Report on Short-Term Power Market in India: 2022-23

Economics Division
Central Electricity Regulatory Commission

Report on
Short-Term Power Market in India
2022-23

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Contents

List of Tables

List of Figures

Preface

The Electricity Act 2003 consolidates the laws relating to the generation, transmission, distribution, trading, and use of electricity and generally for taking measures conducive to the development of electricity industry, promoting competition therein, protecting the interest of consumers and supply of electricity to all areas, rationalization of electricity tariff, ensuring transparent policies, etc. This is further strengthened by the regulatory initiatives of the Electricity Regulatory Commissions through various regulations and orders required to enable a framework for a robust and healthy power market in the country.

The Central Electricity Regulatory Commission sets the regulatory process in motion through Trading License Regulations, Open Access Regulations, Power Market Regulations, REC Regulations, Deviation Settlement Mechanism Regulations, Ancillary Services Regulations, and Cross Border Trade of Electricity Regulations. Under these regulations, the short-term power market covers contracts of less than a year for electricity transacted through Inter-State Trading Licensees and directly by the Distribution Licensees, on Power Exchanges, and Deviation Settlement Mechanism. The short-term power market, as an integral part of the power sector, has been beneficial for meeting the short-term needs of consumers, suppliers, and the sector as a whole. In 2022-23, the short-term market constituted about 12% per cent of the total electricity generation in India.

The annual report on the short-term power market in India provides a snapshot of short-term transactions of electricity through different instruments used by various market participants. The Central Electricity Regulatory Commission brings out this report with the objective of keeping market participants and other stakeholders aware and updated on the state of the power market in the country. The dissemination of information through the report is one of the key elements to ensure efficiency and competition in the sector and for stakeholders and consumers to maintain faith in the system. This report covers an overview of the power sector, trends in short-term transactions of electricity on annual, monthly, and daily basis, time of the day variation

in volume and price of electricity, trading margin for bilateral transactions, analysis of transactions carried out by various types of participants with emphasis on open access consumers on power exchanges, effect of congestion on volume of electricity traded on power exchanges, and ancillary services operations. The report also covers cross border trade of electricity between India and its neighbouring countries, tariff of long-term sources of power and analysis on transactions of Renewable Energy Certificates.

In order to ensure ease of access, this report is also made available on the CERC website www.cercind.gov.in. We are hopeful that market participants and stakeholders will find the Report on Short-term Power Market in India, 2022-23 useful.

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Abbreviations

Abbreviation	Expanded Version
AC	Alternating Current
ACE	Area Control Error
ACS	Average Cost of Supply
ADSS	Any Day Single Sided Contract
AGC	Automatic Generation Control
APCPDCL	Andhra Pradesh Central Power Distribution Company Limited
APDCL	Assam Power Distribution Company Ltd
APL	Above Poverty Line
APPCC	Andhra Pradesh Power Coordination Committee
APSPDCL	Andhra Pradesh Southern Power Distribution Company Limited
APTEL	Appellate Tribunal for Electricity
ARR	Average Revenue Realized
AT&C	Aggregate Technical and Commercial
BESS	Battery Energy Storage Systems
Block	15 Minutes Time Block
BSPHCL	Bihar State Power Holding Company Limited
BU	Billion Units (Billion kWh)
CAGR	Compound Annual Growth Rate
CBTE	Cross Border Trade of Electricity
CCGT	Combined Cycle Gas Turbine
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CESC	Calcutta Electric Supply Corporation
CGS	Central Generating Station
CGSEB	Chhattisgarh State Electricity Board
Ckm	Circuit km
COD	Commercial Operation Date
COP	Conference of the Parties
CPP	Captive Power Producer/Plant
CSPDCL	Chhattisgarh State Power Distribution Company Limited
CTU	Central Transmission Utility
DAM	Day Ahead Market
DBFOO	Design, Build, Finance, Own and Operate
DBFOT	Design, Build, Finance, Operate and Transfer
DDUGJY	Deendayal Upadhyaya Gram Jyoti Yojana
DISCOMs	Distribution Companies
DNHDDPDCL	Dadra and Nagar Haveli and Daman and Diu Power

Abbreviation	Expanded Version
	Distribution Corporation Limited
DSM	Deviation Settlement Mechanism
DVC	Damodar Valley Corporation
EDCL	Energy development Company Limited
EGoM	Empowered Group of Ministers
ER	Eastern Region
ERSS	Eastern Region Strengthening Scheme
FCAS	Frequency Control Ancillary Services
FGUTPS	Firoz Gandhi Unchahar Thermal Power Station
FRAS	Fast Response Ancillary Services
G-DAC	Green Day Ahead Contract
G-DAM	Green Day Ahead Market
GOHP/GoHP	Government of Himachal Pradesh
GPS	Gas Power Station
GRIDCO	GRIDCO Limited
G-TAM	Green Term Ahead Market
GUVNL	Gujarat Urja Vikas Nigam Limited
GW	Giga Watts
HEP	Hydro Electric Project
HHI	Herfindahl-Hirschman Index
HP	Himachal Pradesh
HPDAM	High Price Day Ahead Market
HPO	Hydro Purchase Obligation
HPP	Hydroelectric Power Plant
HPPC	Haryana Power Purchase Centre
HPSEB	Himachal Pradesh State Electricity Board
HPX	Hindustan Power Exchange Ltd.
HVDC	High-Voltage Direct Current
IDAM	Integrated Day Ahead Market
IEGC	Indian Electricity Grid Code
IEX	Indian Energy Exchange
IPDS	Integrated Power Development Scheme
IPP	Independent Power Producers
ISGS	Inter State Generating Station
ISTS	Inter State Transmission System
JBVNL	Jharkhand Bijli Vitran Nigam Limited
J&K PDD	Jammu & Kashmir Power Development Department
JKPCL	Jammu Kashmir Power Corporation Ltd.
JVVNL	Jaipur Vidyut Vitaran Nigam Ltd.

Abbreviation	Expanded Version
KSEB	Kerala State Electricity Board
KV	Kilovolt
kWh	Kilo Watt Hour
LHP	Large hydro Power Plants
LDC	Longer Duration Contracts
LDP	Low Dam Project
LTA	Long Term Access
Ltd.	Limited
MBD	Model Bidding Document
MCP	Market Clearing Price
MNRE	Ministry of New and Renewable Energy
MOP	Ministry of Power
MPDCL	Meghalaya Power Distribution Corporation Limited
MPP	Merchant Power Plant
MPPGCL	Madhya Pradesh Power Generating Company Limited
MPPMCL	MP Power Management Company Limited
MSEDCL	Maharashtra State Electricity Distribution Co. Ltd.
MU	Million Units
MVA	Mega Volt Ampere
MW	Mega Watts
MWh	Mega Watt Hour
NCAS	Network Control Ancillary Services
NCTP	National Capital Thermal Power Plant
NEEPCO	North Eastern Electric Power Corporation Limited
NER	North Eastern Region
NHDC	National Hydro Development Corporation Limited
NHPC	NHPC Limited
NLC	NLC India Limited
NLDC	National Load Dispatch Centre
NR	Northern Region
NRSS	Northern Region Strengthening Scheme
NSGM	National Smart Grid Mission
NTPC	NTPC Limited
NTPL	NLC Tamil Nadu Power Limited
OA	Open Access
OAC	Open Access Consumer
OTP	Other than RTC and Peak period
OTPC	ONGC Tripura Power Company
PCKL	Power Company of Karnataka Limited

Abbreviation	Expanded Version
PFC	Power Finance Corporation
PGCIL/POWERGRID	Power Grid Corporation of India Limited
POSOCO	Power System Operation Corporation Limited
PPA	Power Purchase Agreement
PSPCL	Punjab State Power Corporation Limited
PX	Power Exchange
PXIL	Power Exchange India Limited
RDSS	Revamped Distribution Sector Scheme
RE	Renewable Energy
REC	Renewable Energy Certificate
RES	Renewable Energy Sources
RFP	Request for Proposal
RFQ	Request for Qualification
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
RGPS	Ratnagiri Gas Power Station
RLDC	Regional Load Despatch Centre
ROR	Run of River
RPC	Regional Power Committee
RPO	Renewable Purchase Obligation
RRAS	Reserves Regulation Ancillary Services
RTC	Round the Clock
RTM	Real Time Market
RUVNL	Rajasthan Urja Vikas Nigam Limited
S1	Southern Region 1
S2	Southern Region 2
S3	Southern Region 3
SAARC	South Asian Association for Regional Cooperation
SBD	Standard Bidding Document
SEB	State Electricity Board
SEBI	Securities & Exchange Board of India
SJVNL	Satluj Jal Vidyut Nigam Limited
SRAS	System Restart Ancillary Services
SR Grid	Southern Region Grid
St	Stage
STPP	Super Thermal Power Plant
STPS	Super Thermal Power Station
TAM	Term Ahead Market
TANGEDCO	Tamil Nadu Generation and Distribution Corporation
THDC	Tehri Hydro Development Corporation Limited

Abbreviation	Expanded Version
TNEB	Tamil Nadu Electricity Board
TPP	Thermal Power Plant
TPS	Thermal Power Station
TSSPDCL	Telangana Southern Power Distribution Company Limited
TSPCC	Telangana State Power Coordination Committee
UDAY	Ujwal DISCOM Assurance Yojana
UMPP	Ultra Mega Power Projects
UPPCL	Uttar Pradesh Power Corporation Limited
UPCL	Uttarakhand Power Corporation Limited
VAE	Virtual Ancillary Entity
W1	Western Region 1
W2	Western Region 2
WBSEDCL	West Bengal State Electricity Distribution Company Ltd
WR	Western Region
WRSS	Western Region Strengthening Scheme

Executive Summary

The 'Report on Short-term Power Market in India: 2022-23' provides a snapshot of the developments in the power sector, with a focus on short-term power transactions through different mechanisms by various market participants. The report broadly comprises five sections, viz., an overview of the power sector, trends in the short-term power market in India, cross-border trade of electricity, long-term sources of power, and trading of renewable energy certificates.

The chapter on the Overview of the power sector discusses the year-wise trend in electricity generation, transmission and distribution, including the revenue gap of state electricity distribution companies (DISCOMs)/SEBs and the measures/reforms undertaken by the Ministry of Power in recent years. The salient features of the power sector, as discussed in the report, are as under:

1. Thermal energy (mainly from Coal) is an important source of electricity generation in India, contributing about 57% of the total installed generation capacity in 2022-23, followed by Renewable Energy Source (RES) (30.1%), Hydro (11.3%), and Nuclear (1.6%).

2. The Compound Annual Growth Rate (CAGR) of total installed generation capacity was 7.7% during the period from 2008-09 to 2022-23. The CAGR in RES was 17.4%, whereas it was 5.7% in all other sources during the period.

3. During the period from 2008-09 to 2022-23, the share of the State sector in the total installed generation capacity declined from 54% to 25%, and the share of the central sector declined from 31% to 24%, while the share of the private sector increased from 15% to 51%.

4. Gross electricity generation in India increased from 747.07 BU in 2008-09 to 1624.47 BU in 2022-23, and it increased at a CAGR of 5.71%.

5. The CAGR in gross electricity generation from 2008-09 to 2022-23 was low (5.71%) when compared with the annual installed electricity generation capacity (7.7%).

6. An increase in the installed capacity resulted in a decrease in the demand shortage (both energy and peak shortage). The energy shortage decreased from 11.1% in 2008-09 to about 0.5% in 2022-23, whereas the peak deficit decreased from 11.9% to 4.0%.

7. From 2008-09 to 2022-23, the bulk transmission grew at a CAGR of 5.6%, while the growth in the transmission capacity of substations was at the rate of 10.6%.

8. The annual transmission charges increased at a CAGR of 16.48% during the period from 2011-12 to 2022-23.

9. The total electricity consumption increased from 611.29 BU in 2008-09 to 1403.40 BU in 2022-23 (estimated), registering a CAGR of 6.1%. During the period, per-capita consumption of electricity also increased from 734 kWh to 1327 kWh.

10. All India average cost of supply and average revenue (without subsidy) of state power utilities increased from ₹3.40/kWh and ₹2.63/kwh, respectively, in 2008-09 to ₹6.29/kWh and ₹4.98/kWh, respectively, in 2021-22. During the last 5 years, the revenue as percentage of cost was varying between 76% and 81%, indicating that the weighted average tariff for all categories of consumers was about 21% lower than the weighted average cost of supply.

'Short-term transactions of electricity' refers to contracts of less than one-year period for electricity transacted under bilateral transactions through Inter-State Trading Licensees (only inter-state part) and directly by the Distribution Licensees (also referred to as Distribution Companies or DISCOMs), Power Exchanges {Indian Energy Exchange Ltd. (IEX), Power Exchange India Ltd. (PXIL) and Hindustan Power Exchange (HPX)}, and Deviation Settlement Mechanism (DSM). The analysis of the short-term power market includes (i) yearly/monthly/daily trends in short-term

transactions of electricity; (ii) time of the day variation in volume and price of electricity transacted through traders and power exchanges; (iii) trading margin charged by trading licensees for bilateral transactions (iv) analysis of open access consumers on power exchanges; (v) major sellers and buyers of electricity in the short term market; (vi) effect of congestion on volume of electricity transacted through power exchanges; and (vii) ancillary services operations. Salient features of the short-term power market during 2022-23 are as under:

1. Of the total electricity procured in India in 2022-23, the short-term power market comprised about 12%. The balance 88% of generation was procured mainly by distribution companies through long-term contracts and short-term intra-state transactions.

2. From 2009-10 to 2022-23, the volume of short-term transactions of electricity increased at a higher rate (CAGR of 8.7%) when compared with the gross electricity generation (CAGR of 5.9%).

3. In terms of volume, the size of the short-term market in India increased from 186.75 BU in the year 2021-22 to 194.35 BU in 2022-23, registering an annual growth of about 4%.

4. Excluding DSM and direct bilateral sale between the DISCOMs, the volume of electricity transacted was 136.76 BU in 2022-23. In monetary terms, the size of this segment of the short-term market was ₹84152 crore in the year 2022-23[1], which was about 35% more than in the year 2021-22. The increase in the size of the market was mainly due to increased volumes transacted through power exchanges and traders.

5. The volume of electricity transacted through power exchanges increased at a CAGR of 29%, and the volume of electricity transacted through traders increased at a CAGR of 3.1% from 2008-09 to 2022-23.

[1] *excluding banking transactions*

6. The volume of DSM transactions increased by 4% in 2022-23 over the year 2021-22. The share of DSM as a percentage of the total volume of short-term transactions of electricity continued a downward trend in past years, and it declined from 39.2% in 2009-10 to 13.5% in 2022-23.

7. In terms of volume, the direct bilateral transactions between DISCOMs witnessed an increase of about 52% in 2022-23 as compared to 2021-22. The share of direct bilateral transactions between DISCOMs as a percentage of total short-term transaction volume increased from 9.4% in 2009-10 to 16.1% in 2022-23.

8. The weighted average price of electricity transacted through power exchanges was ₹6.25/kWh and through trading licensees it was ₹5.85/kWh in 2022-23. The corresponding values for the year 2021-22 were ₹4.69/kWh and ₹3.72/kWh, respectively. The weighted average prices of electricity transacted through Day Ahead Market, Green Day Ahead Market, Real-Time Market, Term Ahead Market and Green Term Ahead Market sub-segment of the power exchanges in 2022-23 were ₹6.03/kWh, ₹5.64/kWh, ₹5.67/kWh and ₹7.55/kWh and ₹6.51/kWh respectively.

9. The price of DSM increased from ₹3.73/kWh in 2021-22 to ₹5.39/kWh in 2022-23.

10. During 2022-23, 47% of the volume of electricity transacted through traders was at a price less than ₹5/kWh and 95% of the volume was transacted through traders at less than ₹10/kWh.

11. In Day Ahead Market, during 2022-23, 83% of the volume of electricity was transacted at a price less than ₹10/kWh, while about 50% of the volume was transacted at a price less than ₹5/kWh at IEX. In case of PXIL, 84% of the volume of electricity was transacted at a price less than ₹10/kWh and 47% of the volume was transacted at less than ₹5/kWh. In case of HPX, about 79% of the volume was transacted at less than ₹10/kWh and 60% of the volume of electricity in DAM was transacted at less than ₹5/kWh.

12. In Green Day Ahead market, during 2022-23, about 87% of the volume of electricity was transacted at a price less than ₹10/kWh, while about 57% of the volume was transacted at a price less than ₹5/kWh, at IEX. In the case of GDAM, 100% of the volume was transacted at less than ₹6/kWh. There was no trade in G-DAM segment on HPX.

13. In Real-Time Market (RTM), during 2022-23, 93% of the volume of electricity was transacted at a price less than ₹10/kWh while about 78% of the volume was transacted at a price less than ₹5/kWh at IEX. In case of PXIL, only 4% of the volume was transacted at less than ₹5/kWh, and 6% of the volume was transacted at a price less than ₹10/kWh. There was no trade in RTM on HPX.

14. During 2022-23, of the total electricity bought under bilateral transactions from traders, 85.8% was on round the clock (RTC) basis, followed by 14.1% in periods other than RTC and peak (OTP), and 0.1% was during peak hours. The per unit price of electricity procured during the Peak period was high (₹7.92/kWh) when compared with the price during RTC (₹6.03/kWh) and OTP (₹4.79/kWh).

15. It is observed from the block-wise and region-wise prices of electricity transacted through power exchanges in 2022-23 that the price of electricity in all the regions was almost similar at IEX, which is indicative of very few instances of congestion. Though no consistent trend has been observed in price in different regions in case of PXIL, the price of electricity in the southern region was relatively high when compared with the prices in other regions.

16. From 2008-09 to 2022-23, the number of traders who were undertaking trading increased from 15 to 38. The Herfindahl-Hirschman Index (HHI), based on the volume of electricity transacted in the short-term through traders, increased from 0.1630 in 2008-09 to 0.1874 in 2022-23. The concentration of market power, in terms of the volume of electricity transacted through traders/trading licensees, was moderate in 2022-23.

17. The weighted average trading margin charged by the trading licensees in 2022-23 was ₹0.027/kWh, which is in line with the CERC Trading License Regulations, 2020.

18. In the power exchanges, Open Access industrial consumers bought 7.6 BU of electricity, which formed 9.6% of the total day ahead, green day ahead, and real-time market volume transacted in the power exchanges during 2022-23.

19. The weighted average price of electricity bought by open access consumers at IEX was ₹3.92/kWh, which was lower as compared to the weighted average price of the total electricity transacted through IEX (₹5.90/kWh), i.e., through day-ahead, green day-ahead & real-time market. The weighted average price of electricity bought by open access consumers though PXIL (₹4.06/kWh), was lower compared to weighted average price of the total electricity transacted though PXIL (₹6.49/kWh) in 2022-23. In case of HPX, the weighted average price of electricity bought by open access consumers (₹5.30/kWh), was lower compared to weighted average price of the total electricity transacted though HPX (₹6.51/kWh) in 2022-23.

20. The year witnessed very few constraints on the volume of electricity transacted through power exchanges due to transmission congestion. During 2022-23, the actual transacted volume was about 0.02% less than the unconstrained volume. Due to a few instances of congestion and the splitting of the market, the congestion amount collected during the year was ₹16.58 crore.

21. The energy scheduled under Regulation UP of RRAS increased from 2212.28 MU in 2016-17 to 4153.26 MU in 2022-23. The energy scheduled under Regulation DOWN of RRAS increased from 286.00 MU in 2016-17 to 4532.77 MU in 2022-23.

Salient features of the cross-border trade of electricity and renewable energy certificates transacted through power exchanges are as under:

1. India has been importing electricity from Bhutan and exporting electricity to Bangladesh, Nepal, and Myanmar. India was net importer of electricity from 2013-14 to 2015-16, and a net exporter of electricity from 2016-17 onwards. Cross Border Electricity Trade in the Day Ahead Market of IEX was commenced in 2021-22. The trade with Nepal was commenced on 17.04.2021, whereas the trade with Bhutan was commenced on 01.01.2022.

2. During 2022-23, a total of 82.50 RECs were transacted on the power exchanges and bilaterally through trading licensees. The categorization of RECs between solar and non-solar has been dispensed with, with the introduction of the concept of multiplier under the Central Electricity Regulatory Commission (Terms and Conditions for Renewable Energy Certificates for Renewable Energy Generation) Regulations 2022, w.e.f. 05.12.2022. A new contract, namely "REC", has been made available for trading by the power exchanges w.e.f. December 2022. REC Regulations 2022 also allowed transactions of RECs through the trading licensees.

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Chapter-I

Overview of Power Sector

The Indian power sector is one of the most diversified in the world. The entire electricity supply chain has undergone a phase of transformation in the process of advancing reforms in the sector. This chapter provides an overview of the developments made in the electricity supply chain over the years and the new policy initiatives to address some of the key challenges faced by the sector.

1. Generation

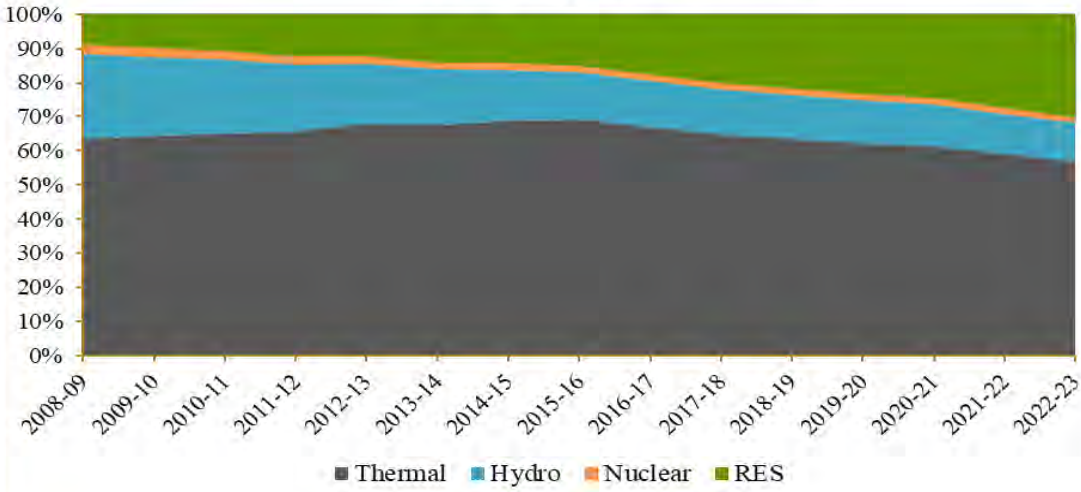
The sources of electricity generation in India can be broadly classified into conventional and non-conventional. The conventional sources of power generation are thermal (coal, lignite, natural gas, and oil), hydro and nuclear power, whereas non-conventional sources of power generation (renewable energy sources) include solar, wind, agricultural and domestic waste, etc. Table-1(a) and Figure-1(a) show the installed electricity generation capacity in India by different sources.

Table-1(a): Installed Electricity Generation Capacity in India (GW), 2008-09 to 2022-23

Year	Thermal	Hydro	Nuclear	RES**	Total
2008-09	93.73	36.88	4.12	13.24	147.97
2009-10	102.45	36.86	4.56	15.52	159.40
2010-11	112.82	37.57	4.78	18.45	173.63
2011-12	131.60	38.99	4.78	24.50	199.88
2012-13	151.53	39.49	4.78	27.54	223.34
2013-14	168.26	40.53	4.78	34.99	248.55
2014-15	188.90	41.27	5.78	38.96	274.90
2015-16	210.68	42.78	5.78	45.92	305.16
2016-17	218.33	44.48	6.78	57.24	326.83
2017-18	222.91	45.29	6.78	69.02	344.00
2018-19	226.28	45.40	6.78	77.64	356.10
2019-20	230.60	45.70	6.78	87.03	370.11
2020-21	234.73	46.21	6.78	94.43	382.15
2021-22	236.11	46.72	6.78	109.89	399.50
2022-23*	237.27	46.85	6.78	125.16	416.06

Source: CEA, Growth of Electricity Sector in India, various issues.
*** RES includes Small Hydro Project (≤ 25 MW)*

Figure-1(a): Installed Electricity Generation Capacity in India (%), 2008-09 to 2022-23



As may be observed from Figure-1(a), thermal is a major source of electricity generation in India, contributing 57% of the total capacity of generation in 2022-23, followed by renewable energy sources (RES) (30.1%), hydro (11.3%) and nuclear (1.6%). However, the share of thermal-based generation capacity in the total installed capacity has gradually come down from 63.3% in 2008-09 to 57% in 2022-23. During this period, the share of hydro-based generation capacity also decreased from 24.9% to 11.3%, whereas renewables-based generation capacity witnessed an increase from 8.9% to 30.1%. The CAGR of total installed electricity generation capacity was about 7.7% during the period as compared to 17.4% in RES and 5.7% in all other sources.

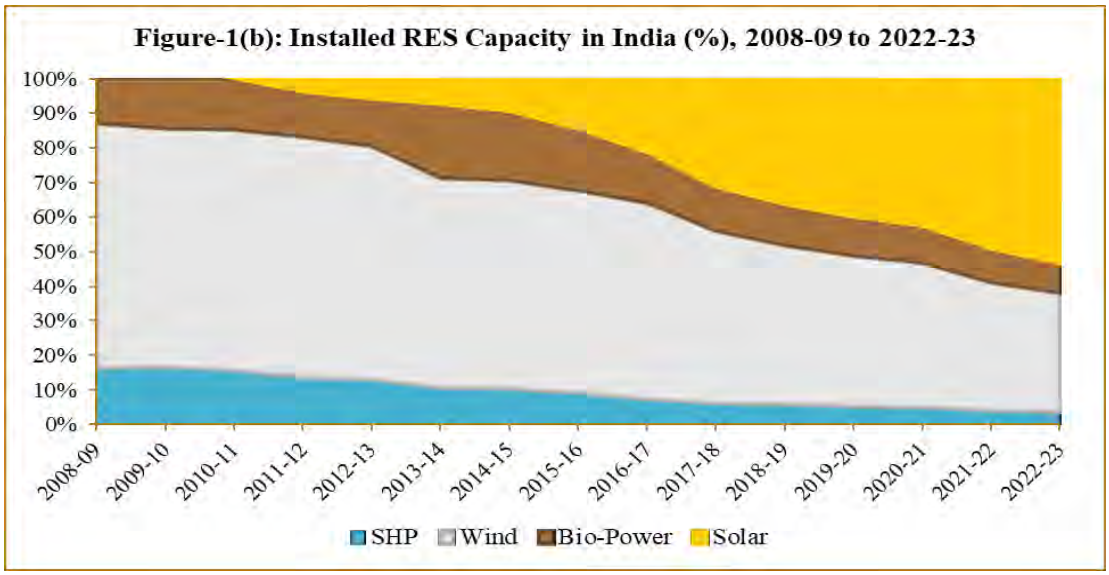
Table-1(b) shows the installed RES capacity from various sources, and Figure-1(b) shows the share of different sources in the installed RES capacity. As can be observed from the figure, solar constitutes around 53.4% of total RES capacity in India, followed by wind (34.1%), bio-power (8.6%) and small hydropower (4%) in 2022-23. Though the capacity from all the sources increased over the years, the relative share of solar increased considerably from less than 1% in 2008-09 to about 53% in 2022-23.

Table-1(b): Installed RES Capacity in India (GW), 2008-09 to 2022-23

Year	SHP	Wind	Bio-Power	Solar	Total RES
2008-09	2.16	9.34	1.74	0.00	13.24
2009-10	2.60	10.65	2.26	0.01	15.52
2010-11	2.91	12.81	2.70	0.03	18.45

2011-12	3.41	16.90	3.26	0.94	24.50
2012-13	3.64	18.49	3.73	1.69	27.54
2013-14	3.80	21.04	7.51	2.63	34.99
2014-15	4.06	23.35	7.81	3.74	38.96
2015-16	4.27	26.78	8.11	6.76	45.92
2016-17	4.38	32.28	8.30	12.29	57.24
2017-18	4.49	34.05	8.84	21.65	69.02
2018-19	4.59	35.63	9.24	28.18	77.64
2019-20	4.68	37.69	10.02	34.63	87.03
2020-21	4.79	39.25	10.31	40.09	94.43
2021-22	4.85	40.36	10.68	54.00	109.89
2022-23	4.94	42.63	10.80	66.78	125.16

Source: CEA, Growth of Electricity Sector in India, various issues.



The Electricity Act of 2003 liberalised the process of electricity generation by shifting towards a license-free regime. This has resulted in increased competition in the generation segment and the share of private players witnessed a significant increase in the total electricity generation.

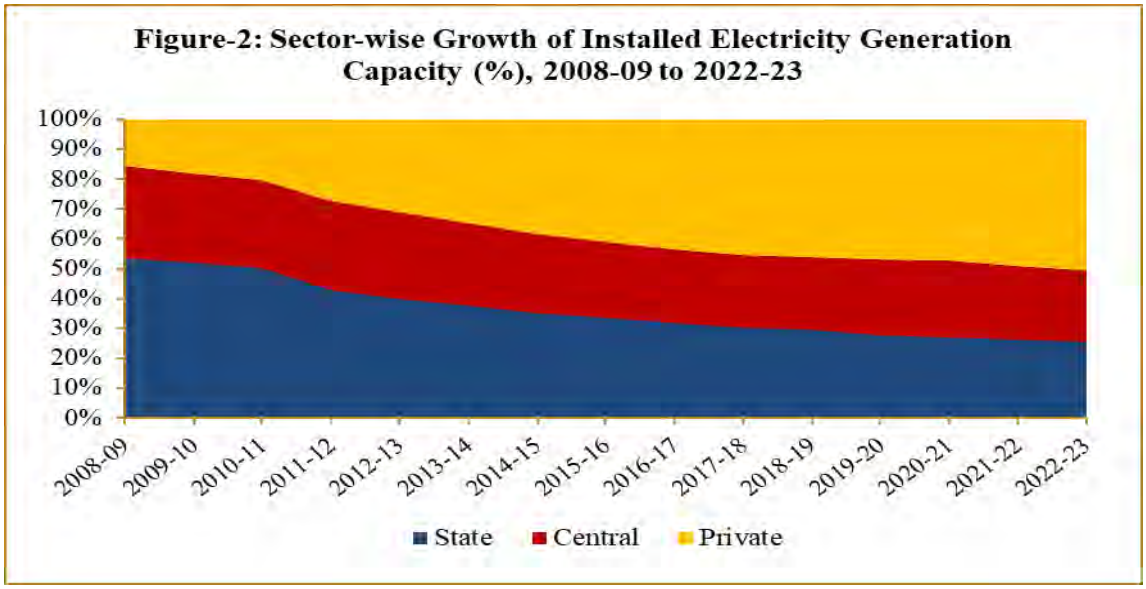
The players in the electricity generation segment can be divided into three types based on ownership and operations. These are: (i) Central public sector undertakings, (ii) State public sector undertakings/State Electricity Boards, and (iii) Private sector companies.

The sector-wise growth of installed generation capacity is shown in Table-2 and Figure-2. It can be observed from the table that the CAGR of total installed generation capacity was about 7.7% during the period from 2008-09 to 2022-23. During the period, the share of the state sector in the total installed generation capacity declined from 54% to 25%, and the share of the central sector declined from 31% to 24%, whereas the share of the private sector increased significantly, i.e., from 15% to 51%.

Table-2: Sector-wise Growth of Installed Electricity Generation Capacity, 2008-09 to 2022-23

Year	Installed Generation Capacity (GW)			
	State	Central	Private	Total
2008-09	79.31	45.78	22.88	147.97
2009-10	82.91	47.48	29.01	159.40
2010-11	87.42	50.76	35.45	173.63
2011-12	85.92	59.68	54.28	199.88
2012-13	89.13	65.36	68.86	223.34
2013-14	92.27	68.13	84.87	245.26
2014-15	95.08	72.52	104.12	271.72
2015-16	101.79	76.30	124.00	302.09
2016-17	103.97	80.26	142.62	326.85
2017-18	103.97	84.52	155.51	344.00
2018-19	105.08	86.60	164.43	356.10
2019-20	103.32	93.48	173.31	370.11
2020-21	103.87	97.51	180.77	382.15
2021-22	104.85	99.00	195.64	399.50
2022-23	105.73	100.05	210.28	416.06

Source: CEA, Growth of Electricity Sector in India, various issues.



