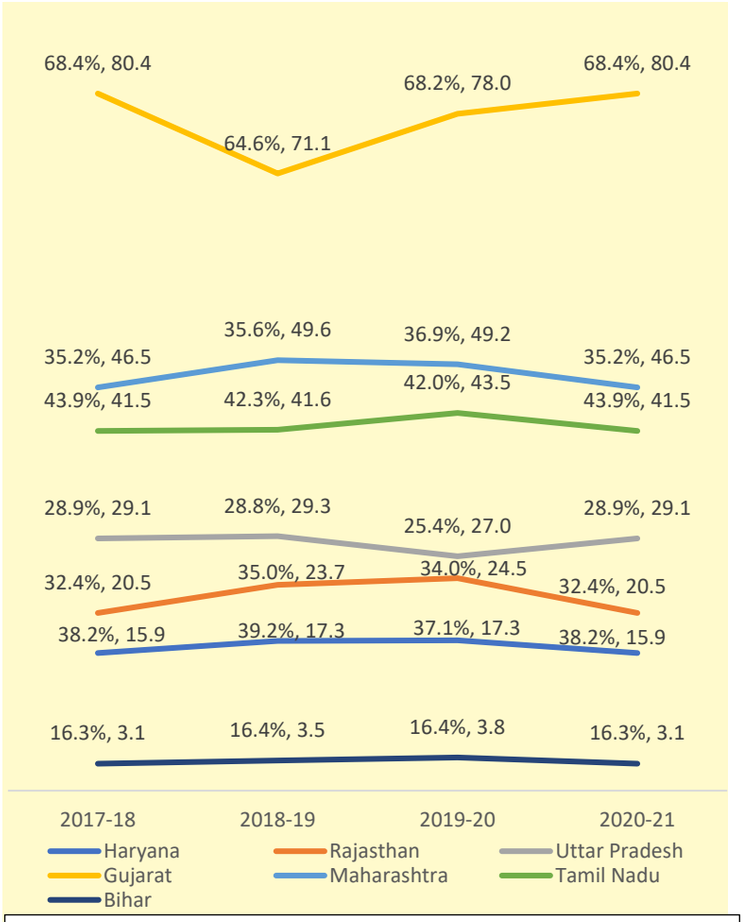


Fig. 3 State wise power consumption by Industries (in '000s)

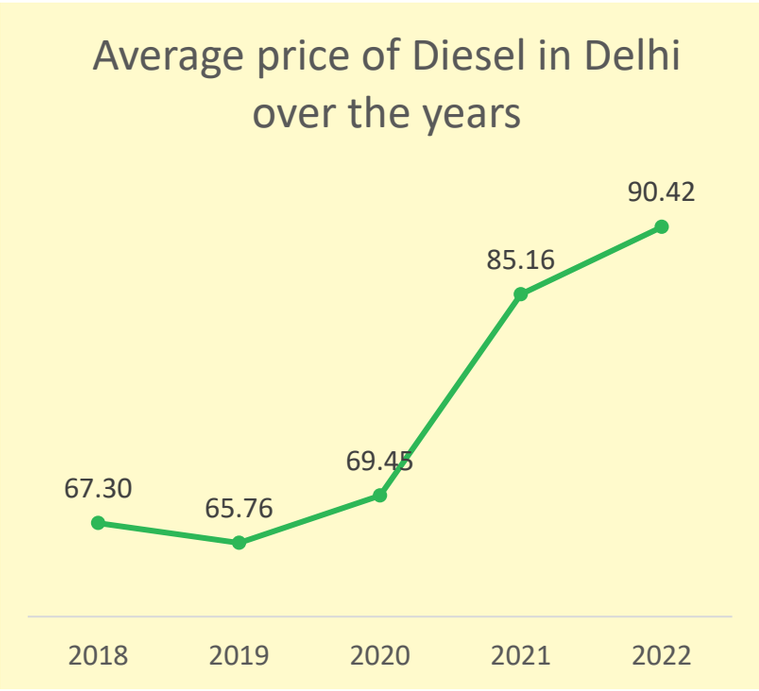
The above graph in Fig. 1 shows the state wise contribution of industrial sector towarsds GDP of states, it also shows the percentage contribution by industries to the overall GDP of the states. The Fig. 2 shows the overall GDP of some states. It can be seen from the graphs that with decrease in contribution by the the Industrial sector, the overall GDP of the state has also shown decline. This shows that Industries GDP has direct impact on the overall GDP of the state

By comparing Fig. 1 & Fig.3 We can see that power consumption by the industrial sector in any state is directly related to the GDP of that state

As we can see in Gujrat the major consumer of power is the industrial sector (Fig.3). & Simultaneously, also the industrial sector is one of the major contributors in the state GDP