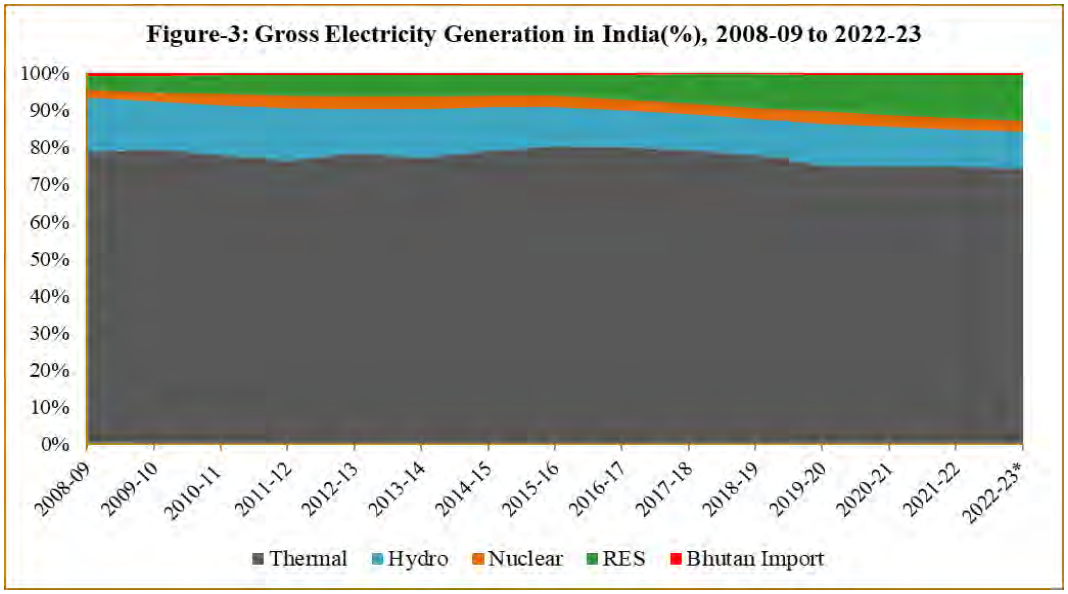
Source-wise gross electricity generation in India is shown in Table-3(a) and Figure-3. As may be observed from the table, gross electricity generation in India has increased from 747.07 BU in 2008-09 to 1624.47 BU in 2022-23, at a CAGR of about 5.7%. The growth in gross electricity generation is low as compared to the growth in annual installed electricity generation capacity (7.7%). This may be primarily due to an increase in capacity from RES with a low utilization factor.

Table-3(a): Gross Electricity Generation in India (BU), 2008-09 to 2022-23

Year	Thermal	Hydro	Nuclear	RES	Bhutan Import	Total
2008-09	588.28	110.10	14.93	27.86	5.90	747.07
2009-10	640.21	104.06	18.64	36.95	5.40	805.26
2010-11	665.00	114.30	26.30	41.15	5.60	852.35
2011-12	708.43	130.51	32.29	51.23	5.30	927.76
2012-13	760.45	113.72	32.87	57.45	4.80	969.29
2013-14	792.05	134.85	34.23	59.62	5.60	1026.35
2014-15	877.94	129.24	36.10	61.79	5.00	1110.07
2015-16	943.01	121.38	37.41	65.78	5.20	1172.78
2016-17	994.22	122.31	37.66	81.87	5.64	1241.70
2017-18	1037.06	126.12	38.35	101.84	4.78	1308.15
2018-19	1072.00	135.00	37.70	126.76	4.40	1375.86
2019-20	1044.45	155.67	46.38	138.32	5.81	1390.63
2020-21	1032.51	150.30	43.03	147.25	8.77	1381.86
2021-22	1114.71	151.63	47.11	170.90	7.49	1491.85
2022-23*	1206.21	162.10	45.86	203.55	6.74	1624.47

**Provisional.*

Source: CEA, Growth of Electricity Sector in India, various issues



*Provisional

Of all the sources, electricity generation from thermal (mainly coal) continues to play a dominant role in the energy mix of the country, with a share of about 74% in 2022-23. Though its relative share continues to be the highest, it has shown a declining trend over the last few years, mainly because of increasing emphasis on renewable energy sources. The amount of electricity generated from RES increased from 3.7% in 2008-09 to 12.5% in 2022-23.

Table-3(b) provides details of renewable electricity generation in India from various sources. As can be observed from the figure, total renewable electricity generation increased from 65.78 BU in 2015-16 to 203.55 BU in 2022-23 at a CAGR of 17.5%. Solar generation increased significantly from 7.45 BU in 2015-16 to about 102 BU in 2022-23 at a CAGR of 45.3%.

Table-3(b): Renewable Electricity Generation* in India (BU), 2015-16 to 2022-23

Year	SHP	Wind	Bio-Power	Solar	Others	Total RES
2015-16	8.36	33.03	16.68	7.45	0.27	65.78
2016-17	7.67	46.00	14.16	13.50	0.21	81.55
2017-18	7.69	52.67	15.25	25.87	0.36	101.84
2018-19	8.70	62.04	16.33	39.27	0.43	126.76
2019-20	9.45	64.65	13.74	50.13	0.37	138.34
2020-21	10.26	60.15	14.82	60.40	1.62	147.25

2021-22	10.46	68.64	16.06	73.48	2.27	170.91
2022-23	11.17	71.81	16.02	102.01	2.53	203.55

Source: CEA, Report of Renewable Generation
** Excluding Large Hydro*

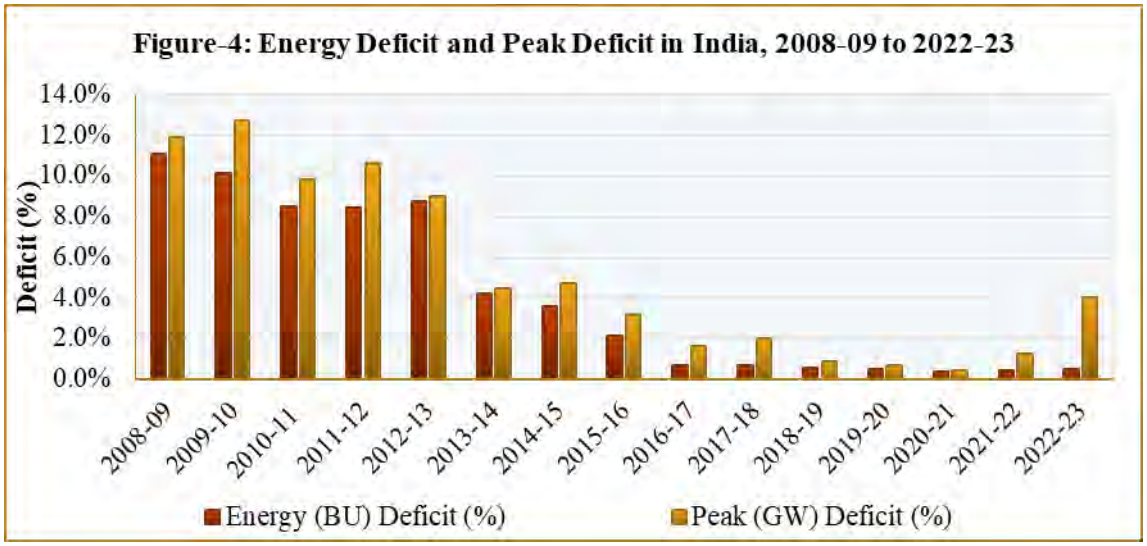
As per the announcement made by the Hon'ble Prime Minister in COP26 Summit at Glasgow in November 2021, Government of India has set an ambitious target for enhancement of non-fossil fuel energy capacity to 500 GW by 2030. The commitment regarding non-fossil fuel energy capacity is proposed to be met mainly from the installation of solar and wind power capacities. This will enable diversification of India's energy mix with increasing share of renewable resources.

The increase in installed electricity generation capacity, as shown in Table-1, had a positive impact on the power supply position. Both energy requirement and peak demand increased from 777.04 BU and 109.81 GW, respectively, in 2008-09 to 1511.85 BU and 215.81 GW, respectively, in 2022-23 (Table-4). An increase in the installed capacity resulted in a decrease in the energy and peak deficit from 11.1% and 11.9%, respectively, in 2008-09 to about 0.5% and 4.0%, respectively in 2022-23 (Figure-4).

Table-4: Power Supply Position in India, 2008-09 to 2022-23

Year	Energy (BU)			Peak (GW)		
	Requirement	Availability	Deficit (%)	Requirement	Availability	Deficit (%)
2008-09	777.04	691.04	11.1%	109.81	96.79	11.9%
2009-10	830.59	746.64	10.1%	119.17	104.01	12.7%
2010-11	861.59	788.36	8.5%	122.29	110.26	9.8%
2011-12	937.20	857.89	8.5%	130.01	116.19	10.6%
2012-13	995.56	908.65	8.7%	135.45	123.29	9.0%
2013-14	1002.26	959.83	4.2%	135.92	129.82	4.5%
2014-15	1068.92	1030.79	3.6%	148.17	141.16	4.7%
2015-16	1114.41	1090.85	2.1%	153.37	148.46	3.2%
2016-17	1142.93	1135.33	0.7%	159.54	156.93	1.6%
2017-18	1213.33	1204.70	0.7%	164.07	160.75	2.0%
2018-19	1274.60	1267.53	0.6%	177.02	175.53	0.8%
2019-20	1291.01	1284.44	0.5%	183.80	182.53	0.7%
2020-21	1275.53	1270.66	0.4%	190.20	189.40	0.4%
2021-22	1379.81	1374.02	0.4%	203.01	200.54	1.2%
2022-23	1511.85	1504.26	0.5%	215.89	207.23	4.0%

Source: Ministry of Power



2. Transmission

The transmission sector was opened for private investments in 1998. The Central Transmission Utility (CTU) is the nodal agency for providing medium-term (3 months to 5 years) and long-term (exceeding 7 years) access (the right to use the inter-state transmission system) typically required by a generating station or a trader acting on the generating station's behalf. The PGCIL has been responsible for inter-state transmission and development of the national grid, and acts as the CTU. The RLDCs are the nodal agencies for grant of short-term open access (upto 3 months). National Load Despatch Centre (NLDC) is the nodal agency providing transmission access to the power exchanges.

Open Access refers to the right to generators of electricity [Captive Power Plants[2] (CPP)/Independent Power Producers (IPP)] and bulk consumers[3] to sell the generated electricity at a certain transmission surcharge and to access the transmission and distribution networks of any generator without any discrimination by the distribution/transmission line owners. The principle of open access is based on the premise that while it is uneconomical to lay down multiple transmission lines in the

[2]*Captive Power refers to generation from a unit set up by industry for its own consumption*
[3] *Bulk consumers are consumers with power requirement of 1MW or above*

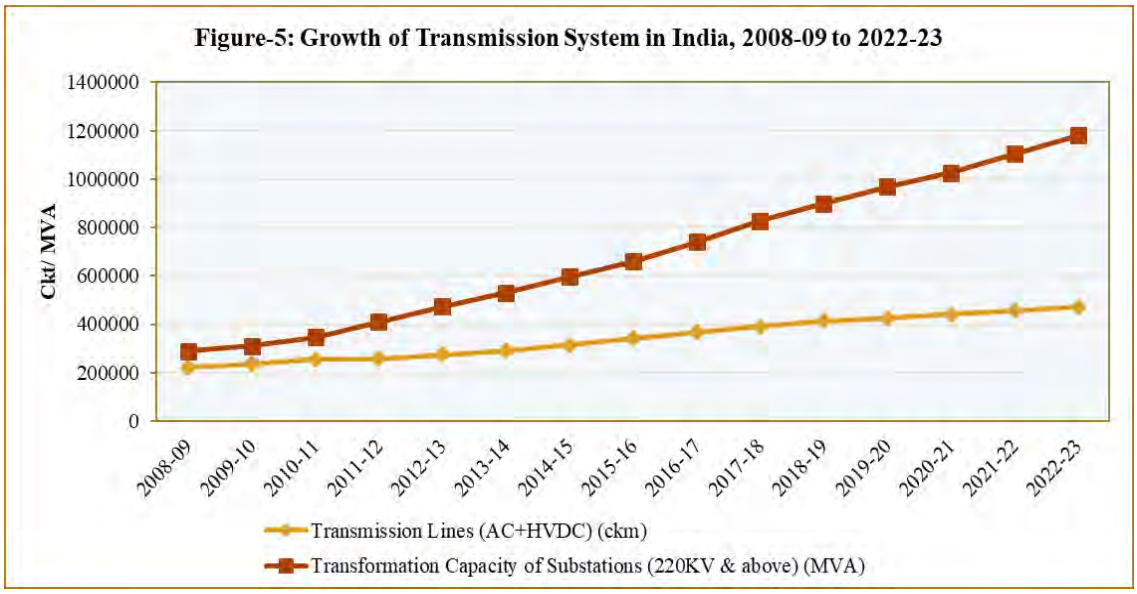
same region because of the large sunk costs involved, it is still best to give consumers a choice to decide which firm's electricity they want to consume.

The growth of the transmission system (transmission lines and transformation capacity) in India during 2008-09 to 2022-23 is shown in Table-5 and Figure-5.

Table-5: Growth of Transmission System in India, 2008-09 to 2022-23

Year	Transmission Lines (AC+HVDC) (ckm)	Transformation Capacity of Substations (220KV and above) (MVA)
2008-09	220794	288615
2009-10	236467	310052
2010-11	254536	345513
2011-12	257481	409551
2012-13	274588	473216
2013-14	291336	530546
2014-15	313437	596100
2015-16	341551	658949
2016-17	367851	740765
2017-18	390970	826958
2018-19	413407	899663
2019-20	425071	967893
2020-21	441821	1025468
2021-22	456716	1104450
2022-23	471341	1180352

Source: CEA, Monthly Reports.



It can be observed from Table-5 that bulk transmission (transmission lines 220 kV & above) has increased from 2.21 lakh ckm in 2008-09 to 4.71 lakh ckm in 2022-23. During the period, the transformation capacity of sub-stations has also increased from 2.89 lakh MVA to 11.80 lakh MVA. The CAGR in the transmission lines and transformation capacity of sub-stations was 5.6% and 10.6%, respectively.

Table-6 provides the data on annual transmission charges (transmission charges applicable for transmission lines owned by PGCIL and other ISTS licensees) for the period from 2011-12 to 2022-23. The annual transmission charges increased at a CAGR of 16.48% during the period. There are various reasons for increase in annual transmission charges, like the growth of transmission lines (especially at higher voltage levels), waiver of transmission charges for inter-state renewable energy generators, and relinquishment of long-term access (LTA).

Table-6: Annual Transmission Charges, 2011-12 to 2022-23

Year	Transmission Charges as on 31st March (₹ Crore)
2011-12	8743
2012-13	12797
2013-14	15118
2014-15	17680
2015-16	22476
2016-17	27383
2017-18	31405
2018-19	35599
2019-20	39285
2020-21	41051
2021-22	41696
2022-23	46800

Source: GRID-INDIA

Transmission sector is having a natural monopoly, as is involves high sunk costs in investing in the infrastructure needed to transmit electricity, such as transmission lines. Because of these characteristics, non-public entities face entry barriers, and private investments are allowed in transmission projects only after the approval from CERC. Although the transmission market is largely dominated by the public sector, there are many lines including High-Voltage Direct Current (HVDC) lines owned by private players. As on 31.3.2023, 85 Inter-state transmission licensees have been granted approval by CERC (Annexure-I).

In March 2023, the Ministry of Power brought out a detailed Plan titled "Transmission System for Integration of over 500 GW RE Capacity by 2030" in consultation with States and other stakeholders. The planned transmission system is expected to provide visibility to the RE developers about the potential generation sites and scale of investment opportunities.

3. Distribution

Distribution is the last leg in the electricity supply chain and assumes significant importance in the overall performance of the sector. State Electricity Distribution Companies (DISCOMs)/State Electricity Boards (SEBs) own the majority of the distribution segment in the electricity supply chain. In order to boost competition and make the sector more efficient, the Government is emphasizing the importance of a well-performing distribution sector and has been focusing on the improvement of the financial health of the distribution utilities. This is necessary to meet the goal of providing people a reliable and good-quality power and universal access to electricity. To meet this goal, it is required to increase rural electrification, reduce aggregate technical and commercial (AT&C) losses incurred while distributing electricity, ensuring financial viability of DISCOMs, and encourage private sector participation.

The growth in electricity consumption (consumer category-wise) is provided in Table-7 & Figure-6. The total electricity consumption increased from 611.29 BU in 2008-09 to 1403.40 BU in 2022-23 at a CAGR of 6.1%. During the period, per capita consumption of electricity in India has increased from 734 kWh to 1327 kWh (provisional). Despite this considerable growth, the level of per capita electricity consumption in India is low as compared to the international average of around 3577 kWh for 2022.

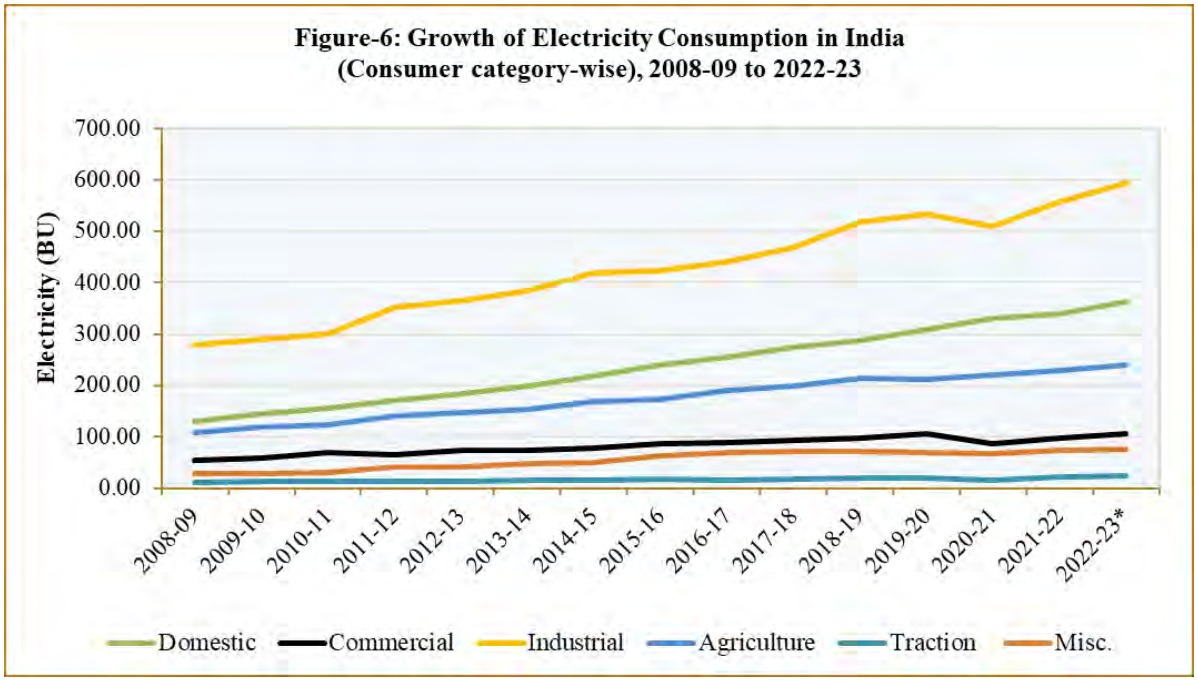
Table-7: Growth of Electricity Consumption in India (Consumer category-wise) (BU), 2008-09 to 2022-23

Year	Domestic	Commercial	Industrial	Agriculture	Traction	Misc.	Total
2008-09	130.06	53.54	279.66	107.78	11.81	28.45	611.29
2009-10	144.25	59.30	290.26	119.32	12.41	27.71	653.24

2010-11	156.02	68.72	301.26	123.39	13.09	29.93	692.40
2011-12	171.10	65.38	352.29	140.96	14.21	41.25	785.19
2012-13	183.70	72.79	365.99	147.46	14.10	40.26	824.30
2013-14	199.84	74.25	384.42	152.74	15.54	47.42	874.21
2014-15	217.41	78.39	418.35	168.91	16.18	49.29	948.52
2015-16	238.88	86.04	423.52	173.19	16.59	62.98	1001.19
2016-17	255.83	89.83	440.21	191.15	15.68	68.49	1061.18
2017-18	273.55	93.76	468.61	199.25	17.43	70.83	1123.43
2018-19	288.24	98.23	519.20	213.41	18.84	72.06	1209.97
2019-20	308.75	106.05	532.82	211.30	19.15	70.03	1248.09
2020-21	330.81	86.95	508.78	221.30	14.67	67.70	1230.21
2021-22	339.78	97.12	556.48	228.45	21.94	73.00	1316.76
2022-23*	362.00	105.10	595.00	240.80	25.00	75.50	1403.40

* Estimated

Source: CEA, Growth of Electricity Sector in India, various issues.



** Estimated*

As per the latest available 'Report on Performance of State Power Utilities-2021-22' published by Power Finance Corporation Ltd (PFC), the average all-India AT&C losses were about 16.42% in 2021-22[4]. More than 90% of these losses can be attributed to Transmission and Distribution Losses, which correspond to electricity produced but not paid for.

[4] As per the revised methodology for calculation of AT&C losses notified by CEA.

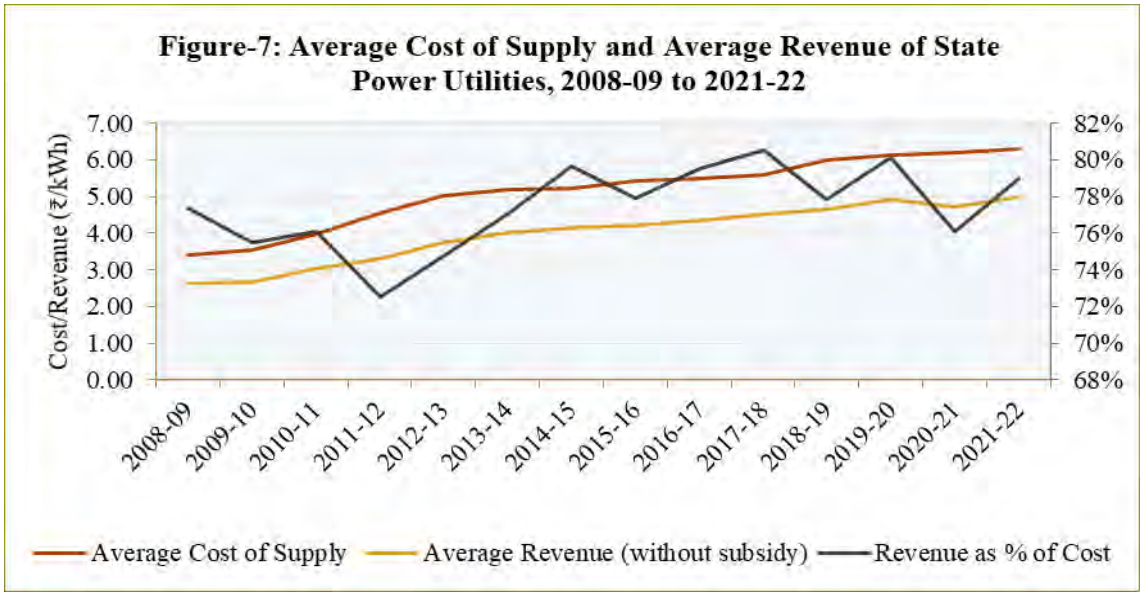
The electricity tariffs charged by the DISCOMs are not cost reflective for various reasons. The DISCOMs sell electricity below cost or provide electricity at free/subsidized rates for agriculture and domestic consumers. The tariffs for residential and agricultural consumers are subsidized by overcharging industrial and commercial users. Average cost of supply and average revenue of all state power utilities has been provided for the period from 2008-09 to 2021-22 in Table-8 and Figure-7.

The all-India average cost of supply and average revenue (without subsidy) increased from ₹3.40/kWh and ₹2.63/kWh respectively in 2008-09 to ₹6.29/kWh and ₹4.98/kWh, respectively, in 2021-22. Here the average revenue includes revenue from operations, regulatory income, revenue grants under UDAY and other income. The gap between the cost of supply and revenue has increased from ₹0.77/kWh to ₹1.31/kWh during the period. The revenue as percentage of cost of supply varied between 76% to 81% during the recent five years, which indicates that the average revenue was about 21% lower than the average cost of supply and this gap is financed through budgetary support as subsidy by the Government.

Table-8: Average Cost of Supply and Average Revenue of State Power Utilities, 2008-09 to 2021-22

Year	Average Cost of Supply (₹/kWh)	Average Revenue (without subsidy) (₹/kWh)	Revenue Gap (₹/kWh)	Revenue as % of Cost
2008-09	3.40	2.63	0.77	77%
2009-10	3.55	2.68	0.87	75%
2010-11	3.98	3.03	0.95	76%
2011-12	4.55	3.30	1.25	73%
2012-13	5.03	3.76	1.27	75%
2013-14	5.19	4.00	1.19	77%
2014-15	5.21	4.15	1.06	80%
2015-16	5.43	4.23	1.20	78%
2016-17	5.48	4.36	1.12	80%
2017-18	5.60	4.51	1.09	81%
2018-19	6.00	4.65	1.35	78%
2019-20	6.15	4.93	1.22	80%
2020-21	6.19	4.71	1.48	76%
2021-22	6.29	4.98	1.31	79%

Source: PFC, Report on The Performance of State Power Utilities.



Due to some of the legacy issues, the DISCOMs are financially stressed with huge operational losses and outstanding debt. Due to which, DISCOMs find it difficult to supply adequate power at affordable rates. To improve their financial health, several policy initiatives have been taken by the Union Government during the last few years, which include implementation of Ujwal DISCOM Assurance Yojana (UDAY, launched in 2015), Integrated Power Development Scheme (IPDS, launched in 2014), National Smart Grid Mission (NSGM launched in 2015), etc. UDAY is being implemented in various States for the financial turnaround and revival of the DISCOMs through four initiatives (i) improving operational efficiencies of DISCOMs; (ii) reduction of cost of power purchase; (iii) reduction in interest cost of DISCOMs; and (iv) enforcing financial discipline on DISCOMs through alignment with State finances.

The IPDS works with the objectives of reducing AT&C losses, establishment of IT enabled energy accounting/auditing system, improvement in billed energy based on metered consumption and improvement in collection efficiency and the scheme is focused on urban areas. The Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY, launched in 2014) is centred on improving distribution and electrification in rural areas. The scheme includes the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) as a key component of the rural electrification initiative.

The Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya Scheme) was launched in September 2017, to provide free electricity connections to all households, for above poverty line (APL) & poor families in rural areas and poor families in urban areas. All DISCOMs, including Private Sector DISCOMs, State Power Departments and Renewable Energy Cooperative Societies shall be eligible for financial assistance under the scheme in line with DDUGJY.

These schemes have helped the DISCOMs in strengthening and augmenting of sub-transmission and distribution network, and also IT enablement. These schemes have supported in achieving the goal of providing universal electricity access to the households enabling significant improvement in availability of power supply in both rural and urban areas.

The Ministry of Power has launched the Revamped Distribution Sector Scheme (RDSS) dated 20.07.2021, with the aim to provide reform-based result-linked financial assistance to DISCOMs to strengthen the supply infrastructure. Main objectives of the scheme include: (i) Reduction of AT&C losses to pan-India levels of 12-15% by FY 2024-25; (ii) Reduction of ACS-ARR gap to zero by FY 2024-25; (iii) improvement in the quality, reliability and affordability of power supply to consumers through a financially sustainable and operationally efficient distribution sector; and (iv) modernization of the DISCOMs through technology enhancement in the areas of asset management, customer experience and business operations. RDSS assist DISCOMS to improve their operational efficiencies and financial sustainability by providing result-linked financial assistance to DISCOMS to strengthen supply infrastructure based on meeting pre-qualifying criteria and achieving basic minimum benchmarks.

Electricity (Late Payment Surcharge and Related Matters) Rules, 2022 provide relief to the DISCOMS, as well as electricity consumers and at the same time Generating companies also get the benefit from assured monthly payments, which will help the whole power sector to become financially viable.

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Chapter-II

Short-term Power Market in India

1. Introduction

Prior to the Electricity Act 2003, the electricity industry recognized generation, transmission, and supply as three principal activities, and the legal provisions were also woven around these concepts. With the enactment of the Electricity Act 2003, the transactions involving purchase and sale of electricity has been recognized as a distinct licensed activity. Recognition of trading as a separate activity is in sync with the overall framework of encouraging competition in all segments of the electricity industry. The Electricity Act 2003, laid down provisions for promoting competition in the Indian power market. Introduction of non-discriminatory open access in electricity sector provided further impetus for enhancing competition in the market. The responsibility of developing the market in electricity has been vested with the Regulatory Commissions. The open access regulations, inter-state trading regulations, power market regulations, etc., of the Central Commission have facilitated power trading in an organized manner. In exercise of the powers conferred under section 178 of the Electricity Act, 2003, the Commission had notified the CERC (Procedure, Terms and Conditions for grant of trading licence and other related matters) Regulations, 2009 in February 2009 and the CERC (Fixation of Trading Margin) Regulations, 2010 in January 2010.

Over the past decade, the Indian power sector has undergone many developments like increased volume of electricity traded on power exchanges, introduction of new type of energy procurement & sale contracts, cross border trade of electricity, etc. Considering the developments, the Commission notified the CERC (Procedure, Terms and Conditions for grant of Trading Licence and other related matters) Regulations, 2020 in January 2020, repealing the earlier Regulations.

The Regulations specify the terms and conditions for grant of trading licence and other related matters including but not limited to capital adequacy and liquidity requirements, obligations of the trading licensees, requirements for submission of

information, penalties for contravention and non-compliance by the trading licensees and the trading margin that shall be charged by the trading licensees for various types of contracts.

To serve the growing volumes of electricity trade and increasing penetration of renewable energy in the grid, the Commission has also introduced new market segments on the Power Exchanges, namely the Real Time Market (RTM) and the Green Term Ahead Market (GTAM), in the year 2020-21. RTM has commenced on the power exchanges from 1st June 2020, to enable better portfolio management by the utilities with efficient power procurement planning, scheduling, and imbalance handling. The market provides the buyers & sellers, an organized platform for trading electricity closer to real time.

Providing a new avenue for renewable energy generators to sell power and for obligated entities to fulfill their RPOs, the GTAM was introduced on the Power exchanges from 1st August 2020. It is a market-based mechanism wherein RE surplus and RE deficit States can trade RE power and balance their RPO targets. This would incentivize RE resource-rich States to develop RE capacity beyond their obligation and aid in the development of RE capacity in India. The contracts in GTAM are similar to contracts in TAM.

With a view to provide avenues to existing and prospective Renewable Energy generators for sale of RE through the Power Exchange and to provide more options to the Obligated Entities to fulfil their RPOs, the Commission granted approval for introduction of Green Day Ahead Contract (GDAC) in Day Ahead Market (DAM) on the power exchanges in 2021-22. In G-DAM, the contracts enable buyers & seller to trade RE power on day ahead basis. The sellers are provided option to transfer their uncleared bids to DAM with flexibility to specify different price for uncleared bids in G-DAM. These contracts have been introduced on IEX from 27th October 2021 and on PXIL from 20th December 2021.

The Commission also granted approval for introduction of hydropower contracts in Green Term Ahead Market on IEX on 24th February 2022. These contracts would

provide an additional avenue for the existing and prospective hydropower generators to sell the power. The obligated entities would able to procure hydropower through these contracts and thus meet their HPO requirements. These hydro GTAM contracts have been approved on the similar lines of existing contracts under GTAM.

In 2022-23, the Commission approved the introduction of longer duration contracts, which were earlier restricted up to 11 days, in the Term-Ahead market and Green Term-Ahead Market. The introduction of these contracts has been made possible due to the outcome of the Hon'ble Supreme Court of India Order dated 6th October 2021, which favourably disposed of the jurisdictional matter between CERC and SEBI in terms of the agreement reached between the two that the CERC will regulate all the physical delivery contracts, whereas the SEBI will regulate the financial contracts. These contracts are allowed as the non-transferable specific delivery-based forward contracts (NTSD contracts) at power exchanges under both conventional as well as renewable energy segments. The Commission approved these contracts for a maximum duration of three months at present. These contracts segment would enable optimization of power procurement costs and would help in hedging the risk of price volatility. These contracts are provided with robust payment security mechanism and provide immense opportunity to open access consumers to buy power at competitive prices for longer duration. The Commission allowed the introduction of Daily, Weekly, Monthly and Any day Single Sided Contracts. Trading in these contracts commenced from June 2022.

The Commission also approved the introduction of High Price Day Ahead Market (HP-DAM) in the Integrated Day Ahead Market (IDAM) at IEX on 16th February 2023. The dedicated market segment has been introduced to enable high-cost generators, who have otherwise not been able to participate in the day-ahead market due to the existing price ceiling. The bid price range initially was between ₹0/kWh to ₹50/kWh in this segment, later revised to ₹20/kWh w.e.f. 11th April 2023. Scheduling for HP-DAM transactions shall be carried out as per NLDC procedure for collective transactions. At present, only following categories are eligible for participation in HP-DAM as sellers:

(i) Gas based generating stations using imported RLNG and Naphtha;

(ii) Imported coal based generating stations using only imported coal; and

(iii) Battery Energy Storage Systems (BESS)

The above list is subject to review by the Commission. Both buyers and sellers in IDAM, can also opt for carry forward of their unselected bids from DAM to HP-DAM submitting a price premium in such case. Buyers are given option to quote their maximum quantum of unselected bids from conventional DAM that they would like to carry forward to the HP-DAM segment. Trading in the HP-DAM segment commenced from 10th March 2023.

The Commission also notified the CERC (Deviation Settlement Mechanism and Related Matters) Regulations, 2022 on 14th March, 2022. These regulations shall be applicable to all grid connected regional entities and other entities engaged in Inter-state sale and purchase of electricity. As per the new regulations, all entities to adhere to schedule and any deviation shall be managed through Ancillary Services. As Ancillary services are deployed, the charges for deviation should be such that it covers the cost of deployed Ancillary Services. Accordingly, the normal rate of deviation for a time block shall be equal to be weighted average Ancillary Service Charge (paisa/kWh) computed based on the total quantum of ancillary services deployed and net charges payable to all the ancillary service providers for all the regions for that time block. Provided that for a period of one year from the date of effect of these regulations, normal rate of charges of deviation for a given time block shall be equal to highest of the weighted average ACP of the Day Ahead Market segments of all the Power Exchanges or the weighted average ACP of the Real Time Market segments of all the Power Exchanges or the Weighted Average Ancillary Service Charge of all the regions for that time block.