Impact on MSMEs with DG set

DG are one of the most popular backup power solutions deployed in the country's MSME sector. However, in the past few years, many state governments & pollution control board banned DG due to its high polluting factor. Although, apart from pollution DG sets entail high operating costs, which are mainly on account of the high cost of fuel. Fuel cost comprises the biggest cost component in operating a DG set and accounts for 75-80 percent of the total lifetime costs. DG sets are popular as a power backup solution for commercial and industrial (C&I) power consumers and come in handy during outages and other unpredictable issues in electricity supply. The higher cost of electricity generation from DG sets is offset by revenue accretion activities that continue unhindered despite outages

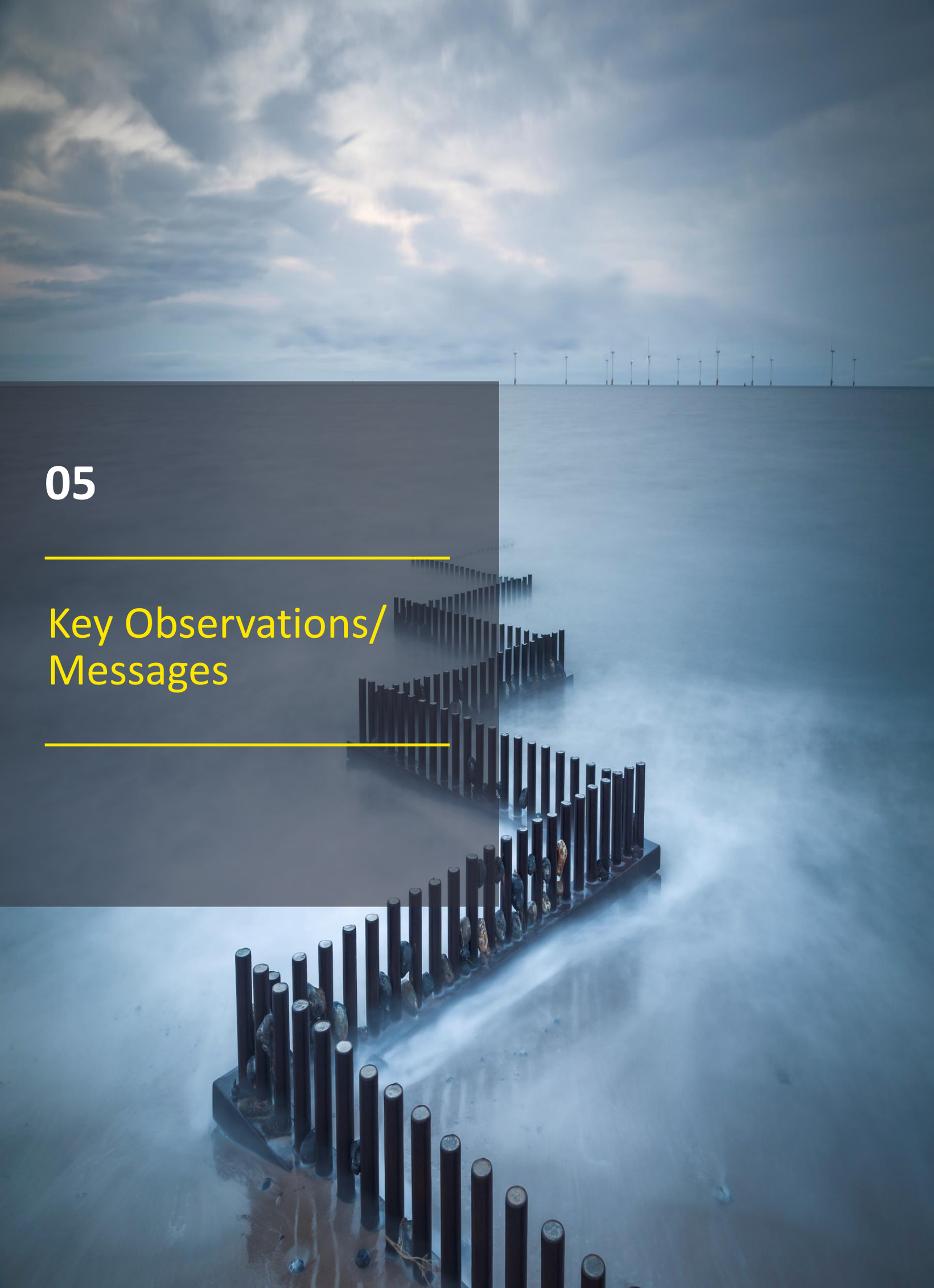


Source : petroldieselprice.com

As we can see the price of diesel in Delhi increased from around 67 Rs. to around 90 Rs. & as we said above that the fuel cost comprises the biggest component in DG operating cost we can clearly see how a hike in diesel price can affect the whole MSME sector.

The increase in the price of diesel on account of all these factors will make electricity from DG sets more expensive.

Here, we also get to know how important it is to provide reliable power for the growth of the MSME sector.

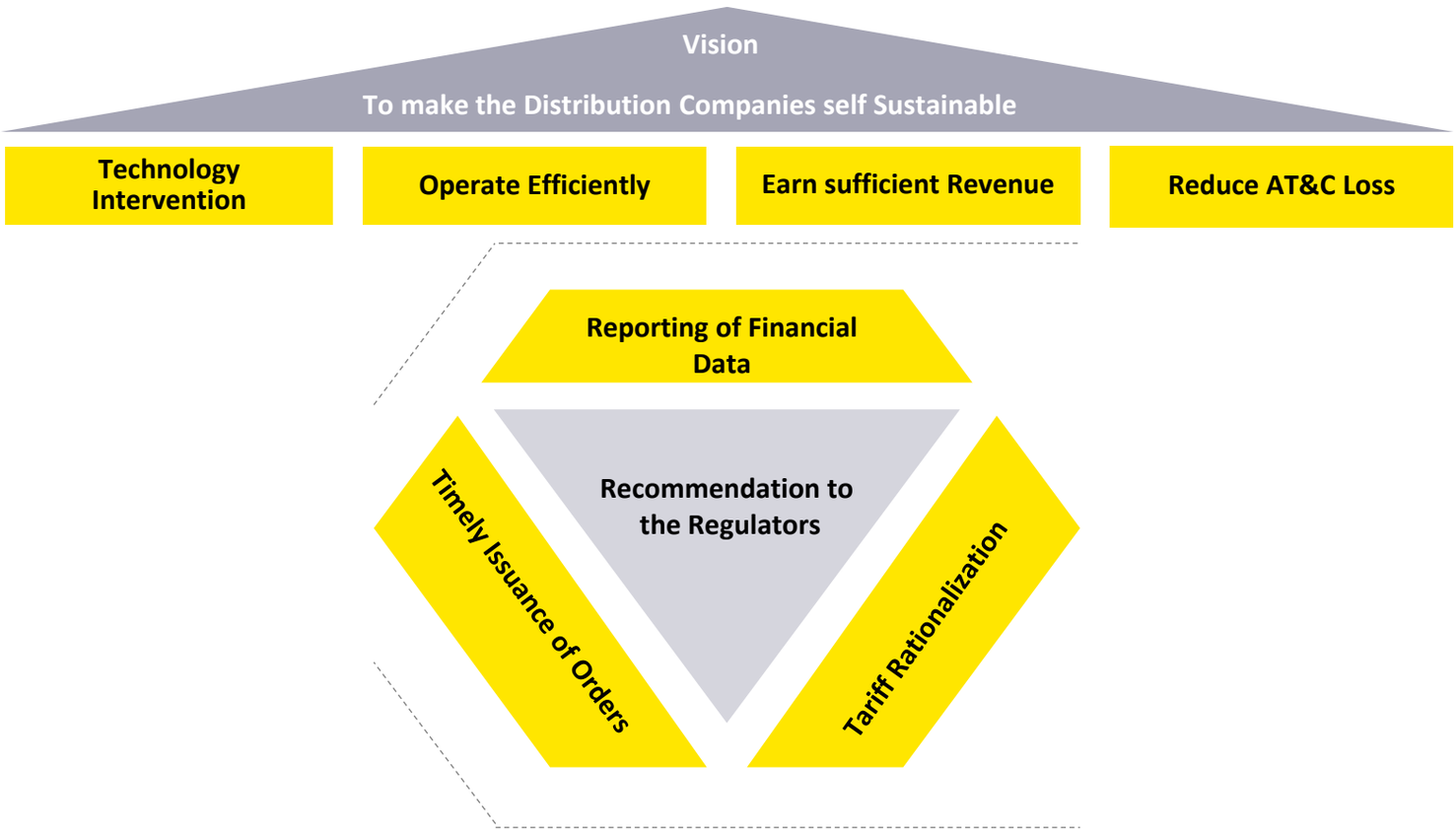


05

Key Observations/ Messages

5.0 Key Observations/ Messages

The Electricity Act, of 2003 recognizes the retail supply of electricity service separately for the purpose of determination of tariff under clause (a) of subsection (1) of Section 86, but it is covered as part of distribution under Section 14 of the Act. The risks involved in the distribution and retail supply of electricity are different from, the transmission and generation of electricity. The internal rate of return of the distribution companies has been abysmal during the last decade and there is a need to give due attention to it for ensuring growth.



- **Reporting of Financial data:** Lack of consistent, reliable, and updated data is a primary barrier to sound business management. It has been observed that many States owned distribution utilities such as Uttar Pradesh, and North Eastern States Utilities do not publish consumer standard performance-related data on their website. Enforcement of timely tariff filing and quality in financial reporting will not only help in monitoring and performance benchmarking but will also help in planning and decision-making. A statutory requirement for utilities to regularly collect primary financial and operational data is advisable. Third-party monitoring/validations may be encouraged.