Based on the control over their generation, the charges of deviation for Over/Under Injection of power shall be applicable as per different volume limits for different type of generators. In case of buyers, given the fact that DISCOMs have less control over the consumption of the consumers, the volume limit for deviation charges in the 2014 regulations has been retained in the 2022 regulations. Further, the charges for deviation for injection of infirm power is zero. The charges for deviation for drawal

of start-up power before COD of a generating unit, or for drawl of power to run the auxiliaries during shut-down of a generating station shall be payable at the normal rate of charges for deviation.

The DSM Regulations 2022 came into effect from 5th December 2022. However, the Commission observed that the normal deviation charge reached as high as ₹40/kWh in some blocks, due to high cost of ancillary services deployed. While such charges serve as a deterrent for over-drawl and under-injection, in cases where the receivables are linked to the normal rate of deviation charge, this has the potential of creating perverse incentive to under-draw or over-inject. Therefore, the Commission, vide its Suo Motu order dated 26.12.2022, decided to resolve this issue by putting a cap of ₹12/kWh on normal rate of charges of deviation. Thereafter, vide its Suo Motu Order dated 06.02.2023, the Commission revised the charges of deviation. As per the Order the normal rate of charges of deviation shall be equal to the higher of the weighted average ACP of the Day Ahead Market segments of all the Power Exchanges and the weighted average ACP of the Real Time Market segments of all the Power Exchanges, for that time block, subject to a ceiling of Rs 12/kWh.

The Chapter, in the following sections, provides a brief analysis of short-term transactions of electricity and DSM transactions over the years. Here, "short-term transactions of electricity" refers to the contracts less than one year for the following trades:

(a) Electricity traded under bilateral transactions through Inter-State Trading Licensees (only inter-state trades)
(b) Electricity traded directly by the Distribution Licensees (also referred as Distribution Companies or DISCOMs)
(c) Electricity traded through Power Exchanges
(d) Electricity transacted through Deviation Settlement Mechanism (DSM)

The analysis includes:

(i) Yearly/monthly/daily trends in short-term transactions of electricity
(ii) Time of the day variation in volume and price of electricity transacted through traders and power exchanges

(iii) Trading margin charged by trading licensees for bilateral transactions

(iv) Analysis of open access consumers on power exchanges

(v) Major sellers and buyers of electricity in the short-term market

(vi) Effect of congestion on volume of electricity transacted through power exchanges

(vii) Ancillary services operations

2. Yearly Trends in Short-term Transactions of Electricity (2009-10 to 2022-23)

The analysis of yearly trends in short-term transactions includes the electricity transacted through the following segments:

- Trading licensees (inter-state part only) under bilateral transactions or "bilateral trader" segment;
- Power exchange segment with transactions in Day Ahead Market, Green Day Ahead Market, Term Ahead Market, Green Term Ahead Market and Real Time Market;
- Direct transactions of electricity between DISCOMs; and
- DSM segment

Inter-state trading licensees (traders) have been undertaking trading in electricity since 2004 and the power exchanges started operating since 2008. As on 31st March 2023, there were total 47 inter-state trading licensees (refer Annexure-II) and three power exchanges operating in the country. The two power exchanges namely, Indian Energy Exchange (IEX) and Power Exchange India Ltd. (PXIL) started their operations in June 2008 and October 2008 respectively, and the third power exchange, namely Hindustan Power Exchange (HPX) started operations in July 2022.

2.1 Total Short-term Transactions of Electricity with respect to Total Electricity Generation

Total volume of short-term transactions of electricity increased from 65.90 BU in 2009-10 to its all-time high of 194.35 BU in 2022-23. During this period, the volume of short-term transactions of electricity increased at a higher rate (CAGR of 8.7%) as

compared to the total electricity generation[5] (CAGR of 5.9%). The volume of short-term transactions of electricity as a percentage of total electricity generation varied from 8.9% to 12.5% during the period (Table-9).

Table-9: Volume of Short-term Transactions of Electricity with respect to Total Electricity Generation, 2009-10 to 2022-23

Year	Volume of Short-term Transactions of Electricity (BU)	Total Electricity Generation (BU)	Volume of Short-term Transactions of Electricity as % of Total Electricity Generation
2009-10	65.90	768.43	9.6%
2010-11	81.56	852.35	9.6%
2011-12	94.51	927.75	10.2%
2012-13	98.94	969.29	10.2%
2013-14	104.64	1026.34	10.2%
2014-15	98.99	1110.07	8.9%
2015-16	115.23	1172.78	9.8%
2016-17	119.23	1241.70	9.6%
2017-18	127.62	1308.15	9.8%
2018-19	145.20	1375.86	10.6%
2019-20	137.16	1390.93	9.9%
2020-21	146.01	1380.06	10.6%
2021-22	186.75	1491.85	12.5%
2022-23	194.35	1624.47	12.0%

Total Generation is the gross generation in India as defined by CEA
Source: NLDC & CEA

The analysis of yearly trends of short-term transactions of electricity for various segments, i.e., electricity transacted through traders and power exchanges, directly between DISCOMs and DSM is presented in the following sections.

2.1.1 Electricity Transacted through Traders and Power Exchanges

Table-10(a), Table-10(b), Table-11 and Figure-8 show details of volume of electricity transacted through traders under bilateral transactions and through power exchanges.

The volume of electricity transacted through traders increased from 21.92 BU in 2008-09 to 33.80 BU in 2022-23 (Table-10(a)) at a CAGR of 3.1%.

[5]*Total electricity generation is the gross electricity generation in India as defined by CEA.*

Table-10(a): Volume of Electricity Transacted through Traders (BU), 2008-09 to 2022-23

Year	Electricity Transacted through Traders
2008-09	21.92
2009-10	26.72
2010-11	27.70
2011-12	35.84
2012-13	36.12
2013-14	35.11
2014-15	34.56
2015-16	35.43
2016-17	33.51
2017-18	38.94
2018-19	47.32
2019-20	29.95
2020-21	26.67
2021-22	39.47
2022-23	33.80

Note: The volume of electricity transacted through traders in 2008-09 (April to July 2008) includes cross border trading and intra-state trading volume.
Source: NLDC data

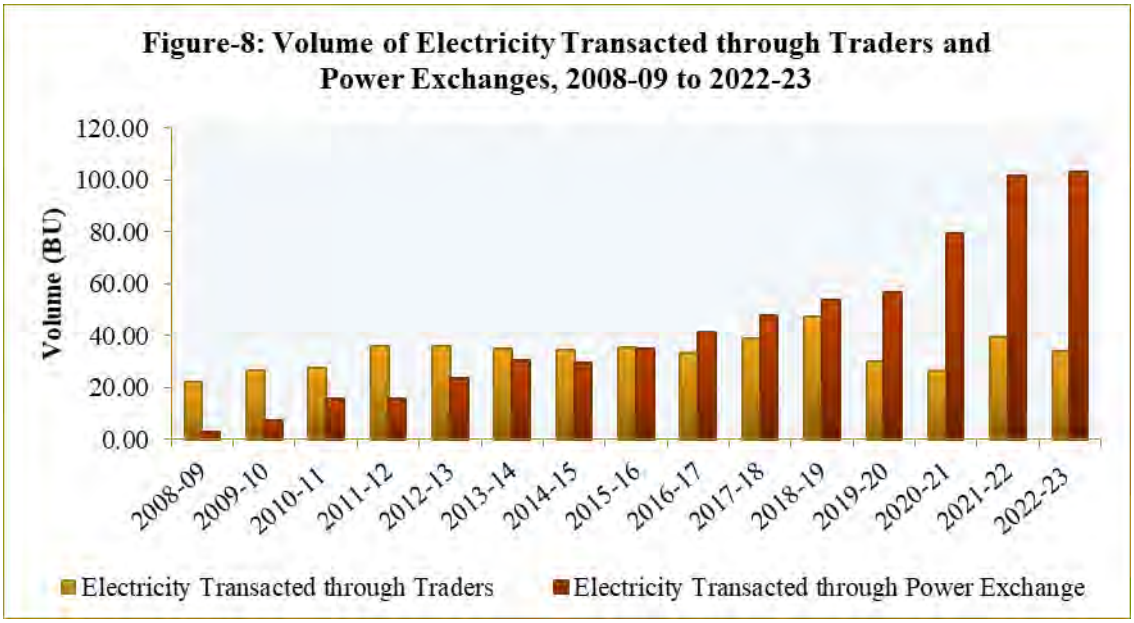
The volume of electricity transacted through all three power exchanges under different market segments increased from 2.77 BU in 2008-09 to 102.95 BU in 2022-23 (Table-10(b)). The CAGR in volume of this segment during 2008-09 to 2022-23 was 29.5%.

Table-10(b): Volume of Electricity Transacted through Power Exchanges (BU), 2008-09 to 2022-23

Year	Electricity Transacted through IEX					Electricity Transacted through PXIL					Electricity Transacted through HPX					Electricity Transacted through Power Exchange
	Day Ahead Market	Green Day Ahead Market	Term Ahead Market	Real Time Market	Green Term Ahead Market	Day Ahead Market	Green Day Ahead Market	Term Ahead Market	Real Time Market	Green Term Ahead Market	Day Ahead Market	Green Day Ahead Market	Term Ahead Market	Real Time Market	Green Term Ahead Market	
2008-09	2.62	-	-	-	-	0.15	-	-	-	-	-	-	-	-	-	2.77
2009-10	6.17	-	0.10	-	-	0.92	-	0.003	-	-	-	-	-	-	-	7.19
2010-11	11.80	-	0.91	-	-	1.74	-	1.07	-	-	-	-	-	-	-	15.52
2011-12	13.79	-	0.62	-	-	1.03	-	0.11	-	-	-	-	-	-	-	15.54
2012-13	22.35	-	0.48	-	-	0.68	-	0.04	-	-	-	-	-	-	-	23.54
2013-14	28.92	-	0.34	-	-	1.11	-	0.30	-	-	-	-	-	-	-	30.67
2014-15	28.12	-	0.22	-	-	0.34	-	0.72	-	-	-	-	-	-	-	29.40
2015-16	33.96	-	0.33	-	-	0.14	-	0.58	-	-	-	-	-	-	-	35.01
2016-17	39.78	-	0.74	-	-	0.25	-	0.35	-	-	-	-	-	-	-	41.12
2017-18	44.84	-	1.37	-	-	0.73	-	0.75	-	-	-	-	-	-	-	47.70
2018-19	50.06	-	2.10	-	-	0.09	-	1.26	-	-	-	-	-	-	-	53.52
2019-20	49.11	-	4.77	-	-	0.05	-	2.52	-	-	-	-	-	-	-	56.45
2020-21	60.38	-	3.27	9.47	0.79	0.24	-	5.45	0.002	0.0004	-	-	-	-	-	79.59
2021-22	65.14	0.92	5.56	19.91	4.02	0.04	0.00	4.43	0.00	1.43	-	-	-	-	-	101.45
2022-23	51.18	3.82	10.10	24.17	1.39	0.19	0.00	8.22	0.01	1.10	0.001	0.00	2.71	0.00	0.07	102.95

Note: Hindustan Power Exchange (HPX) commenced operation from July 2022 onwards

Source: NLDC and Power Exchanges data



A comparison between the volume of electricity transacted through traders and power exchanges is shown in Figure-8 above. It can be observed that the volume of electricity transacted through traders was higher from 2008-09 to 2015-16, but from 2016-17 onwards, the share of electricity transacted through power exchanges increased significantly. This indicates that more demand for electricity is now being met through power exchanges than through bilateral transactions through traders.

The share of electricity transacted through traders and power exchanges as a percentage of total short-term transactions of electricity increased from about 51% in 2009-10 to 70% in 2022-23 (Table-11).

Table-11: Electricity Transacted through Traders and Power Exchanges as percentage of Total Short-term Transactions, 2009-10 to 2022-23

Year	Volume of Electricity Transacted through Traders & Power Exchanges (BU)	Total Short-term Transactions of Electricity (BU)	Electricity Transacted through Traders & PXs as % to Total Volume of Short-term
2009-10	33.91	65.9	51.46%
2010-11	43.22	81.56	52.99%
2011-12	51.38	94.51	54.37%
2012-13	59.66	98.94	60.30%
2013-14	65.78	104.64	62.87%
2014-15	63.96	98.99	64.62%
2015-16	70.43	115.23	61.12%
2016-17	74.63	119.23	62.60%

2017-18	86.64	127.62	67.89%
2018-19	100.84	145.20	69.45%
2019-20	86.40	137.16	62.99%
2020-21	106.26	146.01	72.78%
2021-22	140.92	186.75	75.46%
2022-23	136.76	194.35	70.37%

Source: NLDC and Power Exchanges data

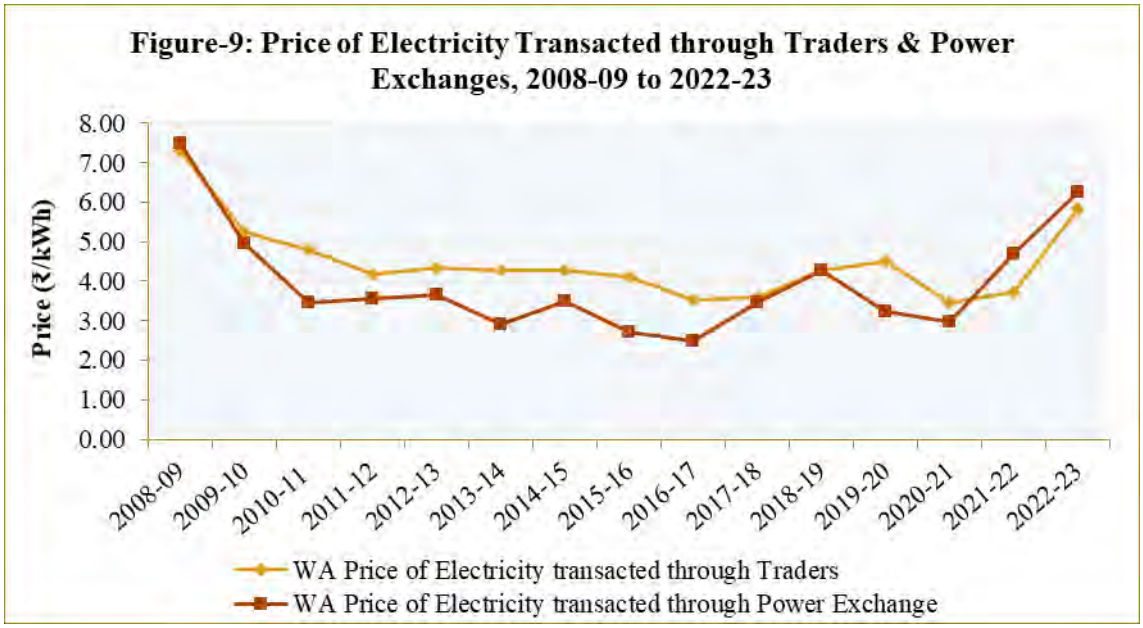
The prices of electricity transacted through traders and power exchanges are shown in Table-12 and Figure-9. The weighted average price of electricity transacted through traders and power exchanges has come down from ₹7.29/kWh and ₹7.49/kWh, respectively in 2008-09 to ₹5.85/kWh and ₹6.25/kWh, respectively in 2022-23.

The nature and duration of contract also influence the price of electricity, like the delivery of electricity through traders is mostly at state periphery whereas in case of power exchanges the delivery of electricity is at regional periphery. Also, the electricity contracts in case of bilateral transactions take place well in advance (i.e. weekly/monthly upto one year), whereas the electricity contract in case of DAM of power exchanges is one day before.

Table-12: Price of Electricity Transacted through Traders and Power Exchanges, 2008-09 to 2022-23

Year	Weighted Average Price of Electricity transacted through Traders (₹/kWh)	Weighted Average Price of Electricity transacted through Power Exchanges (DAM + GDAM + TAM + RTM + GTAM) (₹/kWh)
2008-09	7.29	7.49
2009-10	5.26	4.96
2010-11	4.79	3.47
2011-12	4.18	3.57
2012-13	4.33	3.67
2013-14	4.29	2.90
2014-15	4.28	3.50
2015-16	4.11	2.72
2016-17	3.53	2.50
2017-18	3.59	3.45
2018-19	4.28	4.26
2019-20	4.51	3.24
2020-21	3.47	2.98
2021-22	3.72	4.69
2022-23	5.85	6.25

Source: Traders and Power Exchanges data



The total size of the bilateral electricity market (through traders) and power exchange market increased from ₹17622 crores in 2009-10 to ₹84152 crores in 2022-23, at a CAGR of 12.8% (Table-13). The variation in volume and price affected the size of the bilateral and power exchange market. During 2009-10 to 2022-23, the volume of electricity transacted through traders registered a CAGR of 1.8%, and the volume of electricity transacted through power exchanges increased by around 22.7%. The price of electricity transacted through traders and power exchange increased by 0.8% and 1.8%, respectively, during the period.

Table-13: Volume of Electricity Transacted through Traders and Power Exchanges (BU), 2009-10 to 2022-23

Year	Electricity Transacted through Traders (BU)	Weighted Average Price of Electricity transacted through Traders (₹/kWh)	Size of Bilateral Trader market in ₹ Crore	Electricity Transacted through Power Exchanges (BU)	Weighted Average Price of Electricity transacted through Power Exchanges (₹/kWh)	Size of Power Exchange market in ₹ Crore	Total Size of Bilateral Trader market + Power Exchange market in ₹ Crore
2009-10	26.72	5.26	14055	7.19	4.96	3568	17622
2010-11	27.70	4.79	13268	15.52	3.47	5385	18654
2011-12	35.84	4.18	14979	15.54	3.57	5553	20532
2012-13	36.12	4.33	15624	23.54	3.67	8648	24272
2013-14	35.11	4.29	15061	30.67	2.90	8891	23952
2014-15	34.56	4.28	14801	29.40	3.50	10288	25089
2015-16	35.43	4.11	14557	35.01	2.72	9539	24096
2016-17	33.51	3.53	11844	41.12	2.50	10280	22124
2017-18	38.94	3.59	13970	47.70	3.45	16457	30427
2018-19	47.32	4.28	20255	53.52	4.26	22809	43064
2019-20	29.95	4.51	13516	56.45	3.24	18303	31820
2020-21	26.67	3.47	9245	79.59	2.98	23731	32976
2021-22	39.47	3.72	14688	101.45	4.69	47598	62286
2022-23	33.80	5.85	19769	102.95	6.25	64383	84152

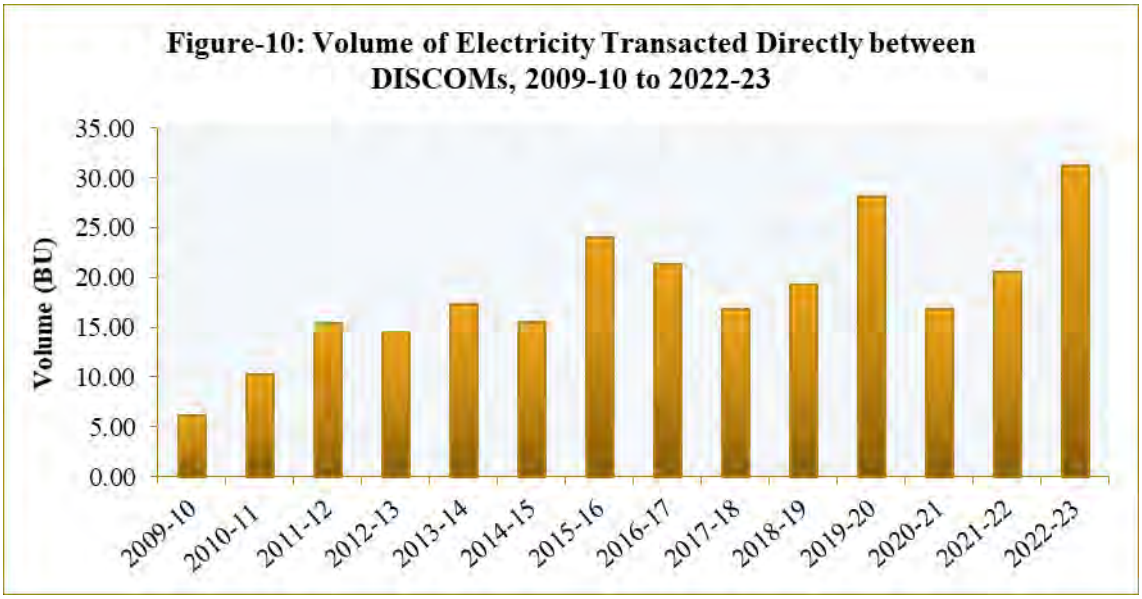
2.1.2 Electricity Transacted Directly between DISCOMs

The volume of electricity transacted directly between DISCOMs is shown in Table-14 and Figure-10. As may be seen from the Table, the volume of electricity transacted directly between DISCOMs increased from 6.19 BU in 2009-10 to 31.30 BU in 2022-23. The volume of electricity transacted directly between DISCOMs as a percentage to the total volume of short-term transactions of electricity was in the range of 9.4% to 20.9% during the period.

Table-14: Volume of Electricity Transacted Directly between DISCOMs, 2009-10 to 2022-23

Year	Volume of Electricity Transacted Directly between DISCOMs (BU)	Total Volume of Short-term (BU)	Volume of Bilateral Direct as % of Total volume of Short-term
2009-10	6.19	65.90	9.4%
2010-11	10.25	81.56	12.6%
2011-12	15.37	94.51	16.3%
2012-13	14.52	98.94	14.7%
2013-14	17.38	104.64	16.6%
2014-15	15.58	98.99	15.7%
2015-16	24.04	115.23	20.9%
2016-17	21.38	119.23	17.9%
2017-18	16.77	127.62	13.1%
2018-19	19.23	145.20	13.2%
2019-20	28.17	137.16	20.5%
2020-21	16.84	146.01	11.5%
2021-22	20.56	186.75	11.0%
2022-23	31.30	194.35	16.1%

Source: NLDC



The increasing trend in the volume of electricity transacted directly by DISCOMs over the years is indicative of the fact that the DISCOMs have independently managed the volume of electricity that they require to buy/sell through directly trading between DISCOMs, in addition to buying/selling through traders and power exchanges.

2.1.3 Electricity Transacted through DSM

The volume and price of electricity transacted through DSM are shown in Table-15 and Figure-11. The volume of DSM as a percentage of total short-term volume declined significantly from its high of 39.2% in 2009-10 to 13.5% in 2022-23. Since the DSM is not a market mechanism, the decline in DSM volume is considered good for the market. So far as the short-term electricity market is concerned, the volume in this segment should be as minimal as possible. The price of DSM plays an important role in ensuring system balance and secure reliable grid operation. As may be seen from the Table-15, the average price of DSM was ₹5.39/kWh in 2022-23.

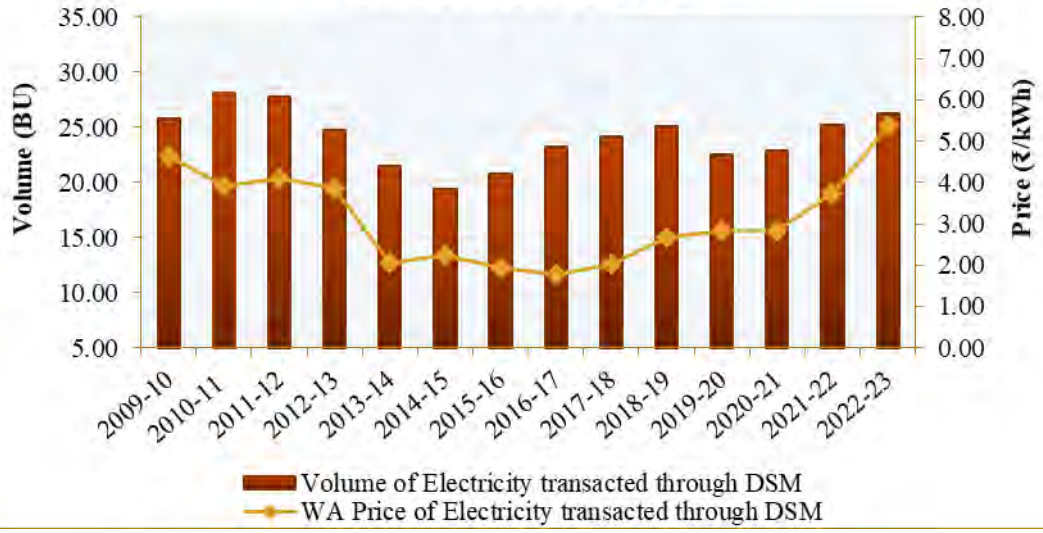
Table-15: Volume and Price of Electricity Transacted through DSM, 2009-10 to 2022-23

Year	Volume of Electricity Transacted through DSM (BUs)	Total Volume of Short-term (BU)	Volume of DSM as % of Short-term	Price of Electricity Transacted through DSM (₹/kWh)
2009-10	25.81	65.90	39.2%	4.62
2010-11	28.08	81.56	34.4%	3.91
2011-12	27.76	94.51	29.4%	4.09

2012-13	24.76	98.94	25.0%	3.86
2013-14	21.47	104.64	20.5%	2.05
2014-15	19.45	98.99	19.6%	2.26
2015-16	20.75	115.23	18.0%	1.93
2016-17	23.22	119.23	19.5%	1.76
2017-18	24.21	127.62	19.0%	2.03
2018-19	25.13	145.20	17.3%	2.68
2019-20	22.59	137.16	16.5%	2.85
2020-21	22.91	146.01	15.7%	2.82
2021-22	25.27	186.75	13.5%	3.73
2022-23	26.30	194.35	13.5%	5.39

Source: NLDC

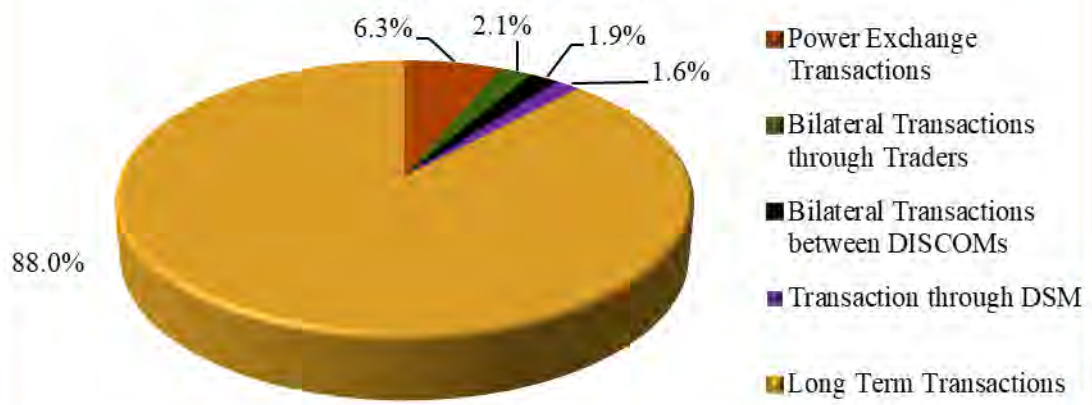
Figure-11: Volume and Price of Electricity transacted through DSM, 2009-10 to 2022-23



3. Monthly Trends in Short-term Transactions of Electricity (April 2022-March 2023)

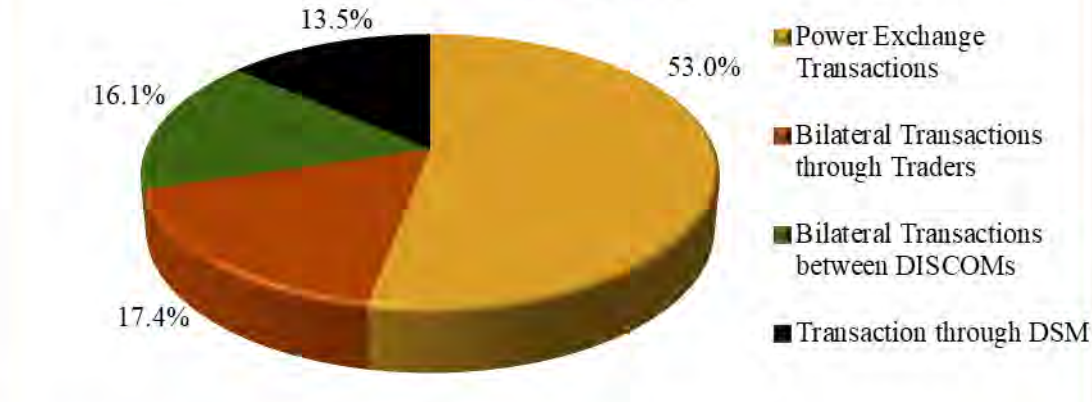
During 2022-23, the share of total short-term transactions and DSM transactions, as a percentage of total electricity generation in the country was about 12% (Figure-12).

Figure-12: Share of Market Segments in Total Electricity Generation, 2022-23



The share of different market segments within the total short-term transactions in 2022-23 is shown in the Figure-13 below.

Figure-13: Share of Market Segments in Short Term Transactions, 2022-23



Of the total short-term transactions in 2022-23, the volume of electricity transacted through power exchanges was maximum at 53%, bilateral transactions through traders at 17.4%, bilateral transactions directly between DISCOMs at 16.1%, and transactions through DSM at 13.5%.

3.1 Volume of Short-term Transactions of Electricity

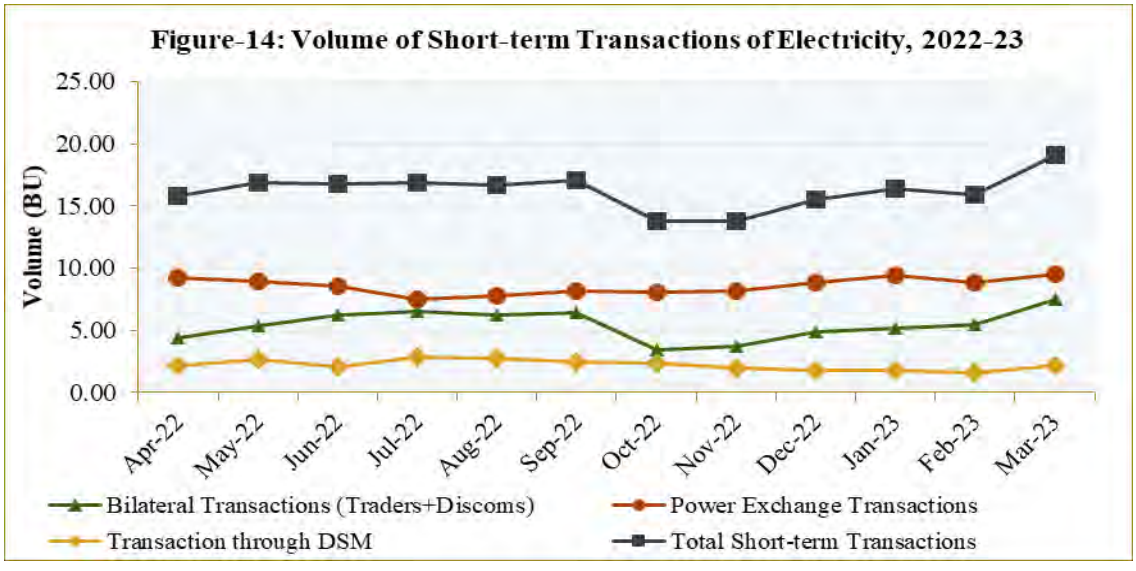
The volume of short-term transactions of electricity during different months of 2022-23 with break-up for different market segments is shown in Table-16 and Figure-14.

Table-16: Volume of Short-term Transaction of Electricity (BU), 2022-23

Month	Bilateral through Traders	Bilateral between DISCOMs	Total Bilateral	Power Exchange Transactions (DAM+ GDAM + TAM + RTM + GTAM)	Transaction through DSM	Total Short-term Transactions	Total Electricity Generation
Apr-22	2.81	1.55	4.36	9.27	2.13	15.76	142.14
May-22	3.53	1.82	5.35	8.88	2.60	16.84	146.10
Jun-22	3.66	2.53	6.19	8.53	2.07	16.79	143.92
Jul-22	3.82	2.74	6.56	7.53	2.79	16.88	138.08
Aug-22	3.17	3.04	6.22	7.77	2.71	16.70	139.77
Sep-22	3.23	3.16	6.39	8.20	2.46	17.05	136.94
Oct-22	2.03	1.37	3.40	8.03	2.33	13.75	123.74
Nov-22	1.55	2.13	3.68	8.14	1.94	13.76	121.84
Dec-22	1.80	3.10	4.90	8.80	1.76	15.46	131.10
Jan-23	1.80	3.38	5.18	9.43	1.80	16.41	136.36
Feb-23	2.12	3.31	5.42	8.86	1.57	15.85	127.12
Mar-23	4.27	3.18	7.45	9.52	2.12	19.09	137.37
Total	**33.80**	**31.30**	**65.10**	**102.95**	**26.30**	**194.35**	**1624.47**

Source: NLDC& CEA

As may be observed from Figure-14, the volume of short-term transactions was subdued during initial months of FY 2022-23 and remained more or less the same from May to September, while October and November 2022 witnessed low demand and volume transacted in the short-term market. The volume transacted increased from December mainly due to heating and lighting loads. As expected, there is no specific trend in the transactions through DSM since these transactions do not move by seasonal variations.