- **Timely issuance of Orders:** The Electricity Act, of 2003 mandates the issue of Tariff orders in 120 days. However, it is observed many SERCs count the 120 days after the admittance of the tariff petition and not from the day of filing of the tariff petition. This is due to incomplete information provided by the Licensee, Data Gaps in the Petition. This resulted in a delay in the issuance of the Tariff Order. Also, many SERCs are not able to conduct timely hearings of the Petition resulting in a delay in the decision. This can be expedited by the fulfillment of vacant posts of the staff of the Commission.

- **Tariff Rationalisation:** The Act envisages that the retail tariff should be rationalized and shall be telescopic in nature. Various States Commission in their several orders has tried to reduce the tariff of different consumer categories. However, still many States such as Uttar Pradesh, and Chhattisgarh have more than 10 tariff categories. Further, adequate and regular tariff revisions need to be the basic foundation of the sustainable functioning of distribution utilities.

Stakeholders and their Roles

The Electricity Act, of 2003 recognizes the retail supply of electricity service separately for the purpose of determination of tariff under clause (a) of subsection (1) of Section 86, but it is covered as part of distribution under Section 14 of the Act. The risks involved in the distribution and retail supply of electricity are different from, the transmission and generation of electricity. The internal rate of return of the distribution companies has been abysmal during the last decade and there is a need to give due attention to it for ensuring growth.

Vision

To make the Distribution Companies self Sustainable

Technology Intervention	Operate Efficiently	Earn sufficient Revenue	Reduce AT&C Loss

Major Stakeholders in Power Sector

1

Policymakers

Ministry of Power is responsible for evolving general Policy in the field of energy. Various departments such as CEA, REC, PFC make the policy and guidelines for the scheme on behalf of Ministry of Power.

2

States

Since Electricity is a concurrent subject, States make the policy in order to promote investments in the State. States as per EA, 2003 appoint the bench for Regulatory Commission

3

Distribution Licensee

Authorised to operate and maintain a distribution system for supplying electricity to the consumers in his area of supply

4

Industries

Perform Business Transactions as per the guidelines of Ministry of Power, Regulations of the SERC and CERC, and policy issued by the States. Helps in bringing competition in the State

Regulators

Perform duties as per Section 86 of the Electricity Act, 2003. Regulates electricity purchase and procurement process, determines tariff, adjudicates disputes between the Licensees

Consumers

Consumer consume Power and Pay tariff as per the Tariff Order of the Regulatory Commission. Promote usage of energy efficient devices.

Recommendations

Reporting of performance related data	▶ Lack of consistent, reliable and updated data is a primary barrier to sound business management. Many States Owned distribution utilities such as Uttar Pradesh, North Eastern States Utilities do not publish Consumer standard performance related data on there website. A statutory requirement for utilities to regularly collect operational data is advisable. Third-party monitoring/validations may be encouraged.
Timely Issuance of Tariff order	▶ Issuance of Timely Orders is mandated as per Electricity Act, 2003. However it is observed many SERC count the 120 days after the admittance of the Tariff Petition due to data gaps/deficiency in the Petition. ▶ It is recommended that process can be expedited by filling up the vacant post of the administrative officers of the Commission.
Tariff Rationalisation	▶ Electricity Act envisages rationalization of the Tariff. Many States such as Uttar Pradesh, Chhattisgarh has more than 10 Tariff Categories. ▶ Rationalization of Tariff Categories will reduce complexity across Tariff categories and will reduce inconsistency in the categorization of certain categories. Also adjusting the two-part tariff to accurately reflect the actual fixed and variable costs will improve cashflow of the DISCOMs.
Availability of Full Bench	▶ Section 82 of the Electricity Act, 2003 requires the State Commission should consists of three members including the chairperson. Further Supreme court in 2018 has also mandated requirement of legal member in the quorum. ▶ It is recommended that the legal member may be accommodated in the bench of the quorum for full functioning of the Commission.

Possible Solutions

1

Functioning of full bench

An effective SERC is essential to a well-functioning distribution sector. All members in the bench should be there for expedition of the process. There should be e-hearing of Petitions filed section 142 of the Act for consumers.

Digital filing of Petitions

Many SERC has implemented the efiling portal for filing of the Petiitons. It is recommended all States to implement, to expediate the process

2

3

Training of Commission Officials

The operation and management of the power distribution business are quite complex. Regular Training helps in improving the skillset and expedition of the process

Recommendations for Policy Makers

Roles of Policy Makers

Under Section 3 of the Electricity Act, 2003, the Central Government (Ministry of power) is responsible for preparation of national electricity policy and tariff Policy in consultation with the State government. Further under various provisions of the Electricity Act, 2003, the State government is powered to make rules.

The Major roles performed by the Central and State Government are:

- General Policy in the electric power sector and issues relating to energy policy and coordination thereof.
- Research, development and technical assistance relating to hydro-electric and thermal power, transmission system network and distribution systems in the States/UTs
- Planning for Long term perspective planning for generation of power and execution of power projects
- Plans and oversee appropriate investments in the power sector, both in the public and private domains
- Enactment of appropriate legislation and framing of rules to facilitate the expeditious development of infrastructure in generation, transmission and distribution of electricity in the states and in the Country

Problem Statement for Policymakers

1. Regular Bailout Packages being provided for functioning of Departments
2. Incease in fuel prices and growing demand of power, there is concern of providing affordable power to the consumers
3. The Policy does not investigate the issues around clearances,, continuance of old and inefficient plants and other regulatory challenges
4. Major players in Power sectors are Governments departments which are dependent on the funding provided by governments

Recommendations

Regulatory Reforms	Challenges such as land acquisition issues, increase in duty hinder the timely completion of the projects and increase the CAPEX of the project. It is recommended to include the provisions in the policies to reduce such challenges faced by the developers.
Provision of Corporate Governance	The current provisions of electricity or tariff/electricity policy does not provide any provision of corporate governance. Central PSUs like NTPC and PGCIL have better corporate governance record than State DISCOMs. It is recommended to include corporate governance in the provision of the policy.
Increasing Competition	Increase in competition will not only reduce monopoly but also provide more choices to the customers. It is recommended that various steps taken such introduction of MBED, DBT mechanisms should be implemented on a large scale to increase competitiveness.
Provisions of Methodology for Charges	Tariff Policy, 2016 provides the detailed methodology for computation of cross-subsidy surcharge. However, there are other charges which are levied on open access consumers such additional surcharge, wheeling charges etc. It is recommended that the policy may provide detail methodology for determination of charges.
Promotion of New Technologies	The current electricity policy was designed in 2006 keeping in view the improvement in power quality reforms. However, the sector is continuously evolving with the changes in technology such as blockchain, IOT etc. It is recommended to redesign new policy with consideration of new technologies.

Possible Solutions

1

Upgradation of policies

It is recommended that continuous changes in Polices will cover the changing prospects of the sector. A new electricity policy will cover the challenges faced by people

Pilot implementation

Pilot Implementation provides a detailed overview of the problems. It is recommended that pilot implementation may be done for MBED, DBT mechanisms in large scale.

2

3

Creation of online portal for complaints

There is already a mechanism for consumer grievance incase of complaint to DISCOMs. Such mechanism should be there for all related parties rather than approaching Commission.

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Recommendations for States

Roles for States

Under various sections of the Electricity Act, 2003, the State government is powered to make rules.

The Major roles performed by the State Government are:

- Creation of Transfer scheme for unbundling of the Electricity Board
- To provide access to electricity to all areas including villages and hamlets through rural electricity infrastructure and electrification of households.
- To manage all aspects of Power sector co-ordination with the central and state level power utilities in a manner that the resources and activities are judiciously covered
- To formulate plans, policies, acts, rules and undertake development activities for better generation, transmission and distribution of electricity for overall development of the society
- To formulate policies, rules to ensure electrical safety and conservation of Power
- Release to timely subsidy to the utilities for any specific category
- Provision of Grants and Loans to the State Commission as that Government may consider necessary
- Creation of Special Courts for the purposes of providing speedy trial of offences referred to sections 135 to 140 and section 150 of the Electricity Act, 2003
- Creation of Rules for works of licensees affecting the property of other persons under sub- section(2) of section 67 of the Electricity Act, 2003
- Preparation of rules in which State Commission shall prepare its Annual Budget, Annual report and Annual Accounts.

Problem Statement for States

1. Long Pending dues from Government department
2. Continuous infusion of grant for financial viability
3. Resistance from Unions for Private participation specially in distribution sector
4. Timely selection of Committee for selection of the members and chairperson for the Commission

Recommendations

Advance payment of Subsidy and timely payment of dues	The section 65 of the Electricity Act, 2003 mandates for advance payment of subsidy to the DISCOMs for the upcoming Financial year. However currently states only declare the amount of subsidy they will provide to the DISCOMs and does not pay the advance subsidy. Due to this, the DISCOMs faces the issue of working capital requirement. Also States should ensure timely payment of Bills of Govt. departments.
Constitution of Committee for selection of SERC Members	The Section 85 of the Electricity Act, 2003 clause 2 provide that if there is a occurrence of vacancy in the Coram of the State Commission, the State government shall within a month make a reference to the selection committee for filling up the vacancy. The States should ensure that there is full bench available in the Commission for speedy redressal of the Issues related to the electricity.
Encourage Competition	In last few years, promising models of distribution franchisees have been developed to obtain efficiencies in distribution. However, the same is yet to find large scale acceptance and further scalability in states who have already implemented such models

Possible Solutions

1

Implementation of Prepaid Meters in Govt. Dept

In order to reduce the working capital requirement of DISCOMs, the State government should mandate the requirement of prepaid meters in the Govt. Departments.

Timely Creation of Committee

It is recommended that State Government should have mandate for timely creation of committee for selection of member of the Commission.