The volume of short-term transactions of electricity as percentage of total electricity generation varied from 11.1% and 13.9% during April 2022 to March 2023 (Table-17).

Table-17: Volume of Short-term Transactions of Electricity as % of Total Electricity Generation, 2022-23

Period	Short-term Transactions as % of Total Electricity Generation
Apr-22	11.1%
May-22	11.5%
Jun-22	11.7%
Jul-22	12.2%
Aug-22	11.9%
Sep-22	12.5%
Oct-22	11.1%
Nov-22	11.3%
Dec-22	11.8%
Jan-23	12.0%
Feb-23	12.5%
Mar-23	13.9%

As on 31.3.2023, there were a total of 47 inter-state trading licensees; of which, 38 trading licensees actively undertook short-term electricity trading during the year 2022-23 (Table-18).

The volume of electricity transacted through traders/trading licensees (inter-state bilateral transactions and transactions through Power Exchanges) has been analysed using the Herfindahl-Hirschman Index (HHI) for measuring competition among the traders (Table-18). Increase in the HHI generally indicates a decrease in competition and an increase of market power, and vice-versa. HHI value below 0.15 indicates un-concentration of market power, the value between 0.15 to 0.25 indicates moderate concentration, the value above 0.25 indicates high concentration of market power. The HHI, based on the volume of electricity transacted through traders during 2022-23 was 0.1874, which indicates moderate concentration of market power among the traders. As compared to 2021-22 with HHI value of 0.2431, the level of market concentration has decreased in 2022-23.

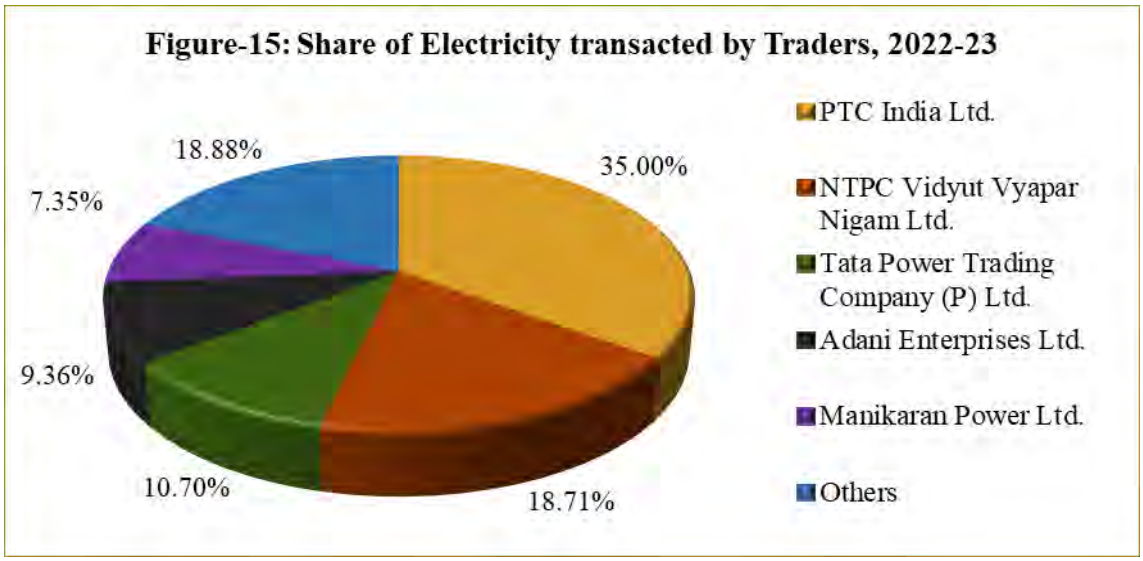
Table-18: Share of Electricity Transacted by Traders and HHI, 2022-23

Sr No	Name of the Trading Licensee	Share of Electricity traded by Licensees	Herfindahl-Hirschman Index (HHI)
1	PTC India Ltd.	35.00%	0.1225
2	NTPC Vidyut Vyapar Nigam Ltd.	18.71%	0.0350
3	Tata Power Trading Company (P) Ltd.	10.70%	0.0115
4	Adani Enterprises Ltd.	9.36%	0.0088
5	Manikaran Power Ltd.	7.35%	0.0054
6	Arunachal Pradesh Power Corporation (P) Ltd	4.31%	0.0019
7	GMR Energy Trading Ltd.	3.57%	0.0013
8	Kreate Energy (I) Pvt. Ltd.	1.91%	0.0004
9	JSW Power Trading Company Ltd	1.79%	0.0003
10	Instinct Infra & Power Ltd.	1.16%	0.0001
11	Greenko Energies Pvt Ltd	0.77%	0.0001
12	RPG Power Trading Company Ltd.	0.64%	0.0000
13	Statkraft Markets Pvt. Ltd.	0.61%	0.0000
14	Ambitious Power Trading Company Ltd.	0.59%	0.0000
15	Knowledge Infrastructure Systems (P) Ltd	0.57%	0.0000
16	NTPC Ltd.	0.51%	0.0000
17	Abja Power Private Limited	0.47%	0.0000
18	Shree Cement Ltd.	0.34%	0.0000
19	NHPC Limited	0.34%	0.0000
20	Shubheksha Advisors Pvt. Ltd.	0.32%	0.0000
21	Saranyu Power Trading Private Limited	0.24%	0.0000
22	Refex Industries Ltd.	0.18%	0.0000
23	Kundan International Pvt. Ltd.	0.15%	0.0000
24	Gita Power & Infrastructure Private Limited	0.13%	0.0000
25	NLC India Ltd.	0.13%	0.0000
26	Instant Venture Pvt. Ltd.	0.07%	0.0000
27	National Energy Trading & Services Ltd.	0.02%	0.0000
28	Customized Energy Solutions India (P) Ltd.	0.01%	0.0000
29	Ideal Energy Solution Pvt. Ltd.	0.01%	0.0000
30	Phillip Commodities India (P) Ltd.	0.01%	0.0000
31	Altilium Energie Private Limited	0.01%	0.0000
32	Amp Energy Markets India Private Limited	0.005%	0.0000
33	Powerfull Energy Trading Pvt. Ltd.	0.003%	0.0000
34	Refex Energy Limited	0.003%	0.0000
35	Saini Power Transactor	0.003%	0.0000
36	Shell Energy Marketing and Trading India Pvt. Ltd.	0.001%	0.0000
37	Reneurja Power LLP	0.0003%	0.0000
38	SJVN Ltd.	0.0003%	0.0000
Total Volume		**100.00%**	**0.1874**
Share of the Top 5 Trading		**81.12%**	

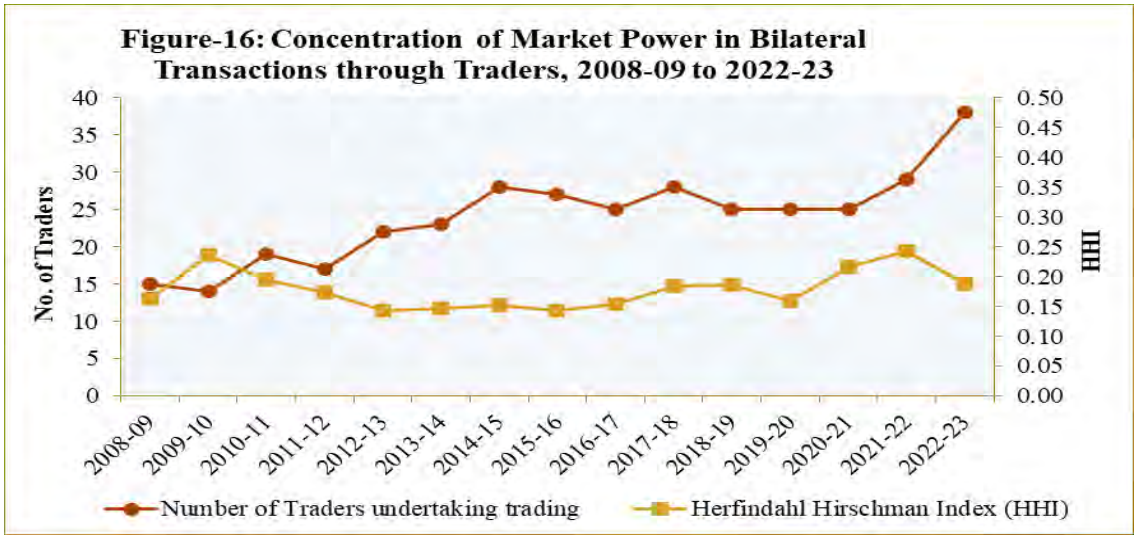
Note: Percentage share in total volume traded by Licensees in 2022-23 is computed based on the volume which includes the volume traded by inter-state trading licensees through bilateral and power exchanges.

Source: Information submitted by Trading Licensees.

The percentage share of electricity transacted by major traders in the total volume of electricity transacted by all the traders is shown in Figure-15.



The concentration of market power based on the volume of electricity transacted through traders and the number of traders is shown in Figure-16. As may be observed from the figure, the number of traders who were undertaking trading bilaterally or through power exchanges or through both, increased from 15 in 2008-09 to 38 in 2022-23.



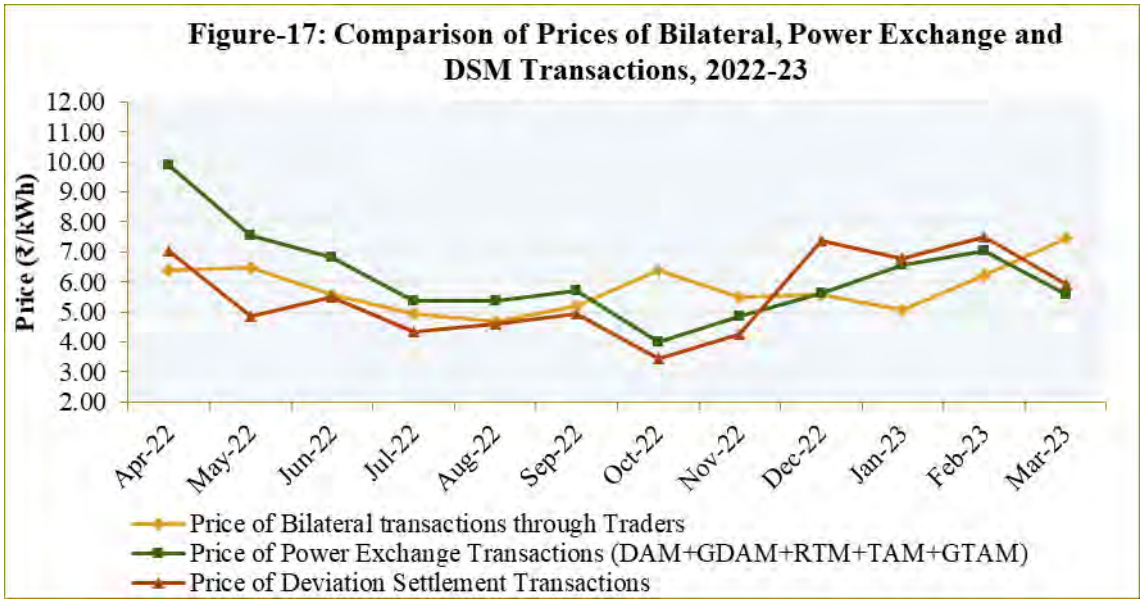
3.2 Price of Short-term Transactions of Electricity

The monthly trends in price of short-term transactions of electricity are shown in Table-19 and Figure-17&18. The price analysis is based on the average price of DSM and the weighted average price of other short-term transactions of electricity. The price of bilateral trader transactions represents the price of electricity transacted through traders. The trend in price of electricity transacted through traders (bilateral trader transactions) are discussed separately for total transactions as well as for the transactions undertaken during Round the Clock (RTC), Peak and Off-peak periods.

Table-19(a): Price of Short-term Transactions of Electricity (₹/kWh), 2022-23

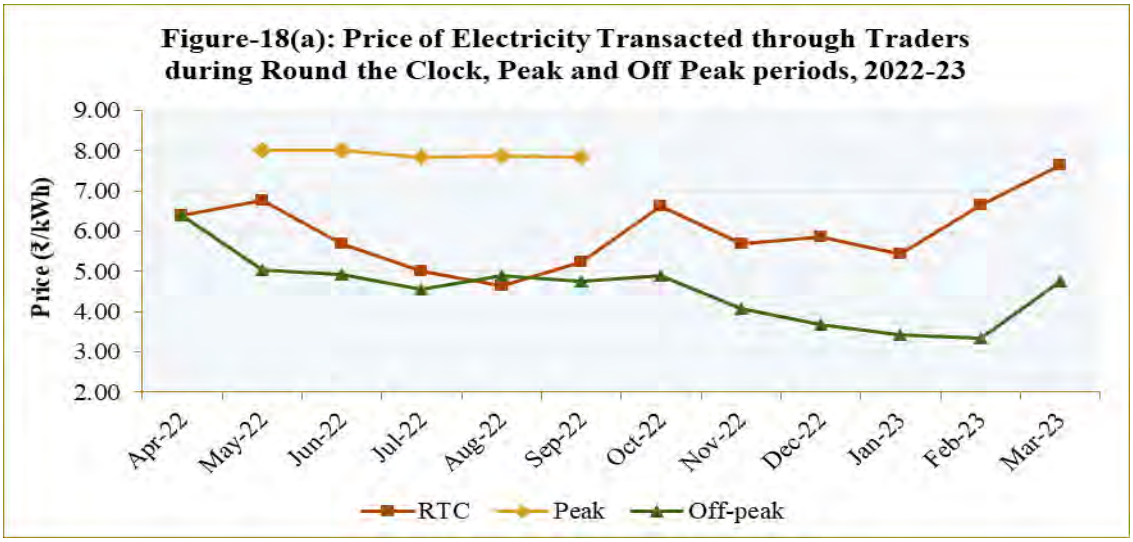
Month	Bilateral through Traders				Power Exchange	DSM
	RTC	Peak	Off-peak	Weighted Average	Weighted Average	All India Grid
Apr-22	6.41	-	6.41	6.41	9.89	7.05
May-22	6.75	8.00	5.04	6.49	7.56	4.87
Jun-22	5.70	8.00	4.92	5.59	6.82	5.48
Jul-22	5.02	7.84	4.56	4.93	5.35	4.35
Aug-22	4.63	7.88	4.89	4.70	5.35	4.60
Sep-22	5.24	7.84	4.75	5.19	5.71	4.95
Oct-22	6.63	-	4.90	6.39	3.99	3.44
Nov-22	5.70	-	4.08	5.48	4.83	4.25
Dec-22	5.86	-	3.67	5.58	5.60	7.36
Jan-23	5.44	-	3.43	5.08	6.58	6.76
Feb-23	6.65	-	3.35	6.22	7.04	7.51
Mar-23	7.63	-	4.74	7.47	5.58	5.93

(-) No price due to no transactions during the month.



It can be observed from the above figure that the price of electricity transacted both through power exchanges and bilaterally through traders witnessed a downward trend from April to September 2022. From October 2022 onwards, there was an increasing trend in the price of power exchange transactions. The prices of bilateral transactions through traders witnessed an uneven trend after September 2022.

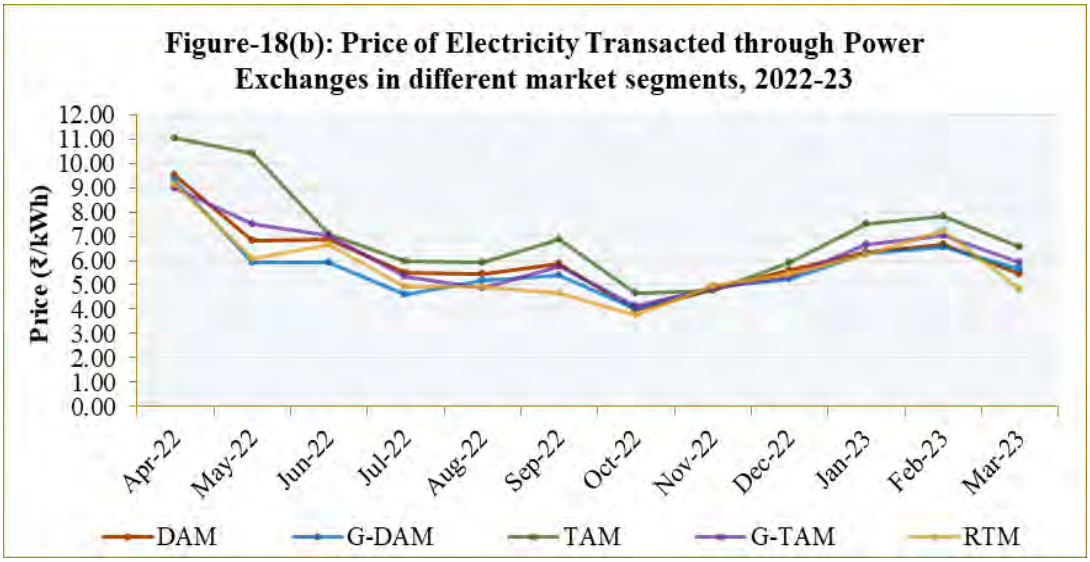
The trend in the price of electricity transacted through traders during RTC, Peak and Off-peak periods are shown in Table-19(a) above and Figure-18(a). There is no price mentioned for electricity transacted during peak for some of the months in 2022-23 because there was no volume of electricity transacted exclusively during the peak period in these months. As can be observed from the figure, except in April and August 2022, the price of electricity transacted during RTC was relatively high when compared to the price of electricity transacted during Off-peak period.



The trend in the price of electricity transacted through Power Exchanges in the various market segments is shown in Table-19(b) and Figure-18(b). The price of electricity transacted across all market segments remained high during April-June 2022 but witnessed a downward trend thereafter. The price of electricity transacted in TAM was relatively high when compared with the price of electricity transacted in other market segments. This may be attributed to the difference in the nature and duration of contracts transacted, and difference in price discovery methodology followed in the two markets.

Table-19(b): Price of Power Exchange Transactions of Electricity (₹/kWh), 2022-23

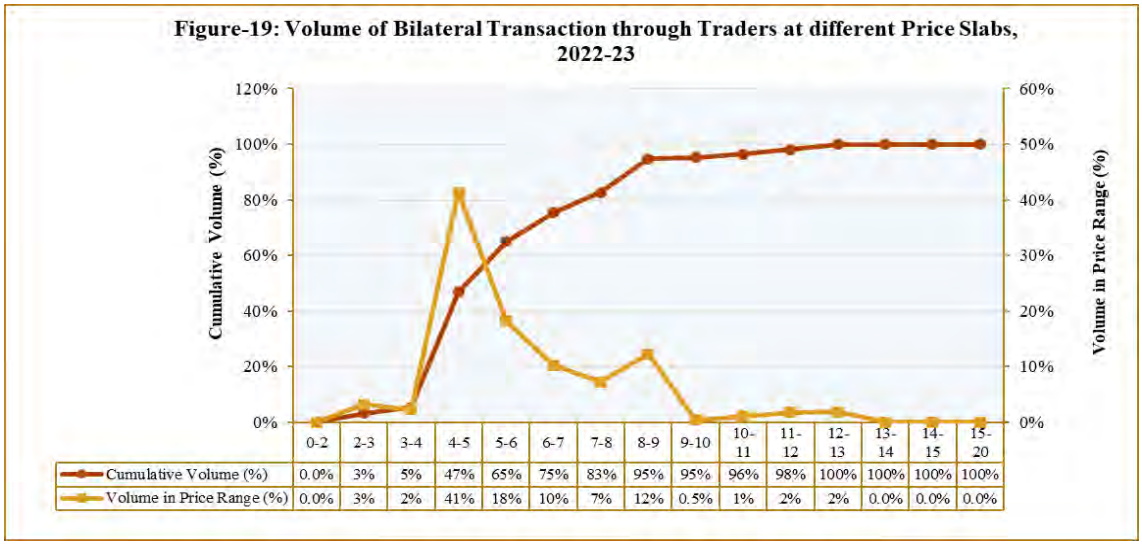
Month	Power Exchange					
	DAM	G-DAM	TAM	G-TAM	RTM	Weighted Average
Apr-22	9.52	9.29	11.01	8.95	9.12	9.89
May-22	6.80	5.91	10.41	7.51	6.10	7.56
Jun-22	6.87	5.94	7.07	7.02	6.67	6.82
Jul-22	5.50	4.63	5.97	5.36	4.92	5.35
Aug-22	5.44	5.20	5.94	4.88	4.90	5.35
Sep-22	5.87	5.42	6.85	5.74	4.68	5.71
Oct-22	3.96	4.02	4.67	4.12	3.74	3.99
Nov-22	4.80	4.91	4.78	4.86	4.99	4.83
Dec-22	5.58	5.24	5.90	5.36	5.47	5.60
Jan-23	6.36	6.30	7.50	6.67	6.26	6.58
Feb-23	6.64	6.57	7.81	7.03	7.24	7.04
Mar-23	5.44	5.67	6.54	5.90	4.82	5.58



3.3 Volume of Electricity Transacted in various Price Slabs

The volume of electricity transacted in various price slabs is shown for the bilateral trader segment and power exchange segment separately. In the case of power exchanges, DAM, G-DAM, and RTM segments have been considered separately. Since no trade happened in the HP-DAM segment at IEX during 2022-23, it has not been discussed.

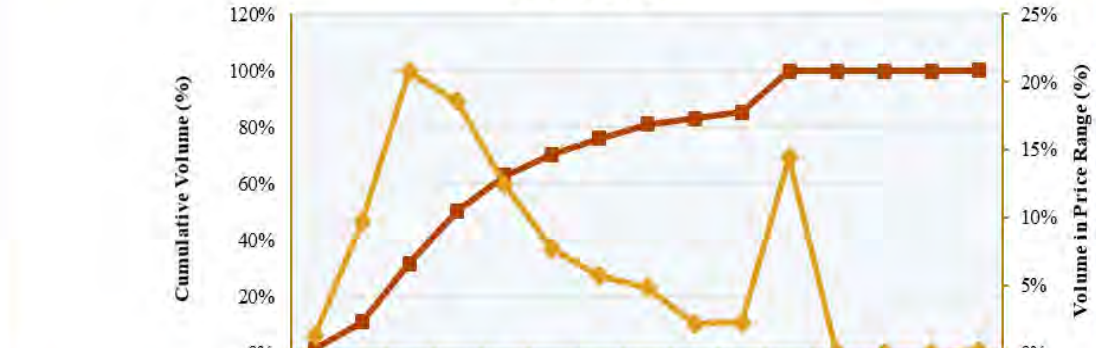
The volume of bilateral transactions at different price slabs in 2022-23 is depicted in Figure-19. The figure shows that about 47% of the volume of electricity was transacted through traders at less than ₹5/kWh and 95% of the volume of electricity was transacted through traders at less than ₹10/kWh.



	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-20
Cumulative Volume (%)	0.0%	3%	5%	47%	65%	75%	83%	95%	95%	96%	98%	100%	100%	100%	100%
Volume in Price Range (%)	0.0%	3%	2%	41%	18%	10%	7%	12%	0.5%	1%	2%	2%	0.0%	0.0%	0.0%

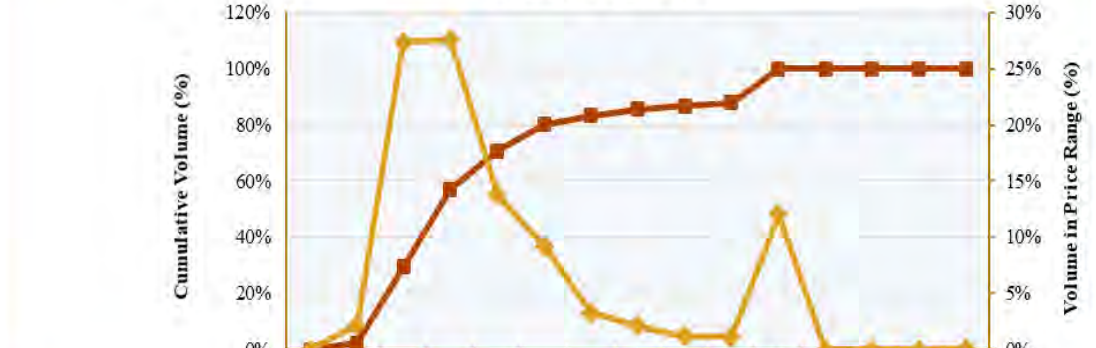
The volume of electricity transacted in IEX at different price slabs in DAM, G-DAM and RTM segments during 2022-23 are depicted in Figure-20(a), 20(b) and 20(c) respectively. The figure shows that 50% of the volume of electricity in DAM was transacted at less than ₹5/kWh and 83% of the volume of electricity was transacted at less than ₹10/kWh. In case of G-DAM, about 57% of the volume of electricity was transacted at less than ₹5/kWh and 87% of the volume of electricity was transacted at less than ₹10/kWh. Similarly, under RTM segment, 55% of the volume of electricity was transacted at less than ₹5/kWh and 85% of the volume of electricity was transacted at less than ₹10/kWh.

Figure-20 (a): Volume of IEX Transactions in Day Ahead Market at different Price Slabs, 2022-23



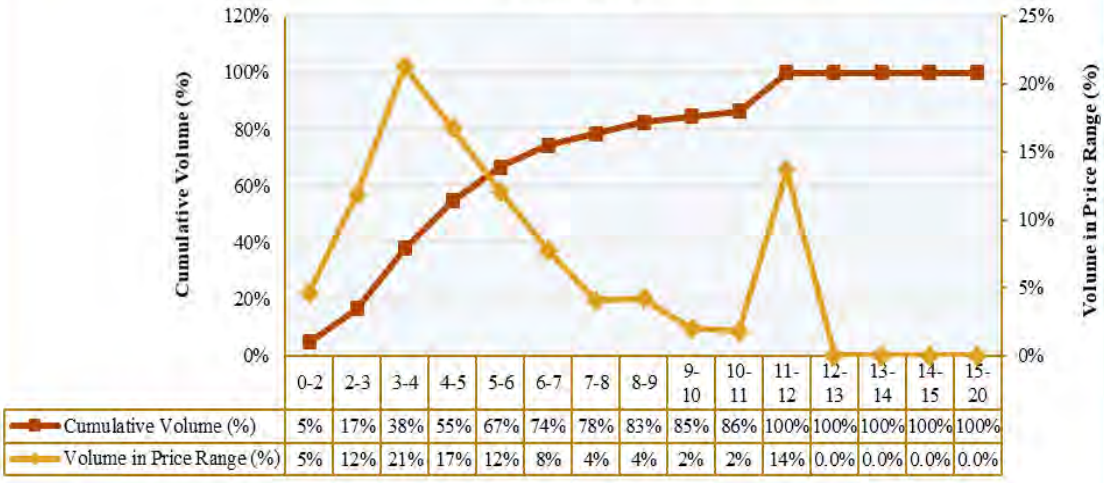
	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-20
Cumulative Volume (%)	1%	11%	32%	50%	63%	70%	76%	81%	83%	85%	100%	100%	100%	100%	100%
Volume in Price Range (%)	1%	10%	21%	19%	12%	8%	6%	5%	2%	2%	14%	0.0%	0.0%	0.0%	0.2%

Figure-20 (b): Volume of IEX Transactions in Green Day Ahead Market at different Price Slabs, 2022-23



	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-20
Cumulative Volume (%)	0%	2%	30%	57%	71%	80%	83%	86%	87%	88%	100%	100%	100%	100%	100%
Volume in Price Range (%)	0%	2%	27%	28%	14%	9%	3%	2%	1%	1%	12%	0.0%	0.0%	0.0%	0.1%

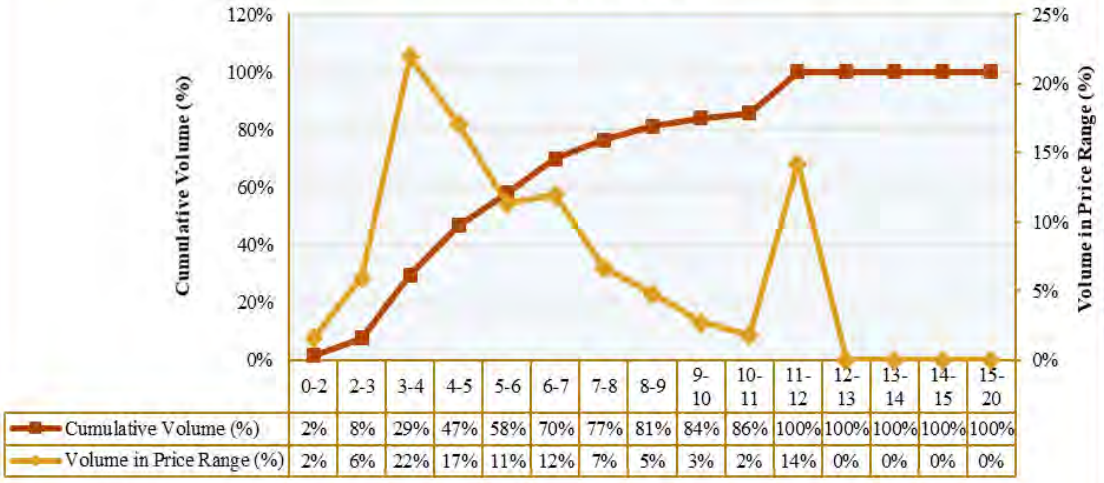
Figure-20 (c): Volume of IEX Transactions in Real Time Market at different Price Slabs, 2022-23



	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-20
Cumulative Volume (%)	5%	17%	38%	55%	67%	74%	78%	83%	85%	86%	100%	100%	100%	100%	100%
Volume in Price Range (%)	5%	12%	21%	17%	12%	8%	4%	4%	2%	2%	14%	0.0%	0.0%	0.0%	0.0%

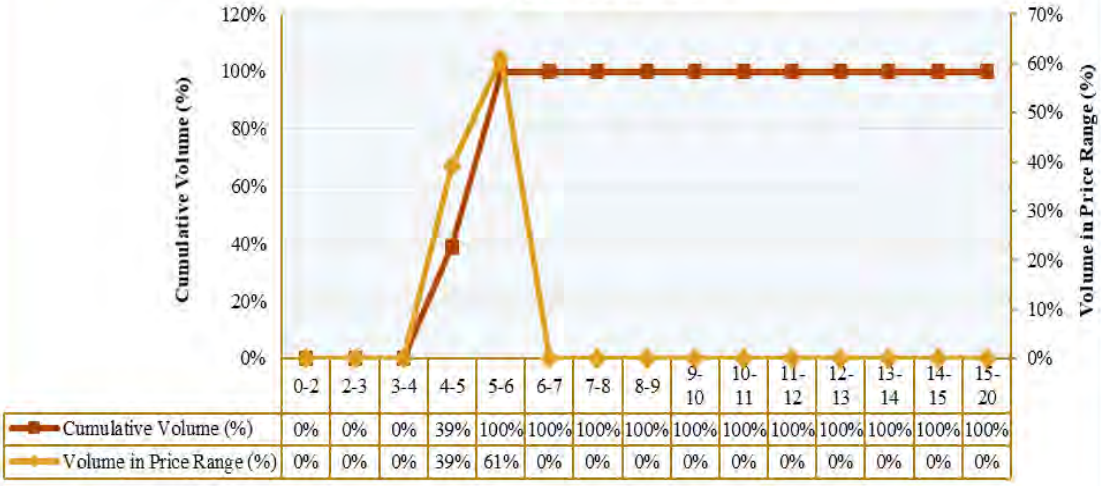
The volume of electricity transacted in PXIL at different price slabs in DAM, GDAM and RTM is depicted in Figure-21(a), 21(b) and 21(c) respectively. The figure shows that 47% of the volume of electricity in DAM was transacted at less than ₹5/kWh, and about 84% of the volume of electricity was transacted at less than ₹10/kWh. There were very few transactions through PXIL in G-DAM and RTM during 2022-23. In the case of G-DAM, 100% of the volume was transacted at less than ₹6/kWh. Similarly, in case of RTM, only 4% of the volume was transacted at less than ₹5/kWh, and 6% of the volume was transacted at less than ₹10/kWh.