2

3

Creation of Policy Framework for promotion of Competition

Many States has amended existing policies as well release new policies such as EV, Solar, wind based on the potential in the State. It can be expediated by creation of a portal where suggestions from the public can be taken for the improvement.

Recommendations for Distribution Licensee

Roles of Distribution Licensee

The major functions performed by Distribution Licensees are:

- To develop and maintain an efficient, co-ordinated and economical distribution system in his area of supply and to supply electricity
- To undertake the activities of distribution to all consumers irrespective of the voltage, provision, supply, wheeling, purchase, sale, import, export and trading of electricity, introduce open access in distribution as per the Electricity Act,2003 and/or the directions of the regulator.
- Perform duties as per the Licence provided by the Commission
- Provide quality supply of electricity to the consumers
- Comply with the directions provided by the Regional Load Despatch centre, Regulatory Commission and State Load Despatch Centre.
- To provide supply of electricity on receipt of request.
- To undertake Rural Electrification schemes in the licensed area
- To comply with standard of performance regulations
- To work for promotion, development and maintenance of Power Distribution Network including provision of adequate and reliable power supply in the State.
- To make a befitting contribution to the overall development of the State
- To collect electricity duty against energy sold on behalf of State Government.

Problem Statement for Distribution Licensee

1

High Power Purchase Cost

Power purchase cost comprises of 85% of the discom expenses. Incase of any deviation it effects the finances of DISCOMs

3

Low Consumer Services

Major State owned DISCOM fails in providing good services to the consumers.

2

High AT&C Loss

Almost all DISCOMs have high AT&C Loss due to low collection and billng effciency

4

Delay in filing of Tariff and other Petitions

DISCOMs are guided by the MYT Regulations in which they have to file timely tariff and FAC Petition.

Recommendations

Timely Filing of Petition	Distribution companies work as per the licensee provided to them by the SERC as per Section 14 of the Electricity Act, 2003. If the Discom timely file the Tariff Petition for the ensuing year, the new Tariff can reduce the burden of the distribution companies.
Optimisation of Power Purchase Cost	It has been observed that most of the better performing Distribution utilities have relatively lower power procurement cost per unit and higher cost coverage. It is therefore recommended that Distribution utilities, with low cost coverage and high power procurement cost, should focus on prudent power procurement mechanisms.
Strengthening techno-commercial efficiency	Most of the distribution utilities having high AT&C losses should focus on strengthening metering, billing and collections to improve the commercial efficacy of the Distribution utilities. It is therefore recommended that the Distribution utilities should strive to adhere to the loss reduction targets set by the respective SERCs
Procurement Policy for Energy Efficient devices	Distribution Utilities may revise there procurement policy and should encourage usage of 5 star/rated energy efficient devices like Distribution Transformer.

Possible Solutions

1

Deployment of Tools for demand forecasting

Proper demand forecasting will not only reduce the requirement of costly power from short term market but also better manages the requirement load curve.

Regular Energy Audit

Energy Audit keeps a check on the pilferage but also provides direction on the grey areas where there is a huge technical losses.

2

3

Deployment of Smart meters

Smart Meters can not only reduce the working capital requirement but also increase the collection and billing effciency.

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Recommendations for Consumers

The Electricity Act, 2003 defines the consumers as:

Any person who is supplied with electricity for his own use by a licensee or the Government or by any other person engaged in the business of supplying electricity to the public under this Act or any other law for the time being in force and includes any person whose premises are for the time being connected for the purpose of receiving electricity with the works of a licensee, the Government or such other person, as the case may be.

The various types of consumer based on the consumption of the distribution companies are:

- Domestic consumers
- Agricultural consumers
- Industrial consumers
- Commercial consumers
- Bulk Supply
- Railway Traction

Problem Statement for consumers

1. **Lack of Consumer Services**
   As there is no direct cost benefit in increase in consumer care Centre, hence DISCOMs prefer less to invest on new customer care Centre.

2. **Lack of clarity for energy saving**
   There is less information of energy saving benefits which a consumer gets directly, and very little knowledge is available for consumers for energy saving

3. **Lack of information on DSM**
   Demand side Management initiatives not only reduces the requirement of peak power but also flattens the load curve. The consumers are unaware of such developments

4. **Less knowledge for Delayed Payment Surcharge**
   Delay in payment of bills leads to application of delayed payment surcharge. Consumers are unaware of such penalty and do not pay bills on time

Recommendations

DSM adoption	Adoption of Demand Side Response initiatives can not only reduces the requirement of power at peak hours but also reduces the wastage of the energy. These initiatives flatten the load curve which helps the utilities in better planning and management. It is recommended that the consumers should reduce there unwanted consumption during the peak hours
Energy saving	Energy Saving not only reduce the wastage of heat but also reduces the requirement of additional capacity Installation. It is recommended that the consumers may adopt the energy saving devices which reduces there electricity bill and also the demand pattern.
Timely payment of electricity bill	Consumers are recommended for timely payment of bills to avoid Late payment surcharge and prepayment of bills using prepaid meters to avail the facility of rebate.

Possible Solutions

1

Strengthening of Customer care centers

Customer care centers not only helps in delivering services but also improves the DISCOMs service rating.

Promotion of consumer awareness programs

There is regular requirement of consumer awareness programs for timely payment of bills. It will reduce the short-term capital requirement of the DISCOMs.

2

3

Providing changeover options

There is requirement of differentiation of wire and supply business. This will reduce the monopoly as well as improvement of services to the consumers

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Recommendations for Industries

Industries are the bulk consumer of electricity for any distribution companies and also pay the cross subsidy surcharge for other consumer categories

Though many Industrial consumers procure power through open access so that they can avail cheaper electricity and also to meet their RPOs . However because of continuous increase in the cross-subsidy surcharge at times makes this industry less competitive in the international market.

A glimpse of the cross subsidy surcharge is shown below:

State	FY 18	FY 19	FY 20	FY 21
Chhattisgarh	1.68	1.23	0.85	1.31
Maharashtra	1.63	1.57	1.58	1.67
Uttar Pradesh	0.60	0.63	-	1.47

1

Lack of Awareness for environment hazards

Industries are the front runner in adoption of technologies. But due to lack of awareness against the environment hazards, industries are not able to adopt the updated technologies.

2

Lack of Promotion for Energy Audit

Energy Audit helps in identifying the areas where energy can be conserved, which can result into reducing energy bill. However, there is little or less awareness about the energy audit and PAT scheme.

3

Awareness about the climate change initiatives

The country in COP 26 declared a target to achieve net zero emission by 2070. However, there is very little awareness what each consumer segment can play in achieving the said target.

Recommendations

Declaration of Net Zero Target	India in COP 26 has declared a Target of addition of RE capacity of 500 GW by 2030. Also the Target to achieve net zero emissions is set as 2070. This can be achieved when major consumers shift there energy usage towards cleaner fuels. Many industries have declared there individual target to achieve the Net zero emission. It is recommended that more Industries should come forward and declare the Target
Adoption of Energy Efficienct Devices	Energy Efficient devices not only reduces the Energy bills of the Industries, but also helps in enhanced compettiveness and reduced operation and mainatenance cost. Also regular energy audits helps in finding out the improvement areas where energy leakages are there. It is recommended that the Industries must adopt regular energy audit as well as usage of energy effcient appliances
Adoption of Technology	Adoption of Technologies not only helps in making business cost efficienct but also make product lucrative to the consumers. There are various technolgies such as IOT, Block Chain which need to be adopted by the Industries on a large scale.

Possible solutions

1

Promotion for Energy Audit

DISCOMs need to promote energy audit requirement for the industries. This will reduce the requirement of active and reactive power of the industries in the peak hours

Introduction of Green Tariff

DISCOMs need to take approval for Green tariff from the Commission. Thus, it will help industries to meet their net zero target without spending any capex.

2

3

Active Engagement

Industrial organization need to actively engage with the government and other stakeholders for introduction of new technologies.

Promotion of Renewable technologies

Renewable Technologies can reduce the auxiliary consumption requirement of the industries. It is recommended for promotion & adoption of such technologies.

4

06

Way Forward

6.0 Way Forward

Many reforms and schemes have been introduced in the past for improving the distribution sector. However, most of the state DISCOMs are still reeling under financial and operational stress leading to unreliable and poor quality supply of electricity. In order to have a vibrant Indian power sector, it is imperative to improve the shortcomings of the distribution sector which can be achieved through concerted efforts from all policymakers/ regulators.

Some of the major goals include,

Short-term goals:

a. Separation of Carriage and Content

The idea of 'Separation of Carriage and Content' was first introduced by GoI in Electricity (Amendment) Act, of 2014. Through this, the government proposed to segregate the distribution network business and the electricity supply business to promote competition, efficiency in operations, and improvement in the quality of supply of electricity. But, due to resistance from the stakeholders, the idea was procrastinated for years. Many reforms in the past such as the distribution franchisee system and parallel licensing have been introduced in haste which has not resulted in reducing the financial losses of DISCOMs. Therefore, before the full implementation of “Separation of Carriage and Content”, the government should carry out more number of pilot projects in some of the big cities of India to check the viability of the proposed system.

b. Direct Benefit Transfer

State DISCOMs at present use cross-subsidy (charged to industries) and direct annual subsidy (received from state governments) to recover their losses incurred by providing cheaper power to designated users. The subsidy, however, is used by DISCOMs to not only recover their losses but also to cover their operational inefficiencies.

Therefore, to prevent the misuse of subsidies by DISCOMs, states should provide electricity subsidies through DBT, which is an efficient subsidy delivery mechanism. DBT will serve as an important tool for channelling the subsidies to where they need to go, checking the wastage of public funds, and preventing the scope of corruption there.