Figure-21(a): Volume of PXIL Transactions in Day Ahead Market at different Price Slabs, 2022-23



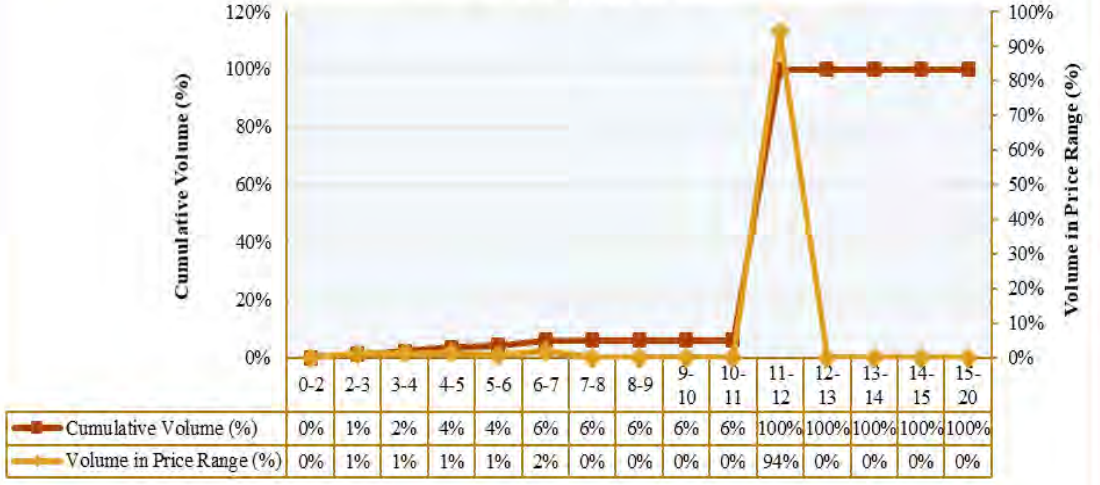
	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-20
Cumulative Volume (%)	2%	8%	29%	47%	58%	70%	77%	81%	84%	86%	100%	100%	100%	100%	100%
Volume in Price Range (%)	2%	6%	22%	17%	11%	12%	7%	5%	3%	2%	14%	0%	0%	0%	0%

Figure-21(b): Volume of PXIL Transactions in Green Day Ahead Market at different Price Slabs, 2022-23



	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-20
Cumulative Volume (%)	0%	0%	0%	39%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Volume in Price Range (%)	0%	0%	0%	39%	61%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

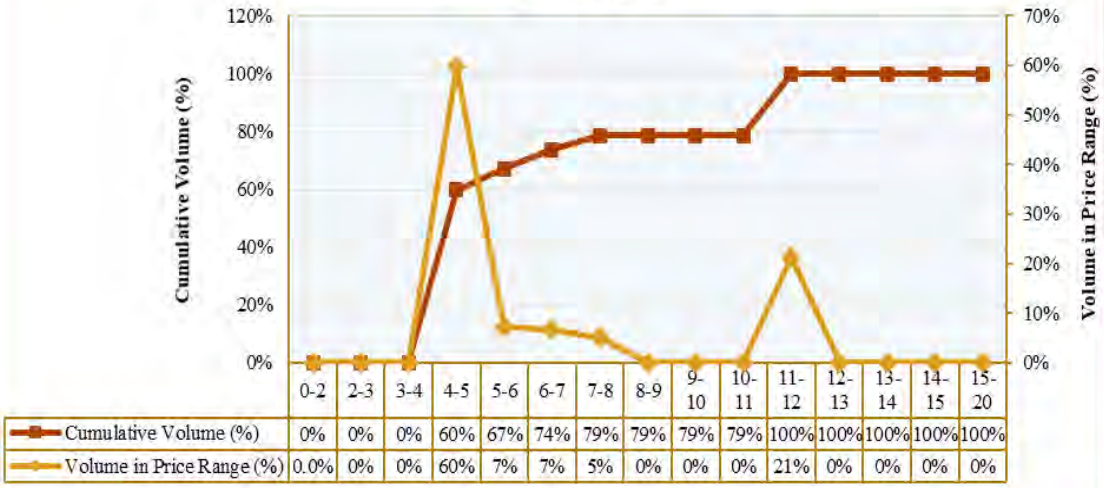
Figure-21(c): Volume of PXIL Transactions in Real Time Market at different Price Slabs, 2022-23



	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-20
Cumulative Volume (%)	0%	1%	2%	4%	4%	6%	6%	6%	6%	6%	100%	100%	100%	100%	100%
Volume in Price Range (%)	0%	1%	1%	1%	1%	2%	0%	0%	0%	0%	94%	0%	0%	0%	0%

The volume of electricity transacted at HPX at different price slabs in DAM is depicted in Figure-22. The figure shows that 60% of the volume of electricity in DAM was transacted at less than ₹5/kWh, and about 79% of the volume was transacted at less than ₹10/kWh. There were no transactions through HPX in G-DAM and RTM during 2022-23.

Figure 22: Volume of HPX Transactions in Day Ahead Market at different Price Slabs, 2022-23

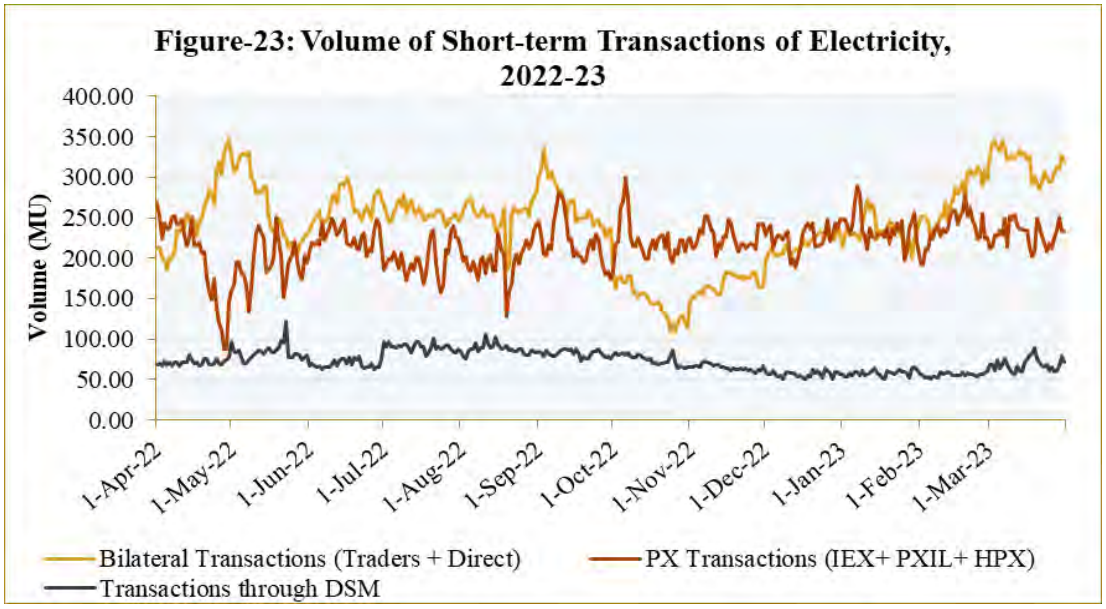


	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-20
Cumulative Volume (%)	0%	0%	0%	60%	67%	74%	79%	79%	79%	79%	100%	100%	100%	100%	100%
Volume in Price Range (%)	0.0%	0%	0%	60%	7%	7%	5%	0%	0%	0%	21%	0%	0%	0%	0%

4. Daily Trends in Short-term Transactions of Electricity (1st April 2022 to 31st March 2023)

4.1 Volume of Short-term Transactions of Electricity

Trends in daily volume of short-term transactions and DSM transactions are shown in Figure-23. It can be observed from the figure that the volume of electricity transacted through power exchanges witnessed a sharp fall during April and May 2022, while bilateral transactions through traders and directly between DISCOMs increased significantly during this period. The volume of bilateral transactions remained high as compared to power exchanges until October 2022, post which transactions in power transactions increased vis-à-vis bilateral transactions. In February and March 2023, there was an increasing trend in the volume of bilateral transactions.



4.2 Price of Short-term Transactions of Electricity

Price and its volatility in the daily price of short-term transactions of electricity through power exchanges and DSM have been analysed in this section. Volatility has been computed using the historical volatility formula (see Annexure-III for the formula).

4.2.1 Price and its Volatility in Power Exchanges

The weighted average price of electricity transacted through IEX in DAM, G-DAM and RTM segments with their respective volatility levels are shown in Figure-24(a), 24(b) and 24(c), respectively. Volatility in the price of electricity transacted through IEX has been computed using daily data for 2022-23, and it works out to be 18.12% in the case of DAM, 15.62% in G-DAM and 23.38% in RTM.

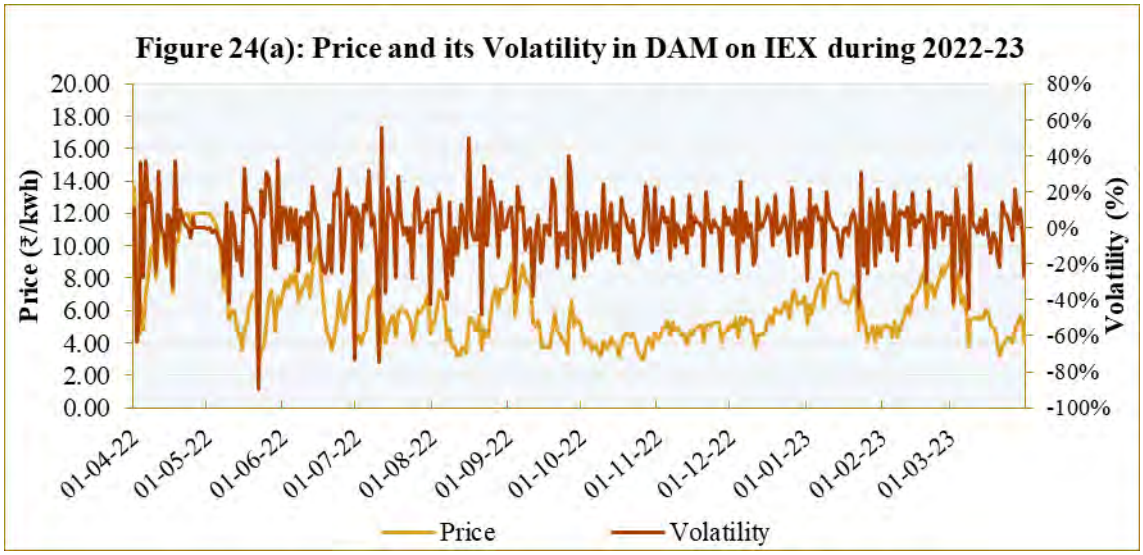


Figure 24(a): Price and its Volatility in DAM on IEX during 2022-23
Price (₹/kwh)
Volatility (%)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
01-04-22
01-05-22
01-06-22
01-07-22
01-08-22
01-09-22
01-10-22
01-11-22
01-12-22
01-01-23
01-02-23
01-03-23
Price
Volatility

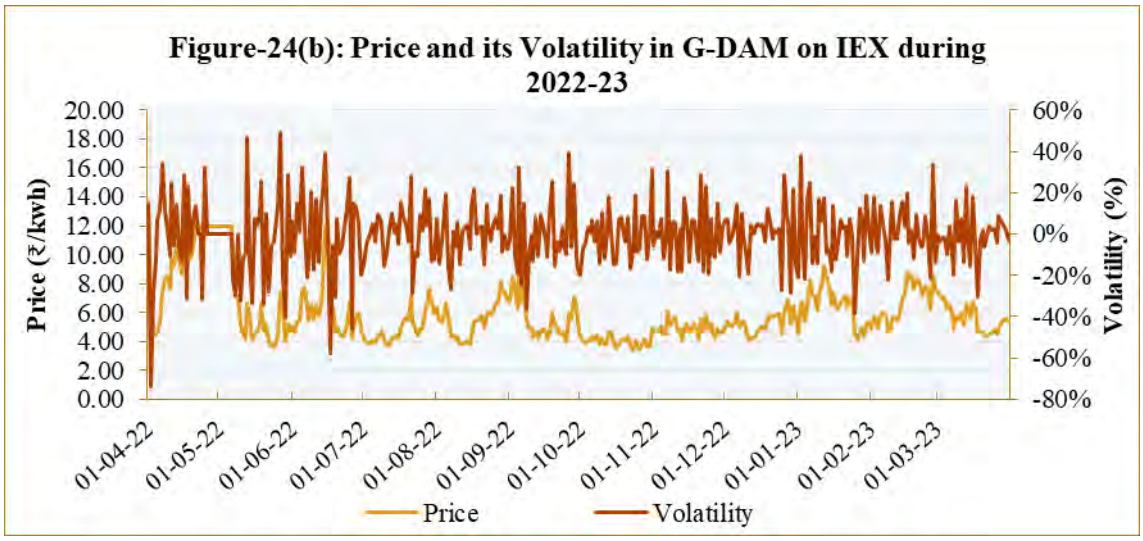


Figure-24(b): Price and its Volatility in G-DAM on IEX during 2022-23
Price (₹/kwh)
Volatility (%)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
60%
40%
20%
0%
-20%
-40%
-60%
-80%
01-04-22
01-05-22
01-06-22
01-07-22
01-08-22
01-09-22
01-10-22
01-11-22
01-12-22
01-01-23
01-02-23
01-03-23
Price
Volatility

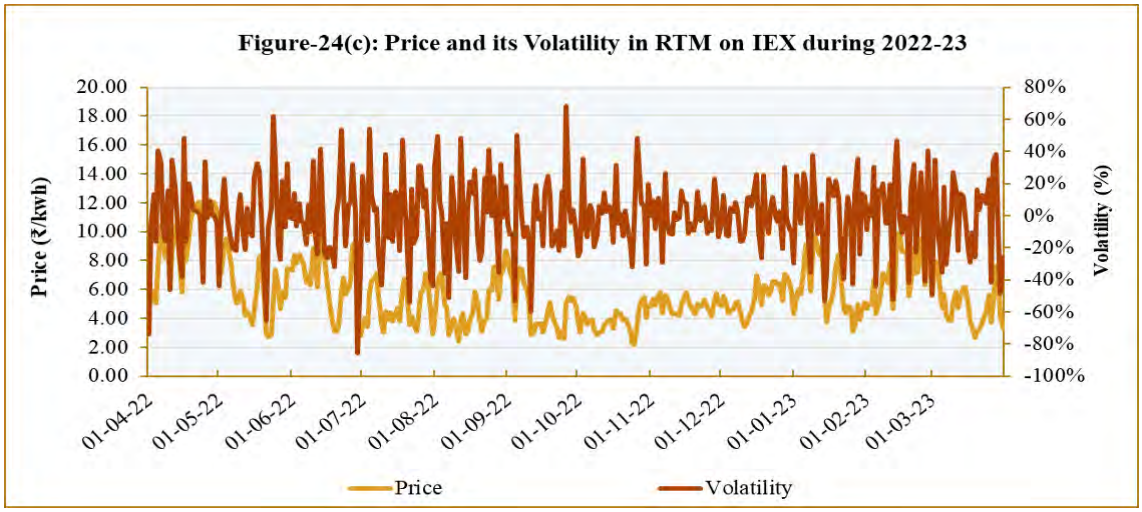


Figure-24(c): Price and its Volatility in RTM on IEX during 2022-23
Price (₹/kwh)
Volatility (%)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
01-04-22
01-05-22
01-06-22
01-07-22
01-08-22
01-09-22
01-10-22
01-11-22
01-12-22
01-01-23
01-02-23
01-03-23
Price
Volatility

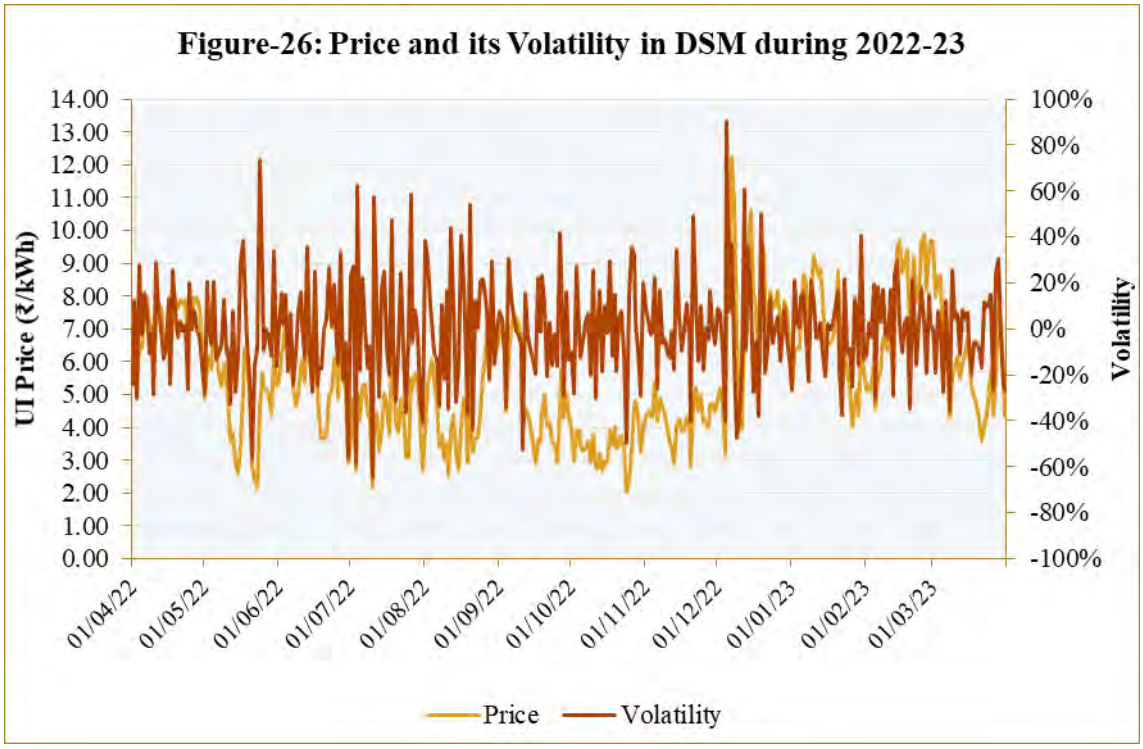
The weighted average price of electricity transacted through PXIL in DAM and its Volatility are shown in Figure-25. The price and its volatility for the electricity transacted through PXIL in GDAM and RTM has not been depicted here due to low liquidity and transactions took place only on few days in 2022-23. Volatility in the price of electricity transacted through PXIL in DAM has been computed using daily data for 2022-23, and it works out to be 22.38%.

Figure-25: Price and its Volatility in DAM on PXIL during 2022-23

The weighted average price of electricity transacted through HPX in DAM and its Volatility has not been depicted as the transactions took place only on two days in 2022-23. Further, no volume was transacted in GDAM and RTM at HPX during 2022-23.

4.2.2 *Price and its Volatility in DSM*

The average price of electricity transacted through DSM and its volatility is shown in Figure-26. Volatility in the price of electricity transacted through DSM has been computed using daily data for 2022-23 and it works out to be 22.01%.



Since the nature of transactions through DSM is different from the transactions through power exchanges, the volatility in the price of electricity transacted through DSM is generally high.

5. Time of the Day Variation in Volume and Price of Electricity Transacted through Traders and Power Exchanges

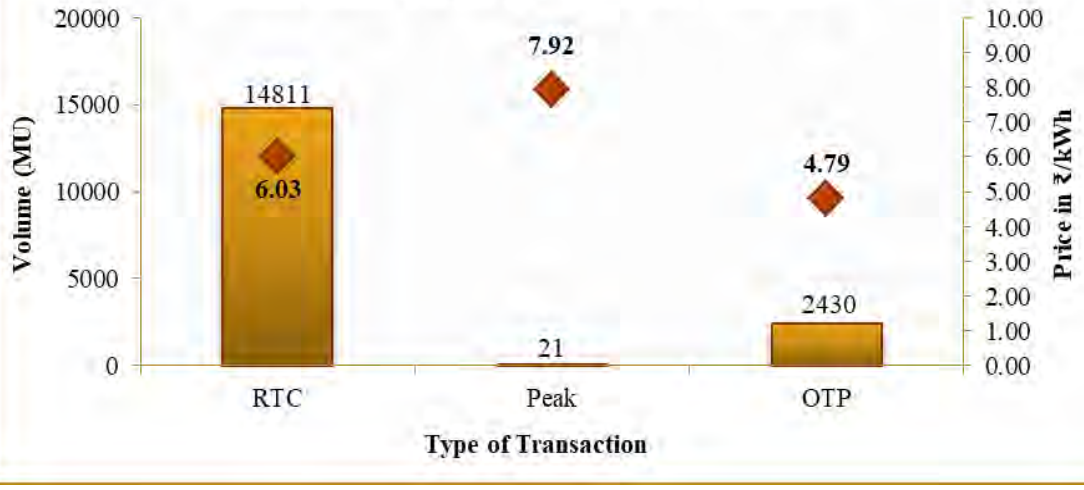
In this section, time of the day variation in volume and price of electricity transacted through traders has been illustrated for RTC (Round the Clock), Peak period and other than RTC & Peak period. Time of the day variation in volume and price of electricity transacted through power exchanges is shown block-wise. Price of electricity transacted through power exchanges is discussed both region-wise and block-wise.

5.1 Time of the Day Variation in Volume and Price of Electricity Transacted through Traders

Time of the day variation in volume and price of electricity transacted bilaterally through traders during 2022-23 is shown in Figure-27. The volume of electricity transacted through traders represent inter-state transactions, i.e., excluding banking

transactions. Time of the day variation in volume is shown during RTC (Round the Clock), Peak period and OTP (other than RTC & Peak period). Of the total volume, about 85.8% was transacted during RTC followed by 14.1% during OTP and 0.1% during peak period. It can be observed from the figure that the share of electricity transacted during peak period is much low with less than 1% of the total transactions. It can also be observed that the weighted average price during Peak period was relatively high (₹7.92/kWh), as compared to price of electricity transacted during RTC (₹6.03/kWh) and OTP (₹4.79/kWh).

Figure-27: Volume and Price of Electricity Transacted through Traders during RTC, Peak and OTP, 2022-23



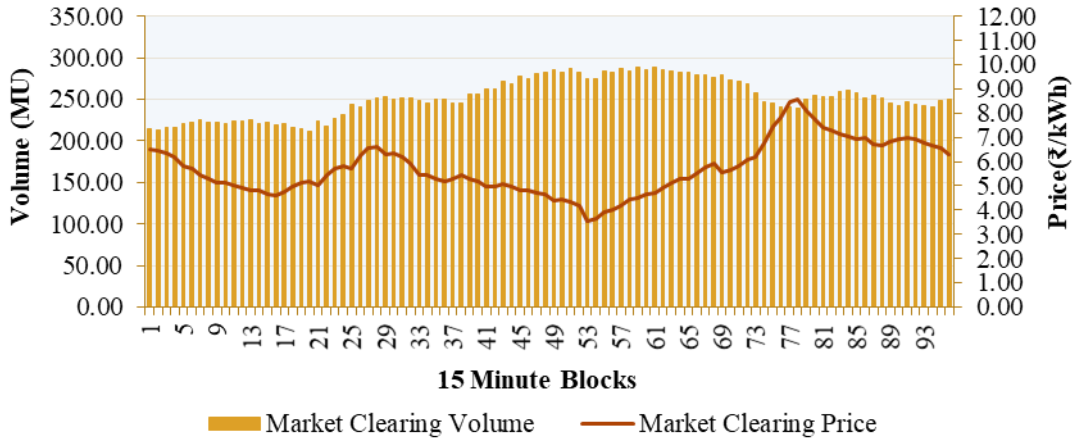
5.2 Time of the Day Variation in Volume and Price of Electricity Transacted through Power Exchanges

Time of the day variation in volume and price of electricity transacted under DAM, G-DAM and RTM at IEX during 2022-23 are shown block-wise in Figure-28(a), 28(b) and 28(c) respectively. It may be observed from the figure that high price was witnessed during morning and evening peak hours in DAM and RTM, and low prices witnessed during the off-peak hours. In case of G-DAM, it can be observed that the market clearing volume increases during day time, i.e., solar hours. With increase in supply during the day time, prices in G-DAM segment remained low, whereas high prices were observed during morning and evening peak when corresponding supply of RE power was low.

Figure-28(a): Block-wise Market Clearing Volume and Price in DAM on IEX during 2022-23

Figure-28(b): Block-wise Market Clearing Volume and Price in G-DAM on IEX during 2022-23

Figure-28(c): Block-wise Market Clearing Volume and Price in RTM on IEX during 2022-23



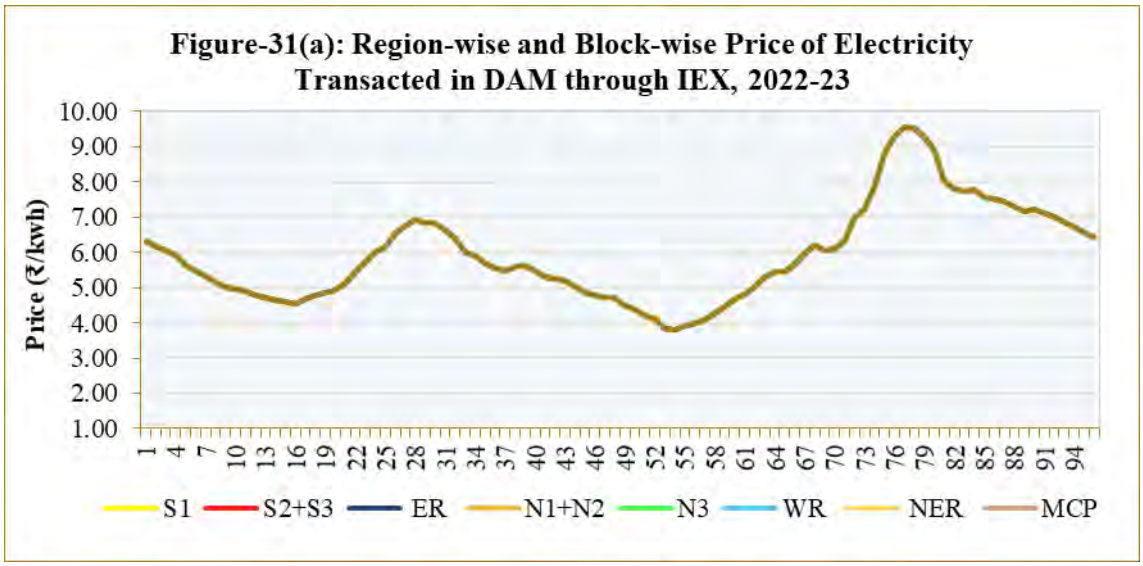
Time of the day variation in volume and price of electricity transacted through DAM on PXIL during 2022-23 is shown block-wise in Figure-29. It may be observed from the figure that the prices in DAM remained subdued during solar hours and increased in the peak evening hours. Due to very limited number of transactions, the time of the day variation in volume and price of electricity transacted through GDAM and RTM at PXIL is not depicted.

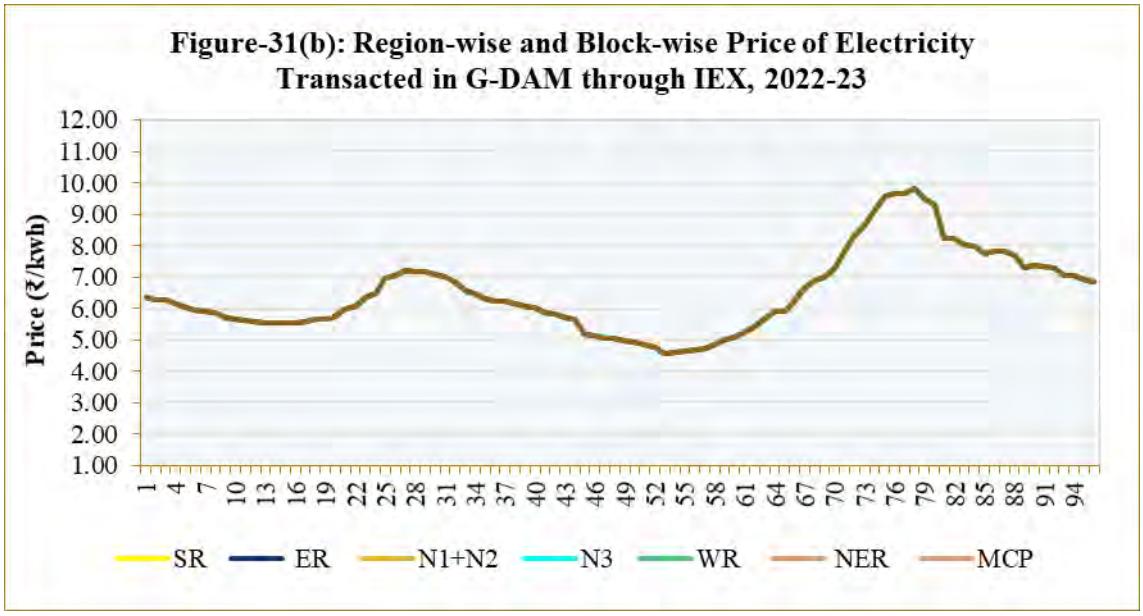
Figure-29: Block-wise Market Clearing Volume and Price in DAM on PXIL during 2022-23

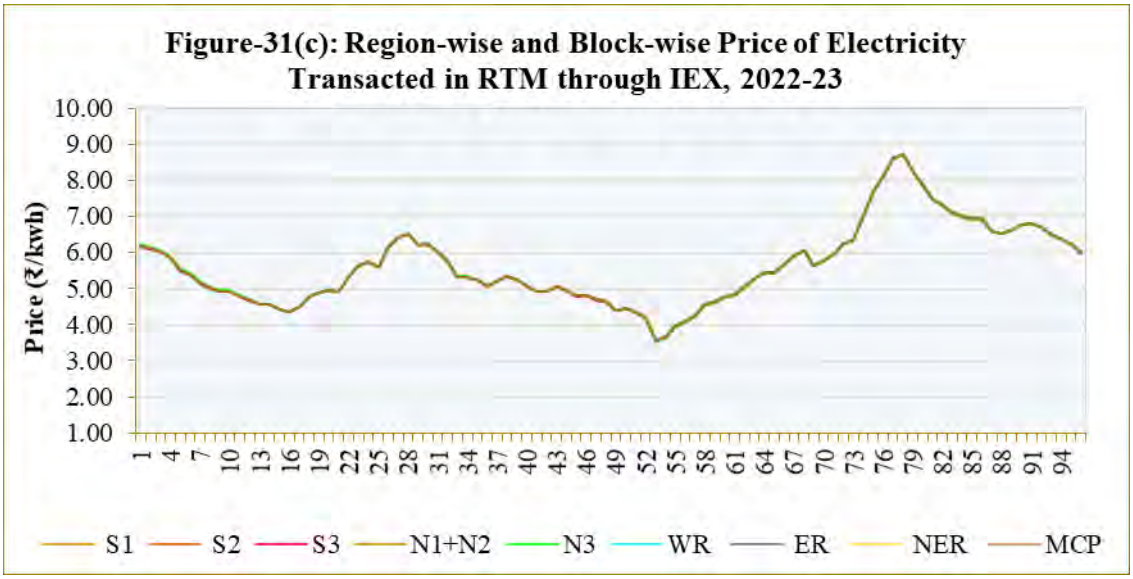
Time of the day variation in volume and price of electricity transacted through DAM at HPX during 2022-23 is shown block-wise in Figure-30. Transactions took

place only on two days in DAM, where prices touched the ceiling of ₹12/kWh during evening peak hours. No transactions took place in GDAM and RTM at HPX during 2022-23.

Region-wise and hour-wise prices of electricity transacted through IEX in DAM, G-DAM and RTM are shown in Figure-31(a), 31(b) and 31(c), respectively. It can be observed that during 2022-23, the price of electricity in all the regions was almost similar, which is indicative of very few instances of congestion.

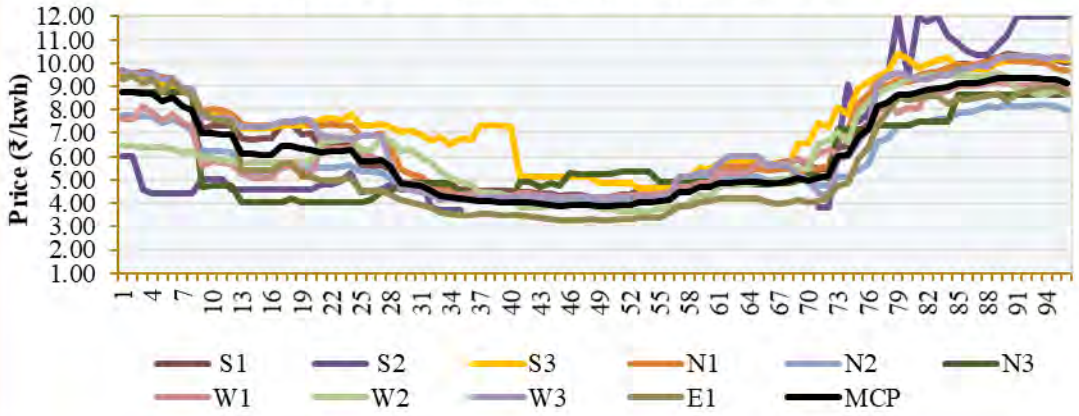






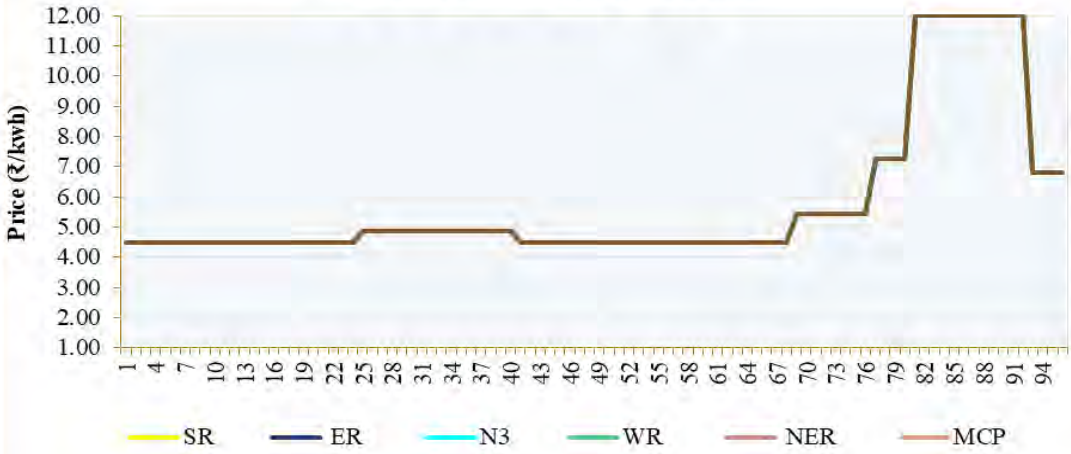
Region-wise and hour-wise prices of electricity transacted through PXIL in DAM are shown in Figure-32. Though no consistent trend has been observed in price in different regions, price of electricity in southern region was relatively high when compared with the prices in other regions. There were very few transactions in G-DAM and RTM through PXIL during 2022-23, due to which the region-wise and hour-wise prices of electricity transacted are not depicted in figure separately.