The DBT scheme for Liquefied Petroleum Gas (LPG) has been a huge success. After the launch of the scheme, the LPG cylinders are sold to customers at market prices by the distribution licensees and customers directly receive LPG subsidies in their bank accounts. The government has saved INR 26,408 crore after the implementation of DBT in LPG. (According to LPG PAHAL scheme)

c. Implementing smart metering & pre-paid metering

To reduce AT&C losses, the installation of smart meters and the concept of pre-paid metering should be paced up by DISCOMs to reduce power theft.

d. Proper power procurement planning

Around 70 percent of DISCOMs expenditure is on power purchases. It is, therefore, imperative for DISCOMs to optimize their power procurement. An improvement in load forecasting and power procurement from different cheaper sources will result in increasing gross margin and energy availability for DISCOMs.

Medium and Long term goals:

a. Bringing dynamic change in Regulatory Governance

Electricity Regulatory Commissions have an important role to play in the proper functioning of the distribution sector. As suggested in Electricity Bill 2020- The Electricity Contract Enforcement Authority (ECEA) under Section 109 (A) of the Bill will be set up to resolve matters relating to the contracts of sale, purchase, and transmission of power between two or more parties. This will improve the business environment both for the government and developers.

b. Elimination of Cross subsidies

As stipulated in Electricity Act 2003; National Electricity Policy, 2005; and Tariff policy, 2006, State Electricity Regulatory Commissioners (SERCs) should take steps for reducing/eliminating cross-subsidies to benefit industries.

c. Phase-wise Renewable Integration

In order to increase the penetration of RE power, reduce their power procurement cost, and handle this variety of power sources, DISCOMs can deploy large-scale energy storage or use hybrid projects such as solar/wind. Storage can be provided by battery systems or pumped hydro-storage systems. Curtailment of renewable power can be reduced by improving the transmission grid, accounting for dynamic changes in transmission capacity, and by retrofitting old thermal plants to enable them to operate at lower loads.

Discoms need to develop better RE forecasting capabilities to reduce their deviation costs and reduce the need for real-time balancing. Currently, many DISCOMs and regulators fear that the rise of Rooftop Solar can harm their revenue stream. Discoms should be fairly compensated for the additional expenses they need to incur to integrate RTS power generation. Further, tariffs for RTS should be set so that all consumers and producers face fair and relevant price signals as relevant to their state. Such initiatives can resolve the issue of quality and reliable power supply across Agriculture, Health, and Education respectively.

Off-grid solar power plants are simpler and cheaper than grid-connected solar plants, though they may require storage. Such off-grid solar plants should receive greater policy encouragement. While the grid has reached most households, the quality and availability of power is still poor in many remote areas. In such areas, mini and microgrids can provide more predictable power. Mini-grids can also be used to provide greater resilience to critical infrastructure. Generally, the cost of mini-grid power is much higher than power from DISCOM.

A PPP model can be explored in such remote areas, with the government providing VGF (or charging a premium, as the case may be) in return for the concessionaire supplying power at a specified Turning Around the Power Distribution Sector. The mini-grid could also act as a distribution franchisee.

d. Conceptualising Power Council for involving states in Central decision-making

Electricity is mentioned in the Constitution's concurrent list, which means that both central and state governments can regulate the sector. Central and state governments are expected to work together to create a secure, affordable, and environmentally friendly electricity system.

The Goods and Services Tax Council (GST) in India offers a promising model for utilizing cooperative federalism to advance a national reform. As a constitutional body, the GST Council has the power to make decisions binding on all political parties. The Council must have a three-quarters majority in order to pass any decision. The objective of the Council is to bring the Indian states and central government together on a single platform.

Indian power sector can adopt a power Council similar to GST council to involve state power ministries in national decision-making. Voting percentage may be specified in the Electricity Act. The Council can make decisions after discussion on interrelated matters such as tariffs, privatisation, subsidies, and grid-decarbonization.

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FICCI, Federation House, Tansen Marg, New Delhi 110001
Website: www.ficci.in
Email: power@ficci.com; renewables@ficci.com

Connect Us

- Mr Arpan Gupta, Additional Director & Head - Mines, Metals, Cement, Power, Coal, Hydrocarbons and Renewable Energy, FICCI (E-mail: arpan.gupta@ficci.com)
- Mr Nishit Jain, Deputy Director – Power & Renewables, FICCI (E-mail: nishit.jain@ficci.com)

Contributors

- Ms. Jyoti Vij, Additional Director General, FICCI
- Mr Arpan Gupta, Additional Director & Head - Mines, Metals, Cement, Power, Coal, Hydrocarbons and Renewable Energy, FICCI
- Mr Nishit Jain, Deputy Director – Power & Renewables, FICCI

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- Mr Ganesh Srinivasan, Co-Chair, FICCI Power Committee and CEO, Tata Power Delhi Distribution Ltd.
- Mr Mayur Karmarkar, Managing Director, International Copper Association India
- Mr Manas Kundu, Advisor Energy - Regulatory Affairs, International Copper Association India

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