Figure-32: Region-wise and Block-wise Price of Electricity Transacted in DAM through PXIL, 2022-23



Region-wise and hour-wise prices of electricity transacted through HPX in DAM in 2022-23 are shown in Figure-33. Transactions in HPX took place only on two days in DAM, and one price was observed across regions. No transactions were there in G-DAM and RTM in HPX during 2022-23.

Figure-33: Region-wise and Block-wise Price of Electricity Transacted in DAM through HPX, 2022-23



6. Trading Margin Charged by Trading Licensees

During the year 2004-05, when trading started through licensees, the licensees voluntarily charged 5 paise/kWh or less as the trading margin for bilateral transactions. However, trading margin increased in 2005 and the weighted average trading margin charged by the licensees went up to 10 paise/kWh during April to September 2005

period. This necessitated fixing trading margin for inter-state trading of electricity. The trading margin was fixed at 4 paise/kWh, vide CERC (Fixation of Trading Margin) Regulations notification dated 26.01.2006. As a result of these trading margin regulations, the licensees charged trading margin of 4 paise or less from 26.01.2006 onwards until revised Trading Margin Regulations, 2010 came into existence on 11.01.2010 (Table-20 & Figure-34).

Based on feedback and experience gained from 2006 Regulations and considering various risks associated with the electricity trading business, CERC revised the trading margin in 2010. As per the CERC (Fixation of Trading Margin) Regulations, 2010, the trading licensees are allowed to charge trading margin up to 7 paise/kWh in case the sale price exceeds ₹3/kWh, and 4 paise/kWh where the sale price is less than or equal to ₹3/kWh.

For increasing the volume of trading, some of the trading licensees misunderstood the intention of the trading margin regulations and charged negative trading margin for some of the transactions. Keeping this in view and to avoid negative trading margin, the Commission, in the CERC (Procedure, Terms and Conditions for grant of trading licence and other related matters) Regulations, 2020 has prescribed the trading margin of not less than zero (0.0) paise/kWh and not exceeding seven (7.0) paise/kWh w.e.f. 31st January, 2020. In these regulations, the applicability of trading margin has been clearly specified separately for transactions under (a) short-term contracts, (b) long-term contracts, (c) banking contracts, (d) back-to-back contracts and (e) cross border trade of electricity. The trading licensees have been charging the trading margin as per the regulations. Due to stiff competition among the trading licensees, the trading margin charged by the trading licensees was always less than the ceiling margin allowed in the trading margin regulations. The new trading margin regulations restrict the trading licensees from charging negative trading margin, i.e., less than zero (0.0) paisa/kWh. The weighted average trading margin charged by the trading licensees for bilateral transactions during 2009-10 to 2022-23 is provided in Table-20 and Figure-34.

Table-20: Trading Margin Charged by Trading Licensees, 2009-10 to 2022-23

Period	Trading Margin (₹/kWh)
2009-10	0.040
2010-11	0.050
2011-12	0.050
2012-13	0.041
2013-14	0.035
2014-15	0.038
2015-16	0.032
2016-17	0.032
2017-18	0.031
2018-19	0.032
2019-20	0.031
2020-21	0.024
2021-22	0.035
2022-23	0.027

Note 1: Weighted Average Trading Margin is computed based on all Inter-state Trading Transactions excluding Banking Transactions

Figure-34: Trading Margin Charged by Trading Licensees, 2009-10 to 2022-23

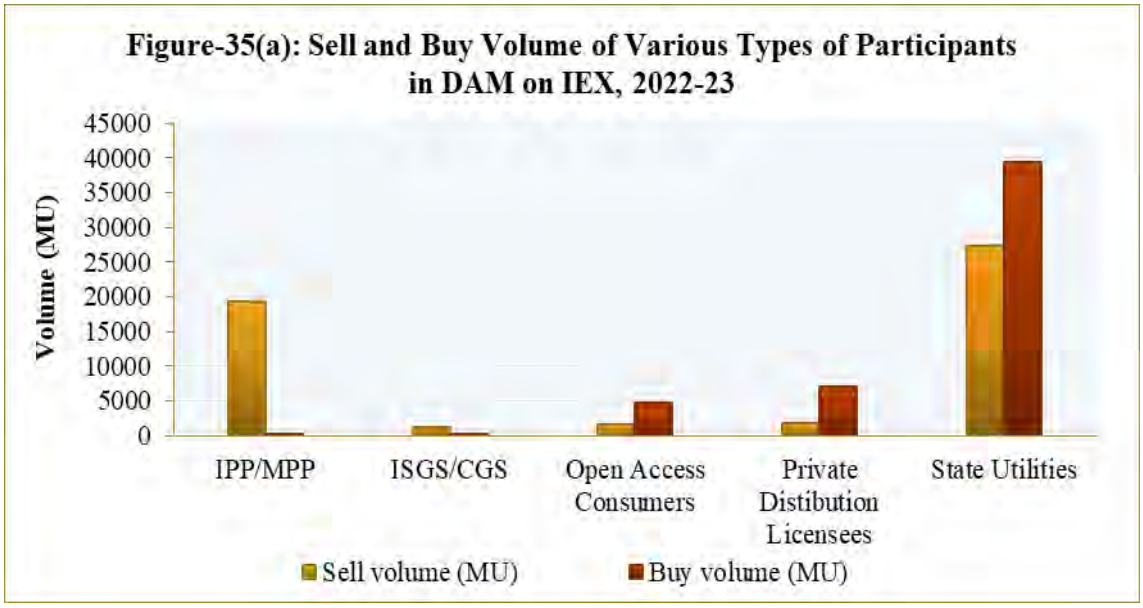
It can be observed from the above figure that the trading margin charged by the trading licensees, in general, witnessed a downward trend over the years. This may be attributed to the increasing competition among the trading licensees.

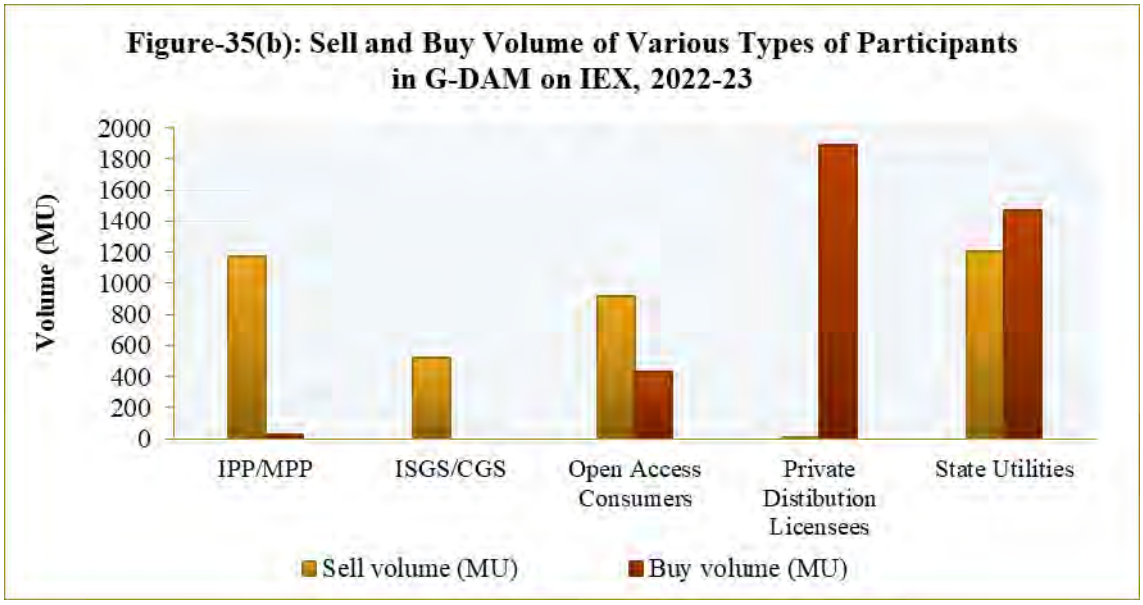
7. Open Access Consumers on Power Exchanges

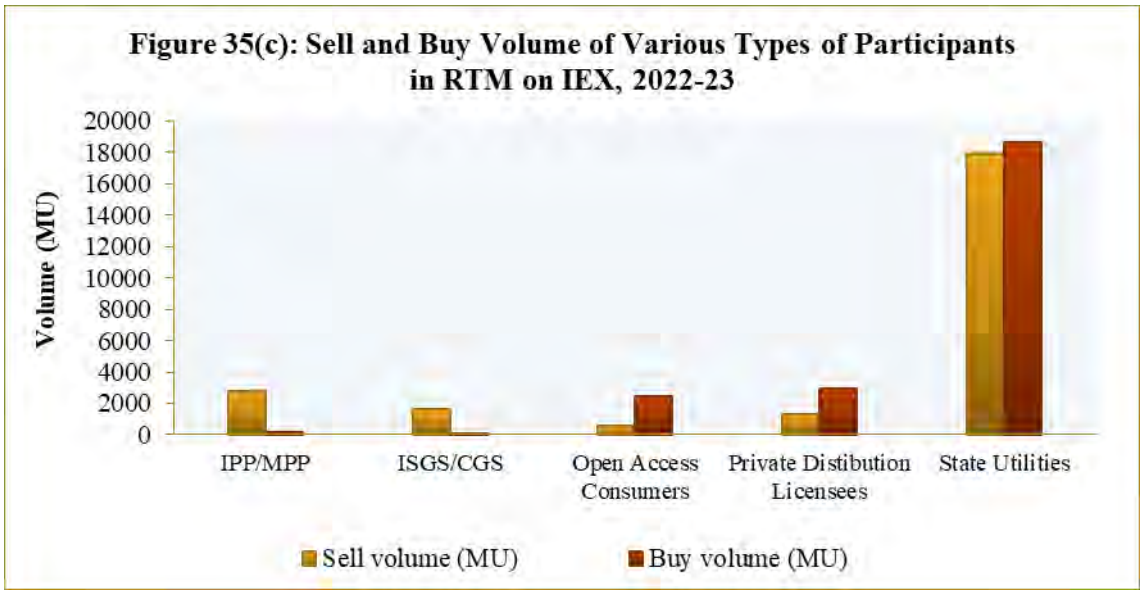
This section discusses the various types of participants in power exchanges and provides analysis of open access consumers in DAM, G-DAM and RTM segments of power exchanges (Open Access consumers include Industrial Consumers and Captive Power Plants).

7.1 Types of Participants in Power Exchanges

As shown in Figure-35(a), 35(b) and 35(c) during the year 2022-23, there were five types of participants at IEX under DAM, G-DAM and RTM. In case of DAM, the major sellers of electricity at IEX were state utilities and independent power producers, while the major buyers of electricity were state utilities followed by private distribution licensees and open access consumers {Figure-35(a)}. In case of G-DAM, the major sellers of electricity were state utilities, followed by independent power producers and open access consumers, while the major buyers of electricity were private distribution licensees followed by state utilities and open access consumers {Figure-35(b)}. In case of RTM, the major sellers of electricity were state utilities followed by independent power producers, whereas, the major buyers were state utilities followed by private distribution licensees {Figure-35(c)}.







There were five types of participants (IPPs, ISGS, Open Access Consumers, Private Distribution Licensees and State Utilities) at PXIL during 2022-23. Details of share of various participants in DAM, G-DAM and RTM segments are shown in Figure-36(a), 36(b) and 36(c), respectively. It can be observed from the figure that major sellers of electricity at PXIL in DAM were ISGS and state utilities constituting more than 90% of the total buy volume. Major buyers in DAM were state utilities and open access consumers. In case of G-DAM, state utilities were the only sellers and open access consumers were the buyers of electricity. In case of RTM, state utilities were the major buyers and sellers of electricity, followed by private distributions licensees and ISGS.

Figure-36(a): Sell and Buy Volume of Various Types of Participants in DAM on PXIL, 2022-23

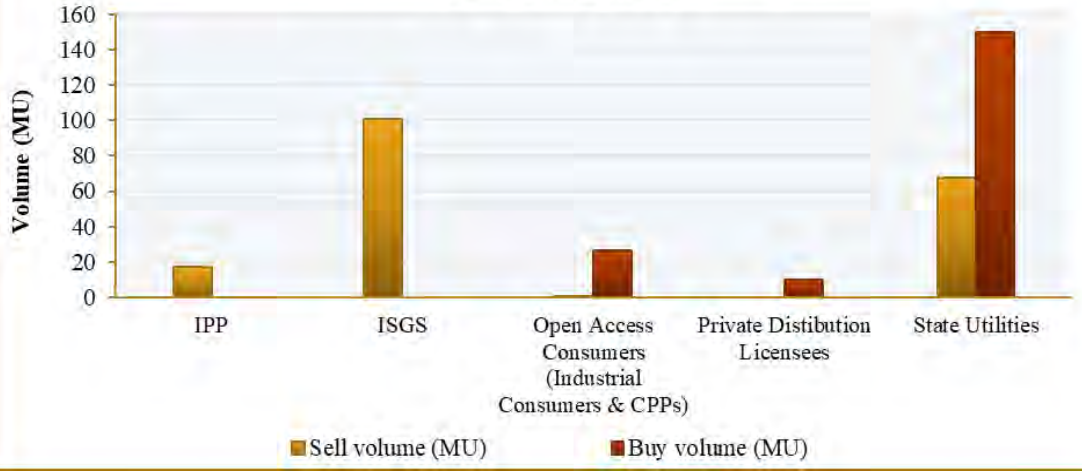


Figure-36(b): Sell and Buy Volume of Various Types of Participants in GDAM on PXIL, 2022-23

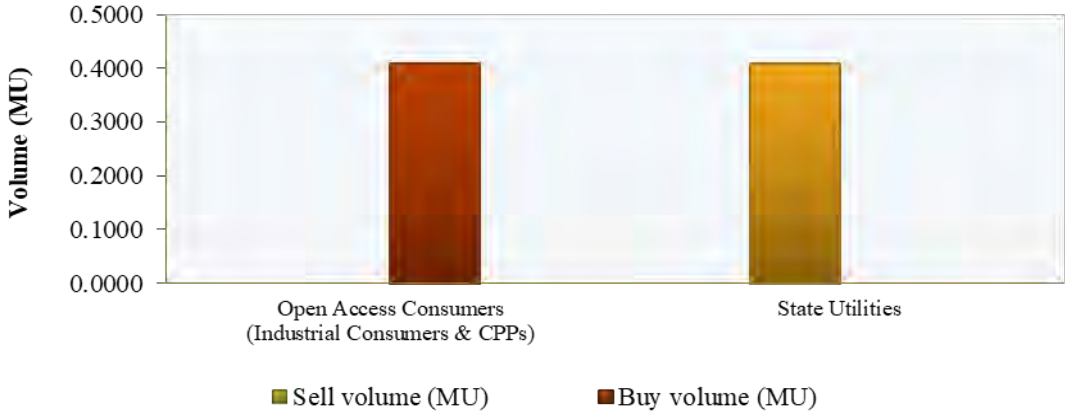
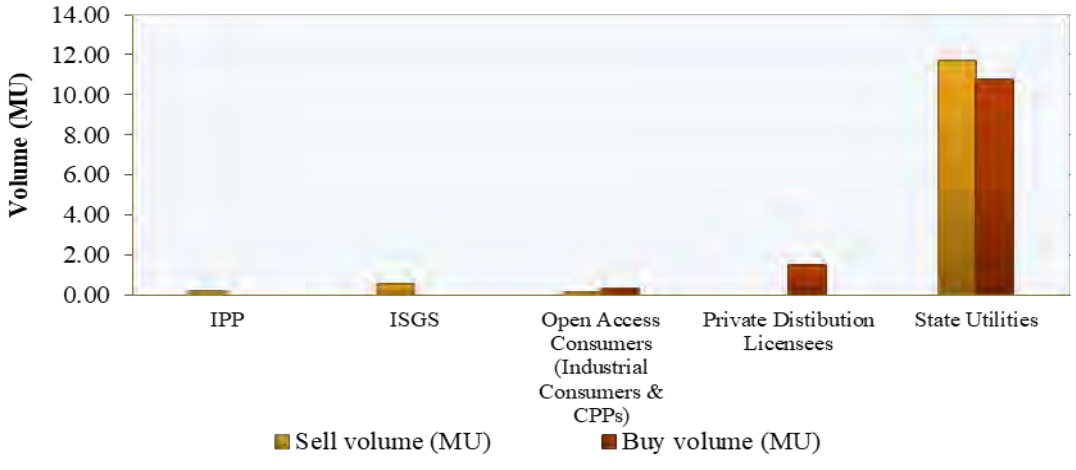
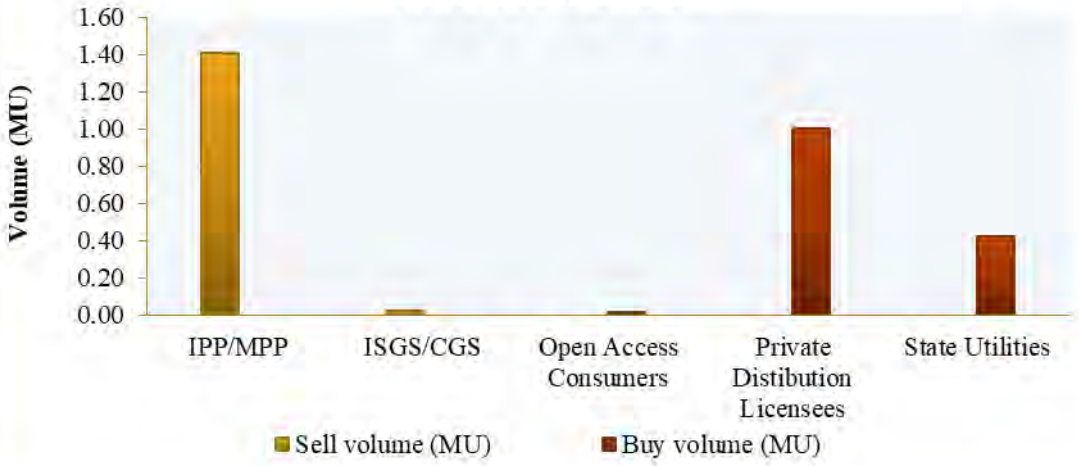


Figure-36(c): Sell and Buy Volume of Various Types of Participants in RTM on PXIL, 2022-23



At HPX in 2022-23, the major sellers were IPPs/Merchant Power Plants, whereas major buyers were Private Distribution Licensees and State Utilities (Figure-37). No transactions took place at HPX in G-DAM and RTM during 2022-23.

Figure-37: Sell and Buy Volume of Various Types of Participants in DAM on HPX, 2022-23



7.2 Analysis of Open Access Consumers on Power Exchanges

The year 2010-11 witnessed collective open access transactions, which marked a significant development in procurement of power by the industrial consumers through power exchanges. The number of Open Access (OA) Consumers at both IEX and PXIL increased from 825 and 170 respectively in 2010-11 to 5159 and 769, respectively in 2022-23 (Table-21). During the period, the percentage of open access consumers in total portfolios varied between 90% to 96% at IEX, whereas the percentage varied between 16% to 90% at PXIL. The number of OA consumers at IEX and PXIL increased at a CAGR of 17%, and 13%, respectively. In case of HPX, which commenced its operations in July 2022, the number of OA consumers was 239 in 2022-23 (Table-21). Though there is an increasing trend in the number of OA consumers at PXIL, the percentage of open access consumers in total portfolio of PXIL declined significantly from the high of about 90% in 2010-11 to about 19% in 2022-23. In case of HPX, the percentage of open access consumers in total portfolio was 49.5% in 2022-23.

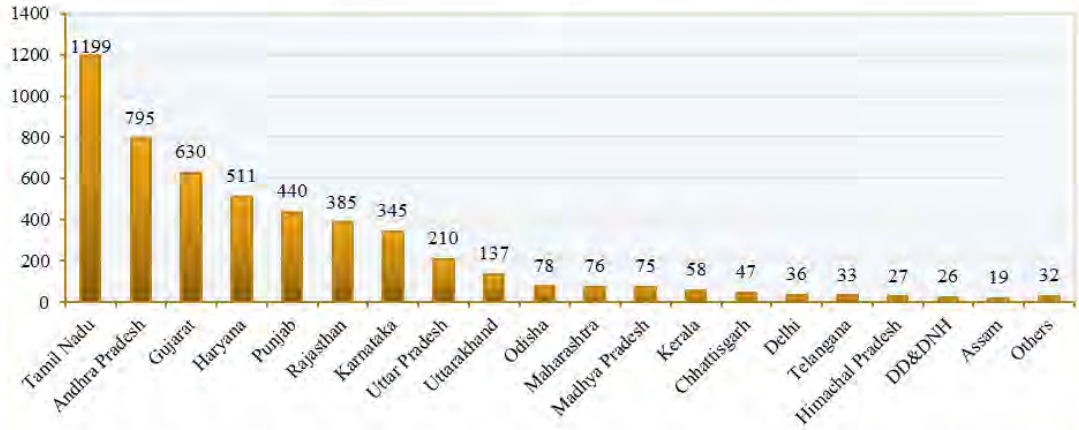
Table-21: Number of Open Access Consumers in Power Exchanges, 2010-11 to 2022-23

Year	IEX			PXIL			HPX		
	No. of Open Access Consumers	Total No. of Portfolios	% of Open Access Consumers	No. of Open Access Consumers	Total No. of Portfolios	% of Open Access Consumers	No. of Open Access Consumers	Total No. of Portfolios	% of Open Access Consumers
2010-11	825	863	95.6%	170	190	89.5%	-	-	-
2011-12	968	1073	90.2%	231	465	49.7%	-	-	-
2012-13	2110	2227	94.7%	336	379	88.7%	-	-	-
2013-14	2958	3083	95.9%	473	1399	33.8%	-	-	-
2014-15	3269	3407	95.9%	517	1779	29.1%	-	-	-
2015-16	3650	3796	96.2%	527	2924	18.0%	-	-	-
2016-17	4071	4281	95.1%	542	3277	16.5%	-	-	-
2017-18	4248	4502	94.4%	559	3422	16.3%	-	-	-
2018-19	4362	4633	94.2%	588	3657	16.1%	-	-	-
2019-20	4555	4857	93.8%	615	3780	16.3%	-	-	-
2020-21	4768	5114	93.2%	632	3805	16.6%	-	-	-
2021-22	4967	5376	92.4%	661	3923	16.8%	-	-	-
2022-23	5159	5640	91.5%	769	4070	18.9%	239	483	49.5%

Note: Status as on 31st March of respective year

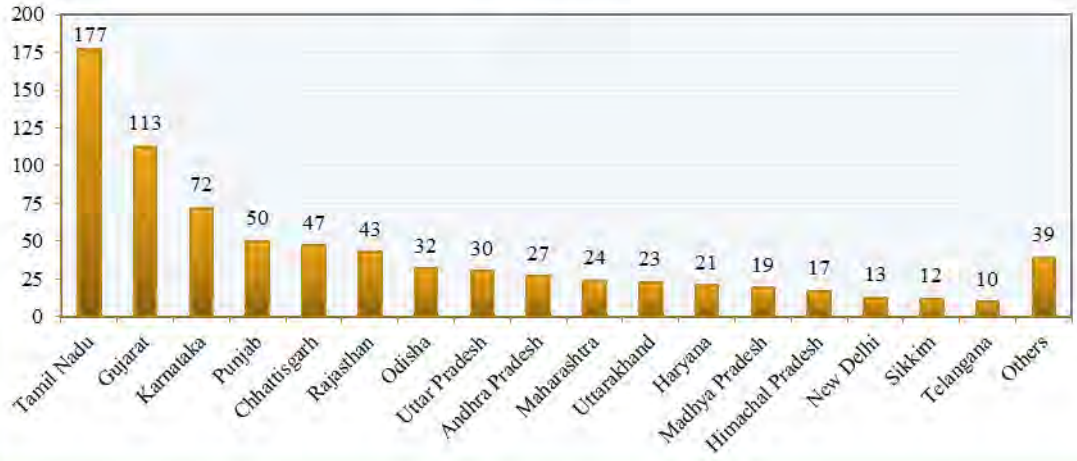
As on March 2023, there were about 5159 OA consumers at IEX. These consumers were mostly located in Tamil Nadu, Andhra Pradesh, Gujarat, Haryana and Punjab (Figure-38). The weighted average price of electricity bought by OA consumers at IEX (₹3.92/kWh) was lower when compared to the weighted average price of total electricity transacted through IEX (₹5.90/kWh).

Figure-38: State-wise Number of Open Access Consumers in IEX, March 2023



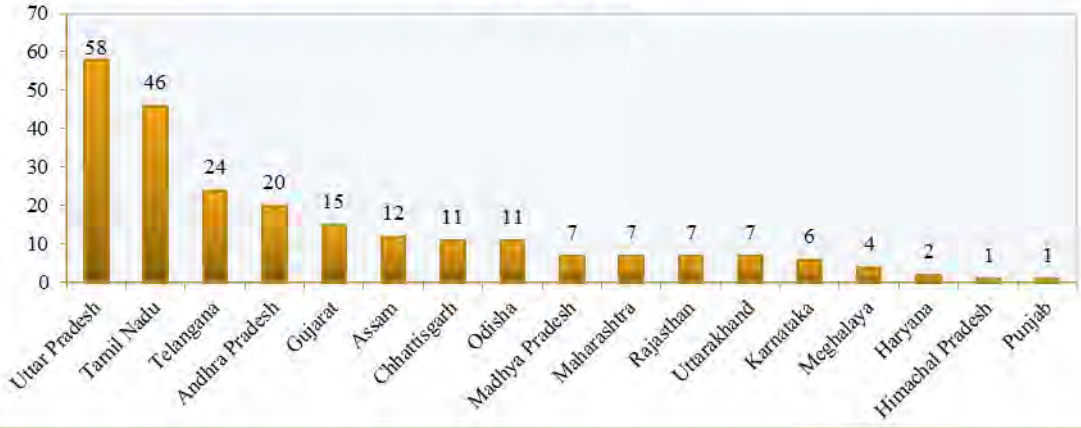
As on March 2023, there were about 769 OA consumers at PXIL. These consumers were mostly located in Tamil Nadu, Gujarat, Karnataka, Punjab, Chhattisgarh (Figure-39). The weighted average price of electricity bought by open access consumers at PXIL (₹4.06/kWh) was lower when compared to the weighted average price of total electricity transacted through PXIL (₹6.49/kWh).

Figure-39: State-wise Number of Open Access Consumers in PXIL, March 2023



In case of HPX, there were about 239 OA consumers as on March 2023. These consumers were mostly located in Uttar Pradesh, Tamil Nadu, Telangana, Andhra Pradesh and Gujarat (Figure-40). The weighted average price of electricity bought by open access consumers at HPX (₹5.30/kWh) was lower when compared to the weighted average price of total electricity transacted through HPX (₹6.51/kWh).

Figure-40: State-wise Number of Open Access Consumers in HPX, March 2023



Annual comparison between purchase volume of OA consumers and total volume in DAM of IEX, PXIL and HPX during 2010-11 to 2022-23 is shown in Table-22(a). As may be seen in the Table below, in case of IEX, during 2010-11 to 2022-23 the volume of electricity procured by OA consumers as a percentage of total volume transacted varied between 9% to 61%, while in PXIL it was between 0.1% to 58%

during the same period. In case of HPX, the volume of electricity procured by OA consumers as a percentage of total volume transacted was 0.9% in 2022-23.

Table-22(a): Volume of Purchase by Open Access Consumers in Day Ahead Market of Power Exchanges, 2010-11 to 2022-23

Year	IEX			PXIL			HPX		
	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Partici-pation	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Partici-pation	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Partici-pation
2010-11	4056.51	11800.58	34.4%	92.72	1740.17	5.3%	-	-	-
2011-12	6275.30	13798.88	45.5%	306.58	2057.60	14.9%	-	-	-
2012-13	10410.13	22374.78	46.5%	263.41	687.96	38.3%	-	-	-
2013-14	17575.17	28924.84	60.8%	503.03	1106.42	45.5%	-	-	-
2014-15	12084.18	28140.72	42.9%	102.95	340.77	30.2%	-	-	-
2015-16	20284.49	34066.52	59.5%	78.78	136.84	57.6%	-	-	-
2016-17	23999.77	39830.66	60.3%	44.06	248.54	17.7%	-	-	-
2017-18	14728.37	44925.11	32.8%	5.70	730.48	0.8%	-	-	-
2018-19	11219.07	50136.03	22.4%	21.02	86.40	24.3%	-	-	-
2019-20	14452.80	49126.10	29.4%	9.96	46.63	21.3%	-	-	-
2020-21	14383.05	60376.03	23.8%	0.24	241.19	0.1%	-	-	-
2021-22	7888.34	65143.03	12.1%	0.03	42.61	0.1%	-	-	-
2022-23	4707.73	51177.54	9.2%	28.65	187.13	15.3%	0.01	1.43	0.9%

The volume purchased by OA consumers vis-à-vis total volume in case of G-DAM is given in Table-22(b). As may be seen from the table, the volume of electricity procured by OA consumers as a percentage of total volume transacted in IEX was 11.4% in 2022-23, while the volume of electricity procured by OA consumers as a percentage of total volume transacted was 100% in PXIL in G-DAM segment in 2022-23. In case of HPX, no transactions took place in GDAM in 2022-23.

Table-22(b): Volume of Purchase by Open Access Consumers in Green Day Ahead Market of Power Exchanges, 2021-22 to 2022-23

Year	IEX			PXIL			HPX		
	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Partici-pation	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Partici-pation	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Partici-pation
2021-22	194.99	920.45	21.2%	0.00	0.00	-	-	-	-
2022-23	434.04	3816.60	11.4%	0.41	0.41	100.0%	-	-	-

The volume purchased by OA consumers vis-à-vis total volume in case of RTM, is given in Table-22(c). As may be seen from the Table, the volume of electricity procured by OA consumers as a percentage of total volume transacted was around 10% in case of IEX and 2.3% in case of PXIL during 2022-23. No transactions took place in HPX in RTM during 2022-23.

Table-22(c): Volume of Purchase by Open Access Consumers in Real Time Market of Power Exchanges, 2020-21 to 2022-23

Year	IEX			PXIL			HPX		
	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Partici-pation	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Partici-pation	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Partici-pation
2020-21	776.73	9467.94	8.2%	0.00	2.29	0.0%	-	-	-
2021-22	1658.36	19908.07	8.3%	0.00	0.00	-	-	-	-
2022-23	2430.71	24173.73	10.1%	0.29	12.57	2.3%	0.00	0.00	-

Note: RTM is operational on the Power Exchanges from 1st June 2020

8. Major Sellers and Buyers of Electricity in the Short-term market

Details of the top 10 sellers and buyers of electricity through traders (bilateral trader segment transactions) in 2022-23 are given in Table-23 and Table-24 respectively. The volume of electricity transacted by these major sellers and buyers, their share in total volume and the price at which they have sold or purchased are also provided in the tables.

Details of the top 10 sellers in DAM, G-DAM and RTM segments of IEX in 2022-23 are given in Table-25(a), 25(b) and 25(c), respectively, and details of the top 10 buyers of electricity in DAM, G-DAM and RTM segments of IEX are given in Table-26(a), 26(b) and 26(c) respectively. Table-27 (a), 27(b), 27 (c) provides details of the top sellers of electricity in DAM, GDAM and RTM, respectively, of PXIL and Table-28(a), 28(b), 28(c) provides details of top buyers of electricity in DAM, GDAM and RTM respectively, of PXIL. Table-29 and Table-30 provides details of the top sellers and buyers, respectively, of electricity traded in DAM of HPX. There was no trade of electricity in G-DAM and RTM of HPX during 2022-23.

Table-23: Major Sellers of Electricity through Traders, 2022-23

S.No.	Seller	State	Volume (MU)	Approximate Percentage of total volume transacted through Traders	Weighted Average Price (₹/kWh)
1	Jindal Power Ltd.	Chhattisgarh	3554.50	20.59%	6.29
2	Jaypee Nigrie STPP	Madhya Pradesh	2099.63	12.16%	5.06
3	Sembcorp Energy India Limited	Andhra Pradesh	963.74	5.58%	6.95

4	Raipur Energen Ltd.	Chhattisgarh	745.98	4.32%	6.25
5	HPSEB (including GOHP)	Himachal Pradesh	706.95	4.10%	4.56
6	JITPL	Odisha	667.86	3.87%	6.15
7	ABC Renewable Energy (RJ 01) Pvt. Ltd.	Rajasthan	553.61	3.21%	2.63
8	Tata Power Haldia	West Bengal	527.05	3.05%	5.49
9	Kameng HEP	Arunachal Pradesh	509.09	2.95%	5.38
10	Jhabua Power	Madhya Pradesh	506.05	2.93%	4.64

Note : Volume sold by major sellers and total volume transacted through traders does not include the volume through banking arrangements.

Table-24: Major Buyers of Electricity through Traders, 2022-23

S.No.	Buyer	State/ Regional Entity	Volume (MU)	Approximate percentage of total volume transacted through traders	Weighted Average Price (₹/kWh)
1	Torrent Power Ltd. - Distribution	Gujarat	3857.76	22.35%	4.79
2	HPPC	Haryana	2304.91	13.35%	5.34
3	TANGEDCO	Tamil Nadu	1820.75	10.55%	7.86
4	PSPCL	Punjab	1408.77	8.16%	4.24
5	Adani Electricity Mumbai Ltd	Maharashtra	1016.93	5.89%	6.73
6	GUVNL	Gujarat	1013.34	5.87%	7.30
7	UPPCL	Uttar Pradesh	902.18	5.23%	5.10
8	BSES Rajdhani Power Limited	Delhi	894.42	5.18%	5.26
9	UPCL	Uttarakhand	582.50	3.37%	7.93
10	TPDDL	Delhi	515.12	2.98%	9.13

Note : Volume Bought by major buyers and total volume transacted through traders does not include the volume through banking arrangements.
Note : Volume Bought by Torrent Power Ltd. includes operations at Ahmedabad and Gandhinagar, Surat and Dahej

As can be observed from Table-24, the weighted average purchase prices of electricity of some of the major buyers from traders (bilateral transactions) like TPDDL,

UPCL, TANGEDCO and GUVNL were much higher than the weighted average price for the entire bilateral trader segment (₹5.85/kWh).

Table-25(a): Major Sellers of Electricity in the Day Ahead Market of IEX, 2022-23

S.No.	Name of Seller	State/ Regional Entity	Sell Volume (MU)	Percentage of the Total Volume Transacted in IEX	Weighted Average Sell Price (₹/kWh)
1	UPPCL	Uttar Pradesh	7093.74	13.86%	5.09
2	BSPHCL	Bihar	4289.84	8.38%	4.90
3	WBSEDCL	West Bengal	3132.04	6.12%	5.17
4	CSPDCL	Chhattisgarh	1907.83	3.73%	4.03
5	PCKL	Karnataka	1607.12	3.14%	4.70
6	TSSPDCL	Telangana	1550.49	3.03%	5.48
7	Raipur Energen Ltd.	Chhattisgarh	1438.36	2.81%	6.81
8	Jindal Power Ltd Stage II	Chhattisgarh	1431.65	2.80%	8.44
9	Jindal India Thermal Power Ltd	Odisha	1370.16	2.68%	7.70
10	Sembcorp Energy India Ltd	Andhra Pradesh	1337.31	2.61%	7.87
Note: Total Volume transacted through Day Ahead Market in IEX was about 51177.54 MU.					

Table-25(b): Major Sellers of Electricity in the Green Day Ahead Market of IEX, 2022-23

S.No.	Name of Seller	State/ Regional Entity	Sell Volume (MU)	Percentage of the Total Volume Transacted in IEX	Weighted Average Sell Price (₹/kWh)
1	APSPDCL	Andhra Pradesh	779.62	20.43%	4.79
2	Adani Hybrid Energy Jaisalmer Four Limited	Rajasthan	231.41	6.06%	5.17
3	TSSPDCL	Telangana	191.58	5.02%	3.76
4	Adani Wind Energy Kutchh Five Limited	Gujarat	165.16	4.33%	6.26
5	APCPDCL	Andhra Pradesh	157.03	4.11%	5.21

6	SBESS Services Projectco Two Pvt. Ltd.	Madhya Pradesh	114.41	3.00%	6.47
7	Adani Hybrid Energy Jaisalmer Three Ltd. (Solar)	Rajasthan	107.50	2.82%	5.48
8	Bannari Amman Sugars Ltd.	Karnataka	92.72	2.43%	5.88
9	Adani Hybrid Energy Jaisalmer Two Ltd. (Solar)	Rajasthan	84.55	2.22%	5.34
10	KPR Sugar & Apparels Ltd.	Karnataka	74.53	1.95%	6.17
Note: Total Volume transacted through Green Day Ahead Market in IEX was about 3816.60 MU.					

Table-25(c): Major Sellers of Electricity in the Real Time Market of IEX, 2022-23

S.No.	Name of Seller	State/ Regional Entity	Sell Volume (MU)	Percentage of the Total Volume Transacted in IEX	Weighted Average Sell Price (₹/kWh)
1	MPPMCL	Madhya Pradesh	3330.15	13.78%	4.54
2	BSPHCL	Bihar	3327.25	13.76%	5.20
3	WBSEDCL	West Bengal	1342.58	5.55%	6.62
4	UPPCL	Uttar Pradesh	1125.38	4.66%	4.96
5	GRIDCO	Odisha	943.38	3.90%	5.63
6	PCKL	Karnataka	937.57	3.88%	5.89
7	TSSPDCL	Telangana	848.04	3.51%	6.09
8	CSPDCL	Chhattisgarh	758.86	3.14%	6.14
9	RUVNL	Rajasthan	758.70	3.14%	4.83
10	Kameng HEP	Arunachal Pradesh	640.66	2.65%	5.43
Note: Total Volume transacted through Real Time Market in IEX was about 24173.73 MU.					

Table-26(a): Major Buyers of Electricity in the Day Ahead Market of IEX, 2022-23

S.No.	Name of Buyer	State/ Regional Entity	Buy Volume (MU)	Percentage of the Total Volume Transacted in IEX	Weighted Average Buy Price (₹/kWh)
1	GUVNL	Gujarat	8460.63	16.53%	5.98
2	TSSPDCL	Telangana	3529.46	6.90%	6.44
3	PSPCL	Punjab	3230.33	6.31%	5.64

4	RUVNL	Rajasthan	3181.72	6.22%	5.91
5	HPPC	Haryana	2252.94	4.40%	7.58
6	MSEDCL	Maharashtra	2202.91	4.30%	5.46
7	JKPCL	Jammu & Kashmir	2149.43	4.20%	4.89
8	APSPDCL	Andhra Pradesh	2089.30	4.08%	7.37
9	APCPDCL	Andhra Pradesh	2059.34	4.02%	6.90
10	TANGEDCO	Tamil Nadu	1615.18	3.16%	8.98
Note: Total Volume transacted through Day Ahead Market in IEX was about 51177.54 MU.					

Table-26(b): Major Buyers of Electricity in the Green Day Ahead Market of IEX, 2022-23

S.No.	Name of Buyer	State/ Regional Entity	Buy Volume (MU)	Percentage of the Total Volume Transacted in IEX	Weighted Average Buy Price (₹/kWh)
1	PSPCL	Punjab	460.43	12.06%	6.92
2	Central Railway	Maharashtra	430.66	11.28%	5.55
3	DVC	DVC	343.28	8.99%	6.49
4	Dadra And Nagar Haveli And Daman And Diu Power Distribution Corporation Lim	Dadra & Nagar Haveli and Daman & Diu	212.19	5.56%	4.00
5	South Western Railway	Karnataka	182.65	4.79%	6.09
6	Indian Railways Gujarat	Gujarat	164.29	4.30%	5.94
7	NDMC	Delhi	159.55	4.18%	5.91
8	Torrent Power Ahmedabad	Gujarat	138.82	3.64%	4.57
9	APDCL	Assam	135.28	3.54%	5.00
10	MSEDCL	Maharashtra	120.16	3.15%	5.88
Note: Total Volume transacted through Green Day Ahead Market in IEX was about 3816.60 MU.					

Table-26(c): Major Buyers of Electricity in the Real Time Market of IEX, 2022-23

S.No.	Name of Buyer	State/ Regional Entity	Buy Volume (MU)	Percentage of the Total Volume Transacted in IEX	Weighted Average Buy Price (₹/kWh)
1	RUVNL	Rajasthan	3011.78	12.46%	5.64

2	TSSPDCL	Telangana	2569.30	10.63%	5.01
3	PSPCL	Punjab	2480.43	10.26%	5.46
4	MSEDCL	Maharashtra	1193.41	4.94%	4.93
5	HPPC	Haryana	1169.70	4.84%	7.91
6	JKPCL	Jammu & Kashmir	964.15	3.99%	4.81
7	WBSEDCL	West Bengal	963.90	3.99%	5.45
8	GUVNL	Gujarat	818.31	3.39%	6.00
9	TANGEDCO	Tamil Nadu	813.14	3.36%	8.73
10	APSPDCL	Andhra Pradesh	692.16	2.86%	7.55
Note: Total Volume transacted through Real Time Market in IEX was about 24173.73 MU.					

From Table-26(a), it can be seen that the weighted average prices of electricity for major buyers such as TANGEDCO, APSPDCL, HPPC, APCPDCL and TSSPDCL in the Day Ahead Market of IEX were much higher than the weighted average price of the electricity transacted through the entire Day Ahead market of IEX (₹6.03/kWh). In case of the G-DAM segment (Table-26(b)), the weighted average prices of electricity for major buyers like PSPCL, DVC and South Western Railways were much higher than the weighted average price of the electricity transacted through the entire G-DAM of IEX (₹5.64/kWh). Similarly, in case of RTM in IEX, the weighted average prices of electricity for major buyers such as TANGEDCO, HPPC, APSPDCL and GUVNL were much higher than the weighted average price of the electricity transacted through the entire real-time market of IEX (₹5.67 kWh) as may be seen in Table-26(c).

Table-27(a): Major Sellers of Electricity in Day Ahead Market of PXIL, 2022-23

S. No	Name of the Seller	State/ Regional Entity	Sell Volume (MU)	Percentage of total volume transacted in PXIL	Weighted Average Sell Price (₹/kWh)
1	Rihand STPS-II	Uttar Pradesh	22.83	12.20%	5.52
2	Aravali Power Company Pvt. Ltd.	Haryana	21.31	11.39%	8.80
3	BSPHCL	Bihar	19.41	10.37%	4.26
4	JBVNL	Jharkhand	17.07	9.12%	3.26
5	Rihand STPS-III	Uttar Pradesh	15.14	8.09%	5.55
6	Rihand STPS-I	Uttar Pradesh	14.77	7.89%	5.67
7	KSEB	Kerala	11.28	6.03%	8.42

8	Raipur Energen Ltd.	Chhattisgarh	8.03	4.29%	8.97
9	PCKL	Karnataka	7.62	4.07%	4.28
10	MPPMCL	Madhya Pradesh	7.48	4.00%	5.21
Note: Total Volume transacted in the Day Ahead Market of PXIL was about 187.13 MU.					

Table-27(b): Major Sellers of Electricity in the Green Day Ahead Market of PXIL, 2022-23

S.No.	Name of Seller	State/ Regional Entity	Sell Volume (MU)	Percentage of the Total Volume Transacted in PXIL	Weighted Average Sell Price (₹/kWh)
1	APCPDCL	Andhra Pradesh	0.41	100.00%	5.34
Note: Total Volume transacted through Green Day Ahead Market in PXIL was about 0.41 MU.					

Table-27(c): Major Sellers of Electricity in the Real Time Market of PXIL, 2022-23

S.No.	Name of Seller	State/ Regional Entity	Sell Volume (MU)	Percentage of the Total Volume Transacted in PXIL	Weighted Average Sell Price (₹/kWh)
1	MPPMCL	Madhya Pradesh	9.44	75.13%	11.98
2	RUVNL	Rajasthan	1.80	14.32%	12.00
3	TANGEDCO	Tamil Nadu	0.25	1.99%	12.00
4	Rihand STPS-III	Uttar Pradesh	0.22	1.72%	5.74
5	JSW Energy Limited	Karnataka	0.20	1.59%	12.00
6	Dalmia Cement Bharat Ltd, Unit Kapilas Cement Manufacturing Works	Odisha	0.15	1.19%	3.20
7	Rihand STPS-II	Uttar Pradesh	0.13	1.04%	2.82
8	BSPHCL	Bihar	0.10	0.82%	8.34
9	KSEB	Kerala	0.10	0.80%	12.00
10	Singrauli STPS	Uttar Pradesh	0.05	0.37%	6.13
Note: Total Volume transacted through Real Time Market in PXIL was about 12.57 MU.					

Table-28(a): Major Buyers of Electricity in Day Ahead Market of PXIL, 2022-23

Sr. No	Name of the Buyer	State/ Regional Entity	Buy Volume (MU)	Percentage of the Total Volume Transacted in PXIL	Weighted Average Buy Price (₹/kWh)
1	APCPDCL	Andhra Pradesh	59.86	31.99%	6.90
2	GUVNL	Gujarat	23.75	12.69%	6.61
3	Vedanta Ltd SEZ Unit Jharsuguda	Odisha	21.46	11.47%	3.44
4	HPPC	Haryana	15.58	8.33%	6.70
5	HPSEB	Himachal Pradesh	13.70	7.32%	5.23
6	RUVNL	Rajasthan	12.26	6.55%	6.76
7	BRPL	Delhi	10.11	5.40%	4.13
8	WBSEDCL	West Bengal	9.38	5.01%	9.55
9	PSPCL	Punjab	5.19	2.77%	5.72
10	BALCO	Chhattisgarh	3.64	1.95%	7.11
Note: Total Volume transacted in the Day Ahead Market of PXIL was about 187.13 MU.					

Table-28(b): Major Buyers of Electricity in the Green Day Ahead Market of PXIL, 2022-23

S.No.	Name of Buyer	State/ Regional Entity	Buy Volume (MU)	Percentage of the Total Volume Transacted in PXIL	Weighted Average Buy Price (₹/kWh)
1	Vedanta Ltd SEZ Unit Jharsuguda	Odisha	0.25	60.98%	5.87
2	BALCO	Chhattisgarh	0.14	34.15%	4.50
3	CALCOM Cement India Ltd.	Assam	0.02	4.88%	4.47
Note: Total Volume transacted through Green Day Ahead Market in PXIL was about 0.41 MU.					

Table-28(c): Major Buyers of Electricity in the Real Time Market of PXIL, 2022-23

S.No.	Name of Buyer	State/ Regional Entity	Buy Volume (MU)	Percentage of the Total Volume Transacted in PXIL	Weighted Average Buy Price (₹/kWh)
1	TANGEDCO	Tamil Nadu	9.50	75.59%	11.98
2	BRPL	Delhi	1.13	9.01%	12.00
3	GUVNL	Gujarat	0.78	6.23%	10.93
4	WBSEDCL	West Bengal	0.50	4.01%	5.23

5	NPCL	Uttar Pradesh	0.22	1.73%	12.00
6	Jindal Stainless Limited	Odisha	0.14	1.08%	12.00
7	Adani Electricity Mumbai Ltd.	Maharashtra	0.14	1.08%	12.00
8	Dalmia Cement Bharat Ltd.	Karnataka	0.08	0.62%	3.20
9	CALCOM Cement India Ltd.	Assam	0.07	0.56%	3.20
10	CESC Limited	West Bengal	0.01	0.08%	12.00
Note: Total Volume transacted through Real Time Market in PXIL was about 12.57 MU.					

From Table-28(a), it can be seen that the weighted average prices of electricity for major buyers such as WBSEDCL, BALCO and APCPDCL in the Day Ahead Market of PXIL were much higher than the weighted average price of the electricity transacted through the entire Day Ahead market of PXIL (₹6.16/kWh). In case of G-DAM segment (Table-28 (b)), the weighted average price of electricity for Vedanta Ltd. SEZ Unit Jharsuguda was higher than the weighted average price of the electricity transacted through the entire G-DAM of PXIL (₹5.34/kWh). Similarly, in case of RTM in PXIL, the weighted average prices of electricity for major buyers such as BRPL, NPCL, Adani Electricity Mumbai Ltd., and CESC Limited were higher than the weighted average price of the electricity transacted through the entire real-time market of PXIL (₹11.55 kWh) as may be seen in Table-28(c).

Table-29: Major Sellers of Electricity in Day Ahead Market of HPX, 2022-23

S. No	Name of the Seller	State/ Regional Entity	Sell Volume (MU)	Percentage of total volume transacted in HPX	Weighted Average Sell Price (₹/kWh)
1	Jaypee Nigrie STPP	Madhya Pradesh	1.18	82.63%	5.67
2	DB Power Ltd.	Chhattisgarh	0.12	8.16%	10.49
3	Jindal Power Limited Stage-I	Chhattisgarh	0.10	7.01%	12.00
4	Teesta Urja Limited	Sikkim	0.02	1.51%	5.65
5	Sorang HEP	Himachal Pradesh	0.01	0.50%	5.65
6	Dikchu Hydro Electric Project	Sikkim	0.002	0.10%	9.37
7	Tadas Wind Energy Pvt. Ltd.	Andhra Pradesh	0.001	0.08%	6.36
Note: Total Volume transacted in the Day Ahead Market of HPX was about 1.43 MU.					

Table-30: Major Buyers of Electricity in Day Ahead Market of HPX, 2022-23

Sr. No	Name of the Buyer	State/Regional Entity	Buy Volume (MU)	Percentage of the Total Volume Transacted in HPX	Weighted Average Buy Price (₹/kWh)
1	Adani Electricity Mumbai Limited	Maharashtra	1.00	69.78%	4.71
2	GUVNL	Gujarat	0.23	16.21%	10.59
3	WBSEDCL	West Bengal	0.19	13.12%	11.13
4	Alsthom Industries Limited	Assam	0.01	0.50%	5.43
5	Sree Rayalaseema Alkalies & Allied Chemicals Ltd	Andhra Pradesh	0.00	0.35%	4.85
6	Sundram Fasteners Limited	Uttarakhand	0.00	0.05%	7.03
Note: Total Volume transacted in the Day Ahead Market of HPX was about 1.43 MU.					

From Table-30, it can be seen that the weighted average prices of electricity for major buyers such as WBSEDCL, GUVNL and Sundram Fasteners Ltd. in DAM of HPX were much higher than the weighted average price of the electricity transacted through the entire day ahead market of HPX (₹6.51/kWh).

As can be observed from the above analysis of the top buyers and sellers, the dominant sellers, both at the power exchanges and traders, are a mixed group comprising of independent power producers, distribution companies and state government agencies. The major buyers from traders and at the power exchanges are mostly state distribution companies and industrial consumers.

9. Effect of Congestion on the Volume of Electricity Transacted through Power Exchanges

The volume of electricity transacted through power exchanges is sometimes constrained due to transmission congestion. Details of congestion in the power exchanges are given in Table-31 and Table-32.

The effect of congestion on the volume of electricity transacted through power exchanges from 2009-10 to 2022-23 is shown in Table-31. The unconstrained cleared volume and actual volume transacted increased from 8.10 BU and 7.09 BU, respectively in 2009-10 to 79.39 BU and 79.37 BU, respectively, in 2022-23. The volume of electricity that could not be cleared (the difference between unconstrained cleared volume and actual volume transacted) as % to unconstrained cleared volume, was varying between 3.7% to 17% during the period from 2009-10 to 2016-17, after which it was less than 1%. Congestion for the volume of electricity transacted through power exchanges has reduced to a great extent since grid integration (integration of NEW Grid and SR Grid) in December 2013, which resulted in a declining trend in the volume of electricity that could not be cleared as a percentage to unconstrained cleared volume in both the power exchanges from 2013-14 onwards. From 2017-18 onwards, the volume of electricity that could not be cleared as % to unconstrained cleared volume was consistently less than 1%, which shows that the congestion remained insignificant.

Table-31: Effect of Congestion on the Volume of Electricity Transacted through Power Exchanges, 2009-10 to 2022-23

Year	Unconstrained Cleared Volume (BU)	Actual Cleared Volume and hence scheduled * (BU)	Volume of electricity that could not be cleared due to congestion (BU)	Volume of electricity that could not be cleared as % to Unconstrained Cleared Volume
2009-10	8.10	7.09	1.01	12.0%
2010-11	14.26	13.54	0.72	5.0%
2011-12	17.08	14.83	2.26	13.0%
2012-13	27.67	23.02	4.65	17.0%
2013-14	35.62	30.03	5.59	16.0%
2014-15	31.61	28.46	3.14	9.9%
2015-16	36.36	34.20	2.16	5.9%
2016-17	41.60	40.08	1.52	3.7%
2017-18	45.86	45.65	0.21	0.5%
2018-19	50.69	50.22	0.47	0.9%
2019-20	49.36	49.16	0.20	0.4%
2020-21	70.13	70.09	0.04	0.06%
2021-22	86.09	86.01	0.06	0.09%
2022-23	79.39	79.37	0.02	0.02%

** This is the power finally scheduled after factoring in congestion and/or other reasons of not scheduling like real time curtailment etc.*

Source: Power Exchanges & NLDC

During 2022-23, in IEX, the unconstrained cleared volume and the actual volume transacted were 51.1844 BU and 51.1775 BU, respectively, in DAM segment (Table-32), and 3.8173 BU and 3.8166 BU, respectively in GDAM segment, whereas in RTM in IEX, the unconstrained cleared volume and the actual volume transacted was 24.1834 BU and 24.1737 BU, respectively. Therefore, the actual transacted volume was 0.01% lesser than the unconstrained volume in DAM, 0.02% in GDAM and 0.04% lesser than the unconstrained cleared volume in RTM segment of IEX.

During 2022-23, in PXIL, the unconstrained cleared volume and the actual volume transacted were 0.1876 BU and 0.1871 BU, respectively, in DAM segment (Table-32). Therefore, the actual transacted volume was 0.26% less than the unconstrained volume in DAM at PXIL. There was no congestion in GDAM and RTM at PXIL. There was no congestion in DAM at HPX during the period. There was no trade in G-DAM and RTM at HPX.

Table-32: Details of Congestion in Power Exchanges, 2022-23

	Items	IEX			PXIL			HPX			Total
		DAM	GDAM	RTM	DAM	GDAM	RTM	DAM	GDAM	RTM	
A	Unconstrained Cleared Volume* (BU)	51.1844	3.8173	24.1834	0.1876	0.0004	0.0126	0.00143	0.00000	0.00000	79.3871
B	Actual Cleared Volume and hence scheduled* (BU)	51.1775	3.8166	24.1737	0.1871	0.0004	0.0126	0.00143	0.00000	0.00000	79.3694
C	Volume of electricity that could not be cleared and hence not scheduled because of congestion (BU)	0.00474	0.00069	0.00964	0.00048	0.00000	0.00000	0.00000	0.00000	0.00000	0.01555
D	Volume of electricity that could not be cleared as % to Unconstrained Cleared Volume	0.01%	0.02%	0.04%	0.26%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%

** This is the power finally scheduled after factoring in congestion and/or other reasons of not scheduling like real time curtailment etc.*

Source: Power Exchanges & NLDC

Transmission congestion, consequent market splitting and the resultant difference in market prices in different regions give rise to congestion charges. The annual congestion charges of all the power exchanges for the period from 2008-09 to 2022-23 are provided in Table-33.

Table-33: Congestion Charges of Power Exchanges, 2008-09 to 2022-23

Year	Congestion Charges of IEX (₹ Crore)	Congestion Charges of PXIL (₹ Crore)	Congestion Charges of HPX (₹ Crore)	Total (₹ Crore)
2008-09	5.27	0.00	-	5.27
2009-10	255.40	22.39	-	277.79

2010-11	273.14	86.61	-	359.75
2011-12	419.13	65.62	-	484.76
2012-13	417.37	35.93	-	453.30
2013-14	387.23	5.10	-	392.33
2014-15	502.41	1.64	-	504.05
2015-16	214.08	0.14	-	214.22
2016-17	305.99	0.09	-	306.08
2017-18	56.56	0.003	-	56.56
2018-19	137.52	0.00	-	137.52
2019-20	55.65	0.00	-	55.65
2020-21	70.95	0.006	-	70.96
2021-22	23.35	0.00	-	23.35
2022-23	16.57	0.01	0.00	16.58

Source: NLDC

10. Ancillary Services Operations

10.1 Background

Ancillary Services is one of the four essential pillars of Electricity Market design, viz., Scheduling and Despatch, Imbalance Settlement, Congestion Management and Ancillary Services. Ancillary Services are support services to maintain power system reliability and support its primary function of delivering energy to customers. These are deployed by the system operator over various timeframes to maintain the required instantaneous and continuous balance between aggregate generation and load. Ancillary Services consist of services required for (a) maintaining load-generation balance (frequency control); (b) maintaining voltage and reactive power support; and (c) maintaining generation and transmission reserves. Historically, ancillary services were provided by the vertically integrated utilities along with the energy supply services. With the unbundling of vertically integrated utilities and increasing private sector participation and competition introduced in the energy markets, there is an increasing need for administering such services so as to ensure reliable and secure grid operation. Ancillary Services are broadly classified as follows:

(i) **Frequency Control Ancillary Services (FCAS)**: Three levels of Frequency Control are generally used to maintain the balance between generation and load, i.e., Primary Frequency Control, Secondary Frequency Control, Tertiary Frequency Control. These three levels differ as per their time of response to a fluctuation and the methodology

adopted to realize the fundamental operating philosophy of maintaining reliability and economy.

(ii) **Network Control Ancillary Services (NCAS)**: This can be further subdivided into Voltage Control Ancillary Service and Power Flow Control Ancillary Services.

(iii) **System Restart Ancillary Services (SRAS)**: It is used to restore the system after a full or partial blackout. Black start is vital and inexpensive service. Its costs are primarily the capital cost of the equipment used to start the unit, the cost of the operators, the routine maintenance and testing of equipment and the cost of fuel when the service is required. At present this is a mandatory service.

10.2 Regulatory Framework of Ancillary Services

Ancillary Services are defined, under Regulation (2)(1)(b) of the CERC (Indian Electricity Grid Code), Regulations, 2010 (IEGC), as follows: *"...in relation to power system (or grid) operation, the services necessary to support the power system (or grid) operation in maintaining power quality, reliability and security of the grid, e.g. active power support for load following, reactive power support, black start, etc;..."*

The Commission notified the CERC (Ancillary Services Operations) Regulations on 13th August, 2015. The objective of Reserves Regulation Ancillary Services (RRAS) is to restore the frequency level at desired level and to relieve the congestion in the transmission network. Specifically, these regulations are the first step towards introducing Ancillary Services in the country that will enable the grid operator to ensure reliability and stability in the grid. The RRAS shall support both "Regulation Up" service (that provides capacity by responding to signals or instruction of the Nodal Agency to increase generation) and "Regulation Down" service (that provides capacity by responding to signals or instruction of the Nodal Agency to decrease generation). The detailed procedures were laid out on the 08th March 2016 and Ancillary Services were implemented by the Nodal Agency, i.e., NLDC in coordination with RLDCs from 12th April, 2016.

The existing framework of Ancillary Services predominantly utilises the thermal power stations which have ramping limitations and as such there is a need for a fast response ancillary service. The fast response reserves become all the more essential in view of the increasing penetration of intermittent renewable energy sources. The present administered mechanism of RRAS cannot accommodate such resources, especially the new and emerging technologies/ resources like energy storage and demand side response. Given the changes in technology, generation mix and increasing decentralized generation, and location specific requirements for ancillary services, the Commission felt the need for a comprehensive framework of Ancillary Services and notified the CERC (Ancillary Services) Regulations, 2022 on 31st January 2022.

These regulations aim to provide mechanisms for procurement, through administered as well as market-based mechanisms, deployment and payment of Ancillary Services at the regional and national level for maintaining the grid frequency close to 50 Hz, and restoring the grid frequency within the allowable band as specified in the India Electricity Grid Code (IEGC) and for relieving congestion in the transmission network, to ensure smooth operation of the power system, and safety and security of the grid.

The Commission has recognised the following types of Ancillary Services:

(a) Primary Reserve Ancillary Service (PRAS);
(b) Secondary Reserve Ancillary Service (SRAS);
(c) Tertiary Reserve Ancillary Service (TRAS); and
(d) Such other Ancillary Services as specified in the Grid Code

The Ancillary Services Regulations, 2022 cover SRAS and TRAS and stipulate that PRAS and other Ancillary Services shall be governed by the Grid Code or as specified separately by the Commission.

The SRAS is proposed to be procured through an administered mechanism to start with. However, there is an enabling provision for market-based procurement of SRAS, the framework for which can be specified separately. The regulations seek to reward fast ramping resources in the SRAS segment. The TRAS is proposed to be

procured through market-based mechanism. A separate Ancillary Service product is to be introduced in the existing Day Ahead Market and Real Time Market. For TRAS-Up, the principle of uniform market clearing price (MCP) shall be adopted. However, for TRAS-Down, the pay-as-you-bid mechanism has been adopted. TRAS-Up cleared but not despatched would be given commitment charge at 10 percent of the MCP for TRAS-Up subject to the ceiling of 20 paise/kWh.

As per the notification dated 31st October 2022, it was decided that all the provisions of the Central Electricity Regulatory Commission (Ancillary Services) Regulations, 2022, except those mentioned below, shall come into effect from 05.12.2022.

The following provisions shall come into force from the date to be separately notified by the Commission:

i. Provisions pertaining to TRAS under Regulation 6;
ii. Regulations 14 to 19;
iii. Provisions pertaining to TRAS in Regulations 20 to 22
iv. Regulations 26.

As provided under the new Regulations, NLDC notified a Detailed Procedure for Secondary Reserve Ancillary Services (SRAS) in December, 2022 and a Draft Detailed Procedure for Tertiary Reserve Ancillary Services (TRAS) in February, 2023. The nodal agency estimates the required quantum for SRAS and TRAS for such period as specified in the Grid Code.

10.3 RRAS Instructions issued by Nodal Agency

Table-34 provides month-wise details on maximum power despatched and maximum power regulated in a time block based on the instructions issued. It can be observed from the table that during the year 2022-23 in a time block, maximum power despatched was 4000 MW in August 2022 while the maximum power regulated was 7000 MW in March 2023.

Table-34: Maximum Ancillary Despatched in a Time Block (MW), 2022-23

Month	Max regulation "UP"	Max regulation "DOWN"
Apr-22	2000	2209
May-22	2508	5580
Jun-22	2500	4809
Jul-22	3000	5000
Aug-22	4000	5000
Sep-22	3000	5000
Oct-22	3300	4745
Nov-22	3047	2212
Dec-22	3000	3000
Jan-23	2000	3000
Feb-23	1500	2500
Mar-23	2000	7000

Source: GRID-INDIA Website

10.4 RRAS Accounting and Settlement

As per Regulation 12 of the CERC (Ancillary Services Operations) Regulations 2015, the Regional Power Committees (RPCs) are required to issue the weekly accounts for RRAS along with the weekly DSM accounts. The RRAS accounts include fixed charges, variable charges, markup, amount of fixed charges to be refunded to the beneficiaries and the payments made from/to the DSM pool.

Energy scheduled to/from Virtual Ancillary Entity (VAE) under RRAS and the payments made for ancillary services during 2016-17 to 2022-23 are given in Table-35.

Table-35: Energy Scheduled and Payments made for Ancillary Services, 2016-17 to 2022-23

Year	Energy scheduled to/from Virtual Ancillary Entity under RRAS (MU)		Payments made for Ancillary Services (₹Crore)	
	Regulation UP	Regulation DOWN	To RRAS provider(s) from DSM pool for Regulation UP	By RRAS provider(s) to DSM pool for Regulation DOWN
2016-17	2212.28	286.00	939.78	42.39
2017-18	4149.25	243.72	2011.47	43.60
2018-19	4811.69	685.42	2810.73	140.83
2019-20	2435.01	1941.31	1333.36	398.40
2020-21	1649.50	2940.01	713.15	610.69
2021-22	2778.22	5353.44	1952.23	1230.65
2022-23	4153.26	4532.77	5378.59	1344.81

Source: GRID-INDIA Website

The energy scheduled under Regulation UP of RRAS has increased from 2212.28 MU in 2016-17 to 4153.26 MU in 2022-23, whereas the energy scheduled under Regulation DOWN of RRAS has increased from 286.00 MU in 2016-17 to 4532.77 MU in 2022-23.

Month-wise energy scheduled to/from VAE under RRAS during 2022-23 can be seen in Figure-41.

Figure-41: Energy scheduled to/from Virtual Ancillary Entity under RRAS (MU), 2022-23

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Chapter-III

Cross Border Trade of Electricity

1. Background

The Cross Border Trade of Electricity (import or export of electricity between India and its neighbouring countries) between India and Nepal and between India and Bhutan has been taking place for more than fifty years. The cross border trade with Bangladesh and Myanmar was respectively started in the year 2013 and year 2017.

The Cross Border Trade of electricity has mainly been taking place under bilateral Memorandum of Understanding/ Power Trade Agreement. The South Asian Association for Regional Cooperation (SAARC) countries envisaged the need for cross border electricity cooperation and signed the SAARC Framework Agreement for Energy Cooperation on 27.11.2014, recognizing the importance of electricity in promoting economic growth and improving the quality of life in the region. In order to facilitate and promote cross border trade of electricity with greater transparency, consistency and predictability in regulatory approaches across jurisdictions and minimize perception of regulatory risks, the Guidelines on Cross Border Trade of Electricity had been prepared by the Inter-Ministerial Working Group in consultation with various stakeholders.

The Ministry of Power (MOP) issued the Guidelines on Cross Border Trade of Electricity on 5.12.2016, which was subsequently substituted by the 'Guidelines for Import/Export (Cross Border) of Electricity-2018' issued on 18.12.2018, to promote cross border trade of electricity with neighbouring countries. Following the guidelines, the Central Electricity Regulatory Commission issued the CERC (Cross Border Trade of Electricity) Regulations, 2019 on 8.03.2019. The Central Electricity Authority (CEA) issued 'Draft Conduct of Business Rules of the Designated Authority' on 25.04.2019 for facilitating the Cross Border Trade of Electricity. In continuation to the draft business rules, on 21.02.2021, CEA notified the 'Procedure for Approval and Facilitating Import/Export (Cross Border) of Electricity by the Designated Authority'.

Under the CERC (Cross Border Trade of Electricity) Regulations 2019, the sale and purchase of electricity between India and the neighbouring countries is allowed through mutual agreements between the local entities and the entities of the neighboring countries, through bilateral agreements between two countries, bidding route or through mutual agreements between entities. Any Indian trader, after obtaining approval from Designated Authority, can trade in Indian Power Exchanges on behalf of any Entity of neighbouring country complying with these regulations.

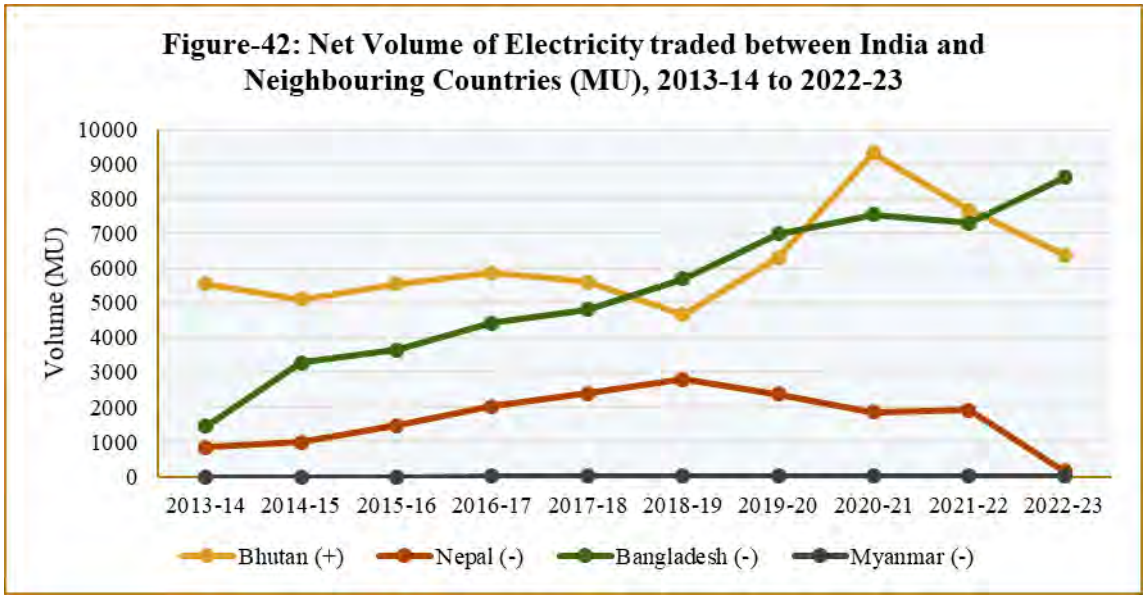
2. Cross Border Trade of Electricity between India and its Neighbouring Countries

Presently, India is a net exporter of electricity to Nepal, Bangladesh, and Myanmar, while India is a net importer of electricity from Bhutan. Table-36 and Figure-42 below provides the details on Cross Border Trade of Electricity between India and its neighbouring countries during the period from 2013-14 to 2022-23. From the table, it can be observed that India was a net importer of electricity from 2013-14 to 2015-16, and became a net exporter of electricity from 2016-17 onwards.

Table-36: Cross Border Trade of Electricity between India and its Neighbouring Countries (MU), 2013-14 to 2022-23

Year	Bhutan (+)	Nepal (-)	Bangladesh (-)	Myanmar (-)	Net Export/Import by India
2013-14	5555.18	840.37	1448.19	0.00	3266.62
2014-15	5109.48	997.17	3271.89	0.00	840.42
2015-16	5555.07	1469.59	3654.4	0.00	431.08
2016-17	5863.58	2021.21	4419.61	3.23	-580.47
2017-18	5611.14	2388.96	4808.83	5.07	-1591.72
2018-19	4657.07	2798.84	5690.31	6.67	-3838.75
2019-20	6310.73	2373.06	6987.94	8.61	-3058.88
2020-21	9318.17	1865.05	7551.99	9.24	-108.11
2021-22	7670.34	1921.09	7301.74	8.8	-1561.29
2022-23	6379.95	158.05	8622.14	9.8	-2410.04

Source: GRID-INDIA



3. Cross Border Electricity Trade of Electricity through Power Exchanges

The Cross Border Electricity Trade of Electricity was commenced in the Day Ahead Market of IEX in 2021-22. The trade with Nepal commenced on 17.04.2021, whereas the trade with Bhutan commenced on 01.01.2022. Table-37 below presents the details of cross-border trade with Nepal and Bhutan through power exchanges.

Table-37: Cross Border Trade of Electricity at IEX, 2021-22 to 2022-23

Year	Nepal				Bhutan			
	Buy		Sell		Buy		Sell	
	Volume Traded	Weighted Average Price	Volume Traded	Weighted Average Price	Volume Traded	Weighted Average Price	Volume Traded	Weighted Average Price
	(MU)	(₹/kWh)	(MU)	(₹/kWh)	(MU)	(₹/kWh)	(MU)	(₹/kWh)
2021-22	785.84	3.59	32.04	3.20	240.11	2.89	-	-
2022-23	1035.69	5.95	1357.77	5.14	318.84	4.39	-	-

Source: IEX Data

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Chapter-IV

Tariff of Long-term Sources of Power

1. Background

Section 61 & 62 of the Electricity Act, 2003 provide for tariff regulation and determination of tariff of generation, transmission, wheeling and retail sale of electricity by the Appropriate Commission. The CERC has the responsibility to regulate the tariff of generating companies owned or controlled by the Central Government. The CERC specifies the terms and conditions for the determination of tariff for the generating companies guided by the principles and methodologies specified. The principles of the tariff are based on: (a) the factors which would encourage competition, efficiency, economical use of the resources, good performance and optimum investments; (b) safeguarding of consumers' interest and at the same time, recovery of the cost of electricity in a reasonable manner; (c) rewarding efficiency in performance; (d) the tariff progressively reflects the cost of supply of electricity and also reduces and eliminates cross-subsidies; and (e) the promotion of co-generation and generation of electricity from renewable sources of energy.

Section 63 of the Act states that "Notwithstanding anything contained in section 62, the Appropriate Commission shall adopt the tariff if such tariff has been determined through transparent process of bidding in accordance with the guidelines issued by the Central Government". Competitive procurement of power requirement by the Distribution Licensees reduces the overall cost of power procurement and in turn leads to significant benefits to consumers.

2. Guidelines and Standard Bidding Documents (SBDs) for Procurement of Electricity by Distribution Licensees through Tariff based bidding process

In compliance with section 63 of the Electricity Act 2003, the Central Government has notified Guidelines for Procurement of Power by Distribution Licensees through Competitive Bidding.

i) **Long Term procurement of Power**: Central Government had initially issued the Standard Bidding Documents (SBDs) containing Request for Qualification (RfQ), Request for Proposal (RfP) and Power Purchase Agreement (PPA) for long-term procurement of power from Case 2 projects (having specified site and location) through tariff based competitive bidding in 2006 and amended it from time to time. The Standard Bidding Documents for long-term procurement of power from Case-1 projects (where the location, technology or fuel is not specified) were issued in the year 2009 and amended it in 2010. In pursuance of the decision of the EGoM on Ultra Mega Power Projects (UMPPs) having specified site and location, the SBDs for Case-2 have been further reviewed and the Model Bidding Documents (MBDs) comprising the Model RFQ, Model RFP and the Model PPA for construction and operation of power generation projects/ UMPPs on design, Build, Finance, Operate and Transfer (DBFOT) basis have been issued on 20th September, 2013. The Guidelines for procurement of electricity from Thermal Power Stations set up on DBFOT basis for Case-2/UMPPs have been published in the Gazette of India on 21st September, 2013. Model Bidding Documents (MBDs) for Thermal Power Stations set up on Design, Build, Finance, Own and Operate (DBFOO) basis for Case-1 issued on 8.11.2013. Further, amendments have been issued in the Documents on 5.5.2015. In order to facilitate use of linkage coal in the long-term procurement of power by Distribution Licensees as per the provisions of SHAKTI Policy, SBDs and Guidelines for long-term Procurement of Electricity from Thermal Power Stations set up on DBFOO basis have been revised and issued in March, 2019.

ii) **Medium Term Procurement of Power**: Model Bidding Documents (MBDs) for procurement of electricity for medium-term from power generating stations set up and/or operated on Finance, Own and Operate (FOO) basis was issued on 29.1.2014. Further, amendments have been issued in the Documents of 20.8.2015. Model Bidding Documents (MBDs) for procurement of peaking power for medium term issued on 20.2.2014. In order to introduce e-bidding process along with reverse action, revised Guidelines and Model Bidding Documents for medium-term procurement of power by Distribution Licensees through tariff based competitive bidding process was notified on 17 January, 2017. Introduction of e-bidding process along with reverse auction will result in greater transparency and fairness in the procurement process for ultimate

benefit of the consumers. Further, for enabling the use of linkage coal as per the new coal linkage policy (SHAKTI Policy) of Ministry of Coal, Revised MBDs and revised Guidelines for Procurement of Electricity for Medium Term were issued on 29.01.2019 and 30.01.2019 respectively.

iii) **Short Term procurement of Power**: The Central Government has issued Guidelines for short-term procurement of electricity i.e. for a period of less than or equal to one year under section 63 of the Electricity Act, 2003 on 16 May, 2012. For introduction of e-reverse auction, the revised guidelines for short-term procurement of electricity were also issued on 30th March, 2016.

The power procurement through competitive bidding resulted in significant capacity addition by private sector. The details on tariff determined by CERC for inter-state power generating companies, mainly the tariff of central public sector power generating companies are discussed in the followings sections.

3. Tariff of Central Public Sector Power Generating Companies

In 2022-23, the central public sector power generating companies (NTPC, NHPC, NLC, NEEPCO, etc.)/central government-owned generating companies accounted for about 40% of the total power generation in the country, which was mainly procured by the various distribution companies through long-term Power Purchase Agreements.

The price paid by distribution companies to procure power from central government-owned thermal generating stations and hydro generating stations in 2022-23 is given in Table-38 and Table-39, respectively.

Table-38: Tariff of Central Thermal Power Stations, 2022-23

S No.	Name of the Station	Installed Capacity (MW) as on 31.03.2023	Normative Fixed Charges (Rs/kwh) @ 85% SG	ECR (Rs/ kWh)	Total Tariff (Rs/ kWh)
NTPC Generating Stations					
1	Singrauli STPS	2000	0.660	1.492	2.152
2	Rihand STPS-I	1000	0.844	1.522	2.366
3	Rihand STPS-II	1000	0.768	1.562	2.330
4	Rihand STPS-III	1000	1.443	1.544	2.987
5	FGUTPS Unchahar-I	420	1.024	4.407	5.431
6	FGUTPS Unchahar-II	420	1.096	4.134	5.230
7	FGUTPS Unchahar-III	210	1.193	4.391	5.584
8	FGUTPS Unchahar-IV	500	1.655	4.131	5.786
9	Tanda-I	440	1.264	5.025	6.290
10	Tanda-II	660	1.469	3.880	5.350
11	NCTPS Dadri-I	840	0.973	4.868	5.841
12	NCTPS Dadri-II	980	1.393	4.788	6.181
13	Korba STPS-I&II	2100	0.743	1.529	2.272
14	Korba STPS-III	500	1.349	1.471	2.820
15	Sipat STPS-I	1980	1.280	1.989	3.270
16	Sipat STPS-II	1000	0.986	2.240	3.225
17	Vindhyachal STPS-I	1260	0.896	1.621	2.517
18	Vindhyachal STPS-II	1000	0.769	1.534	2.304
19	Vindhyachal STPS-III	1000	0.912	1.546	2.458
20	Vindhyachal STPS-IV	1000	1.565	1.532	3.097
21	Vindhyachal STPS-V	500	1.672	1.585	3.256
22	Lara	1600	1.674	2.531	4.205
23	Solapur	1320	1.720	4.962	6.683
24	Mouda STPS-I	1000	1.723	4.240	5.963
25	Mouda STPS-II	1320	1.495	4.298	5.793
26	Gadarwara	1600	2.077	4.230	6.307
27	Khargone	1320	1.813	4.865	6.678
28	Talcher STPS-I	1000	0.959	1.917	2.875
29	Talcher STPS-II	2000	0.714	1.937	2.651
30	Talcher TPS	460	1.662	1.164	2.825

31	Darlipali	800	1.048	3.707	4.755
32	Kahalgaon STPS-I	840	1.089	3.530	4.619
33	Kahalgaon STPS-II	1500	0.824	3.840	4.664
34	Farakka STPS-I&II	1600	1.492	3.730	5.222
35	Farakka STPS-III	500	2.424	3.174	5.598
36	Barh STPS-II	1320	1.840	3.432	5.272
37	Barauni-I	220	0.767	4.583	5.350
38	Barauni-II	250	1.760	2.729	4.489
39	Bongaigaon TPS	750	2.406	3.823	6.229
40	Ramagundam STPS-I&II	2100	0.728	4.024	4.751
41	Ramagundam STPS-III	500	0.833	3.710	4.543
42	Simhadri STPS-I	1000	0.962	4.479	5.441
43	Simhadri STPS-II	1000	1.450	4.350	5.800
44	Kudgi	2400	1.668	5.573	7.241
45	Nabinagar STPS-I	1980	2.174	2.756	4.930
46	Muzaffarpur TPS-II	390	2.741	2.766	5.507
47	North Karanpura-I	660	2.412	1.608	4.020
NTPC Gas Stations Tariff for 2022-23					
48	Faridabad	431.59	0.746	4.080	4.826
49	Auraiya	663.36	0.635	19.134	19.769
50	Dadri	829.78	0.515	14.218	14.733
51	Anta	419.33	0.709	19.270	19.979
52	Gandhar	657.39	0.856	11.741	12.597
53	Kawas	656.20	0.878	17.525	18.402
54	Kayamkulam	359.58	0.384	0.000	0.384
NTPC -JV Stations Tariff for 2022-23					
55	MUNPL, Meja	1320	1.990	3.125	5.114
56	APCPL, Jhajjar	1500	1.585	4.606	6.191
57	NTECL, Vellur	1500	1.727	3.532	5.259
Maithon Power Limited					
58	Maithon Power Limited	1050	1.389	2.741	4.13
NLC Stations					

59	TS-II St.1	630	2.733	0.71	3.44
60	TS-II St.2	840	2.737	0.74	3.47
61	TPS-I Expansion	420	2.443	0.99	3.43
62	BTPS	250			
63	TPS-2 Expansion	500	2.614	2.13	4.75
64	NTPL	1000			
65	NNTPP	1000	2.202	1.80	4.01
DVC					
66	MTPS (1-3)	630	1.04	3.66	4.69
67	MTPS (4)	210	1.00	3.39	4.40
68	MTPS (5-6)	500	1.13	3.78	4.91
69	MTPS (7-8)	1000	1.49	3.58	5.07
70	CTPS (7-8)	500	1.73	3.62	5.35
71	DSTPS (1-2)	1000	1.53	3.79	5.32
72	KTPS (1-2)	1000	1.68	3.54	5.22
73	RTPS (1-2)	1200	1.63	3.88	5.51
74	BTPS A	500	2.20	2.77	4.97
PPCL Bawana					
75	PPCL Bawana TPS	1371.2	1.32	6.759	8.079
ONGC Tripura Power Company Ltd, Palatana Project					
76	Palatana	726.6	1.31	1.95	3.26
NEEPCO Gas Plants					
77	AGBP	291.00	1.8835	2.062	3.9455
78	AGTCCP	135.00	1.884	2.582	4.466
79	TGBP	101.00	2.5354	1.583	4.1184

Table-39: Tariff of Central Hydro Power Stations, 2022-23

S No	Power Station	Installed Capacity (MW)	Annual DE (MU)	Composite Tariff (including water tax for J&K) (Rs/kWh)
NHPC				
1	BAIRASIUL	180	779.28	2.23
2	SALAL	690	3082	1.5
3	TANAKPUR	94.2	452.19	4.76
4	CHAMERA-I	540	1664.55	2.22
5	URI-I	480	2587.38	1.64
6	CHAMERA-II	300	1499.89	2.01
7	DHAULIGANGA	280	1134.69	2.51
8	DULHASTI	390	1906.8	4.57
9	LOKTAK	105	448	3.89
10	RANGIT	60	338.61	3.9
11	TEESTA-V	510	2572.7	2.33
12	Uri-II	240	1123.77	4.26
13	NIMOO BAZGO	45	239.33	9.13
14	CHUTAK	44	212.93	8.9
15	SEWA-II	120	533.53	5.3
16	CHAMEERA-III	231	1108.17	4.21
17	PARBATI-III	520	1963.29	3.08
18	TLDP-III	132	594.07	5.3
19	TLDP-IV	160	720	4.35
20	KISHANGANGA	330	1712.96	3.94
SJVNL				
21	NATHPA JHAKRI	1500	6612	2.406
22	RAMPUR	412	1878.08	4.162
NEEPCO				
23	RANGANADI	405	1509.69	2.745
24	KOPILI ST-I	200	1186.14	1.421
25	KOPILI ST-II	25	86.3	2.96
26	KHANDONG	50	227.61	1.775
27	DOYANG	75	227.24	6.751
28	TUIRIAL	60	250.63	5.124
29	Pare*	110	506.42	5.27
30	Kameng*	600	3353	4
THDC				
31	TEHRI	1000	2797	3.81
32	KOTESHWAR	400	1154.82	5.29
NHDC				
33	INDIRA SAGAR	1000	1442.7	3.8
34	OMKARESHWAR	520	677.47	4.63

DVC				
35	MAITHON	63.2	137	2.999
36	PANCHET	80	237	1.608
37	TALIYA	4	9.97	12.235
IPP				
38	KARCHAM WANGTOO	1000	4559.77	2.798
NTPC				
39	Koldam	800	3054.79	7.332

*Mutually agreed by NEEPCO and its beneficiaries.

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Chapter-V

Trading of Renewable Energy Certificates

1. Renewable Energy Certificate Mechanism

The Renewable Energy Certificate (REC) mechanism is a market-based instrument, to promote renewable sources of energy and development of market in electricity. The REC mechanism provides an alternative voluntary route to a generator to sell his electricity from renewable sources just like conventional electricity and sell the green attribute separately to obligated entities to fulfill their Renewable Purchase Obligation (RPO). Such a generator can either opt to enter into a Power Purchase Agreement for sale at preferential full cost tariff to a distribution licensee or can opt to take the REC route for such untied capacity. If he opts for the REC route, he can sell his electricity to a distribution licensee such as a conventional source-based generation at an average power purchase cost. Or, he can sell to a third party, that is, to an open access consumer at mutually settled prices, or even on power exchanges. On every one-megawatt hour of such electricity generated, he is entitled to get one REC from the central registry (which is regulated by the CERC) after getting registered once with this registry. Such registration requires prior accreditation with the state nodal agency for verifying the source of generation, capacity, and grid metering.

There have been two categories of RECs, namely solar and non-solar, to meet the RPO of the corresponding category. This is because the cost of solar-based generation is very high compared to all other sources. The RE generator as an eligible entity shall apply for issuance of REC within 6 months from the month in which RE power was generated and injected into the grid. The central agency shall issue the RECs to the eligible entity within 15 working days from the date of physical receipt of the application by the eligible entity. The validity of issued REC has been 1095 days. It is to be sold on power exchanges regulated by CERC, which also fixes a price band for exchange of REC (the band of forbearance price and floor price) to protect the interests of obligated entities and generators, respectively. Obligated entities can fulfill RPO by purchasing renewable electricity at full cost preferential tariff or by purchasing REC

equivalent to their RPO. Voluntary buyers can also purchase REC. Regulatory charge for shortfall of RPO compliance is at the rate of forbearance price.

The Central Electricity Regulatory Commission (Terms and Conditions for recognition and issuance of Renewable Energy Certificate for Renewable Energy Generation) Regulations, 2010 were issued on 14th January, 2010 for the development of market in power from non-conventional energy sources by issuance of transferable and saleable credit certificates. The CERC has nominated NLDC as the Implementing Agency (for the Central Registry), which prepares procedures and a web-based platform for the REC mechanism. The REC mechanism was formally launched on 18th November 2010.

CERC notified the Central Electricity Regulatory Commission (Terms and Conditions for Renewable Energy Certificates in Renewable Energy Generation) Regulations, 2022 on 9th May 2022. Some of the key features of REC Regulations 2022 are as under:

I. **Validity of RECs:** As per the new regulations, the certificates issued shall remain valid until they are redeemed.

II. **Eliminated Floor and Forbearance Price:** Floor and Forbearance price are not required for trading of RECs. Prices would be discovered in the power exchanges and as mutually agreed between eligible entities and electricity traders. The Commission will involve in the following circumstances-
    i. There is high volatility in the prices of RECs
    ii. Sudden fluctuations occurred in transaction volumes

III. **REC Fungibility:** There is a new concept of fungibility for Renewable Energy Certificates, where the categorization of RECs, i.e., solar and non-solar has been eliminated in the REC Regulations, 2022. The regulations have provision for all types of renewable energy technologies, like solar, wind, hydro, biomass and biofuel, conversion of waste into energy and any other RE technology into a new REC contract through which RECs of all RE technologies are traded.

IV. **Certificate Multiplier:** A new concept of Certificate Multiplier has been introduced for promoting less mature and high-price RE technologies. The multiplier will increase the market value of different RE technologies. The certificate multiplier assigned to RE technologies depends upon the date of commissioning of the project. Multipliers are assigned as per the tariff range (in Rs/kWh) for different RE technologies as given below:

RE Technologies	Tariff Range (Rs/kWh)	Certificate Multiplier
On Shore Wind and Solar	<=4	1
Hydro	4-6	1.5
Municipal Solid Waste and Non-Fossil Fuel based Cogeneration	6-8	2
Biomass and Biofuel	8-10	2.5

Multipliers will be assigned for the next three years from the date of effect of new regulations. The tariff range and Certificate Multiplier will be revised by CERC as per the maturity level of RE technology. The Certificate Multiplier, once assigned to RE generating stations and Captive generating stations, shall be valid for fifteen years from the date of commissioning of these RE and captive generating stations. The RE projects which have already been commissioned before the new REC regulations came into action shall not be subjected to these conditions.

V. **Transactions of RECs through Trading Licensees:** With a view to increase competition in the Renewable Energy Market and reducing the Transaction costs of RECs, the Commission approved the transactions of RECs through the trading licensees. It will give long-term visibility to all the buyers of RECs, as they can fulfil their RPOs easily. This will facilitate even the small buyers who face difficulty in trading REC to fulfil their RPO.

2. Trading of Renewable Energy Certificates

Trading of RECs is being undertaken on Power Exchanges on the last Wednesday of every month. In the event of a bank holiday on the last Wednesday of any month, trading shall take place on the next bank working day. If there are other exigencies warranting a change in the day for trading, the Central Agency can make such change as considered necessary under intimation to all concerned. The bidding window is kept open on the Power Exchanges designated for dealing in the RECs from 13:00 Hrs to 15:00 Hrs on the day of trading.

One REC is equivalent to 1 MWh of electricity injected into the grid from renewable energy sources. The CERC has notified the band of floor price and forbearance (ceiling) price for trading of RECs, from time to time (Table-40).

Table-40: Floor and Forbearance Price applicable for REC Transactions

Applicable Period	Floor Price (₹/MWh)		Forbearance Price (₹/MWh)	
	Solar	Non-Solar	Solar	Non-Solar
w.e.f 1st June 2010	12000	1500	17000	3900
w.e.f 1st April 2012	9300	1500	13400	3300
w.e.f 1st March 2015	3500	1500	5800	3300
w.e.f 1st April 2017	1000	1000	2400	3000
w.e.f 5th December 2022	The Commission decided to do away with the requirement of determining floor and forbearance price for REC			

The first REC trading session was held on power exchanges in March 2011. The growth of RECs transacted on power exchanges since 2011-12 is given in Table-41. As may be seen in the table, the number of RECs transacted increased significantly from 10.15 lakh in 2011-12 to 162.00 lakh in 2017-18 and then declined to 89.28 lakh in 2019-20. As per the Hon'ble APTEL Order, trading sessions of RECs at both the Power Exchanges remained suspended from July 2020 to October 2021 and resumed from November 2021 as per Hon'ble APTEL Order dated 09.11.2021.

The categorization of RECs between solar and non-solar has been dispensed with the introduction of the concept of multiplier under the REC Regulations, 2022 w.e.f. 05.12.2022. Accordingly, the power exchanges deactivated the Solar and Non-

Solar REC contract for trading w.e.f. December 2022. A new contract, namely "REC", has been made available for trading. During 2022-23, a total of 82.50 lakh RECs were transacted on the power exchanges and bilaterally through trading licensees.

Table-41: Growth of Renewable Energy Certificates transacted on Power Exchanges, 2011-12 to 2022-23

Year	Number of buyers	Number of sellers	Number of RECs transacted (Lakhs)	% increase in Number of RECs Transacted
2011-12	397	197	10.15	-
2012-13	802	683	25.90	155%
2013-14	1083	1044	27.49	6%
2014-15	821	1378	30.62	11%
2015-16	1332	1512	49.55	62%
2016-17	1760	1588	64.88	31%
2017-18	1140	1088	162.00	150%
2018-19	988	830	126.00	-22%
2019-20	830	820	89.28	-29%
2020-21*	277	523	9.21	-90%
2021-22 *	541	749	84.60	819%
2022-23**	511	811	82.50	-2%

** As per Hon'ble APTEL Order trading sessions of RECs at both the Power Exchanges was suspended from July 2020 to October 2021 and resumed from November 2021 as per Hon'ble APTEL Order dated 09.11.2021*

*** Includes RECs traded bilaterally through Trading Licensees*

Source: NLDC

Table-42 shows the demand and supply of RECs, i.e., the gap between the volume of buy and sell bids of RECs on power exchanges from 2012-13 to 2022-23. As may be observed from the table, the volume of buy bids as a percentage of the volume of sell bids initially showed a declining trend from 2012-13 to 2016-17, followed by an increasing trend from 2017-18 to 2019-20 in both the power exchanges because of change in demand for both Solar and Non-Solar RECs.

Table-42: Demand and Supply of RECs on Power Exchanges, 2012-13 to 2022-23

Year	IEX			PXIL			HPX		
	Volume of Buy Bid of RECs (Lakhs)	Volume of Sell Bid of RECs (Lakhs)	Volume of Buy Bid as % of volume of Sell Bid	Volume of Buy Bid of RECs (Lakhs)	Volume of Sell Bid of RECs (Lakhs)	Volume of Buy Bid as % of volume of Sell Bid	Volume of Buy Bid of RECs (Lakhs)	Volume of Sell Bid of RECs (Lakhs)	Volume of Buy Bid as % of volume of Sell Bid
Solar									
2012-13	0.77	0.14	549%	0.12	0.05	265%	-	-	-
2013-14	0.54	5.86	9%	0.14	1.35	10%	-	-	-
2014-15	1.01	37.00	3%	0.63	33.46	2%	-	-	-
2015-16	4.65	227.67	2%	1.83	93.80	2%	-	-	-
2016-17	4.04	323.70	1%	1.53	147.66	1%	-	-	-
2017-18	0.89	34.99	3%	1.20	13.68	9%	-	-	-
2018-19	86.45	152.51	57%	44.46	99.85	45%	-	-	-
2019-20	71.49	19.45	367%	26.80	8.12	330%	-	-	-
2020-21*	1.46	2.44	60%	0.37	0.71	51%	-	-	-
2021-22*	38.73	30.01	129%	6.21	5.58	111%	-	-	-
2022-23 (upto Nov-22)	23.28	215.24	11%	9.33	92.67	10%	0.02	0.09	23%
Non Solar									
2012-13	24.35	91.85	27%	6.55	24.90	26%	-	-	-
2013-14	12.71	251.65	5%	14.11	172.33	8%	-	-	-
2014-15	14.47	553.25	3%	14.51	550.88	3%	-	-	-
2015-16	26.73	889.92	3%	16.34	644.01	3%	-	-	-
2016-17	42.15	981.50	4%	17.16	596.37	3%	-	-	-
2017-18	94.17	635.09	15%	67.89	324.13	21%	-	-	-
2018-19	88.05	60.43	146%	37.82	16.53	229%	-	-	-
2019-20	91.87	94.72	97%	46.71	48.15	97%	-	-	-
2020-21*	5.78	41.70	14%	1.91	21.05	9%	-	-	-
2021-22*	50.84	90.58	56%	21.52	40.41	53%	-	-	-
2022-23 (upto Nov-22)	19.70	238.86	8%	9.70	111.02	9%	0.04	0.12	33%
REC**									
2022-23 (Dec-22 to Mar-23)	25.00	114.35	22%	4.52	33.16	14%	1.10	1.48	74%

** As per Hon'ble APTEL Order trading sessions of RECs at both the Power Exchanges was suspended from Jul'20 to Oct'21 and resumed from Nov'21 as per Hon'ble APTEL Order dated 09.11.2021*

*** The categorization of RECs has been dispensed with, on introduction of the concept of multiplier under the CERC REC Regulations, 2022 w.e.f. 05.12.2022. Accordingly, the power exchanges deactivated the Solar and Non-Solar REC contract for trading w.e.f. December 2022. A new contract named "REC" has been made available for trading.*

Source: CERC MMC Report (Data from Power Exchanges)

The volume and price of RECs transacted on the power exchanges from 2012-13 to 2022-23 is given in Table-43, and the volume and price of RECs transacted through the trading licensees is given in Table-44.

The market clearing volume of Solar RECs transacted on the power exchanges increased from 0.14 lakhs in 2012-13 to 25.86 lakhs in 2022-23 (upto November 2022), whereas the weighted average market clearing price of these RECs declined from ₹12740/MWh in 2012-13 to ₹1189/MWh in 2022-23 (upto November 2022). The

market clearing volume of Non-Solar RECs transacted on the power exchanges increased from 25.76 lakhs in 2012-13 to 29.43 lakhs in 2022-23 (upto November 2022), whereas the weighted average market clearing price of these RECs declined from ₹1692/MWh in 2012-13 to ₹1000/MWh in 2022-23 (upto November 2022).

The market clearing volume of RECs during December 2022- March 2023 was 26.32 lakhs, whereas the weighted average market clearing price of these RECs was ₹1000/MWh during this period.

REC Regulations 2022 also allowed transactions of RECs through the trading licensees. The volume of RECs transacted through the trading licensees was 0.90 lakhs during 2022-23, and the weighted average price of RECs transacted through trading licensees was ₹925/MWh during this period (Table-44).

Table-43: Volume and Price of RECs Transacted on Power Exchanges, 2012-13 to 2022-23

Month	IEX		PXIL		HPX		Total	
	Volume of RECs (MWh) in Lakhs	Weighted Average Price of RECs (₹/MWh)	Volume of RECs (MWh) in Lakhs	Weighted Average Price of RECs (₹/MWh)	Volume of RECs (MWh) in Lakhs	Weighted Average Price of RECs (₹/MWh)	Volume of RECs (MWh) in Lakhs	Weighted Average Price of RECs (₹/MWh)
Solar								
2012-13	0.10	12782	0.04	12615	-	-	0.14	12740
2013-14	0.53	9383	0.14	9668	-	-	0.67	9441
2014-15	1.01	3725	0.63	4756	-	-	1.64	4121
2015-16	4.65	3500	1.83	3500	-	-	6.48	3500
2016-17	4.04	3500	1.53	3500	-	-	5.57	3500
2017-18	0.89	1000	1.20	1000	-	-	2.08	1000
2018-19	46.59	1113	25.36	1067	-	-	71.95	1097
2019-20	17.11	2293	6.04	2292	-	-	23.15	2293
2020-21*	1.19	1491	0.33	1290	-	-	1.52	1447
2021-22*	11.21	2201	2.42	2166	-	-	13.63	2195
2022-23 (upto Nov-22)	18.71	1182	7.13	1208	0.02	1000	25.86	1189
Non-Solar								
2012-13	19.81	1731	5.95	1564	-	-	25.76	1692
2013-14	12.71	1500	14.11	1500	-	-	26.82	1500
2014-15	14.47	1500	14.51	1500	-	-	28.98	1500
2015-16	26.73	1500	16.34	1500	-	-	43.07	1500
2016-17	42.15	1500	17.16	1500	-	-	59.31	1500
2017-18	92.41	1480	67.35	1487	-	-	159.76	1483
2018-19	41.22	1298	10.77	1274	-	-	51.98	1293
2019-20	43.16	1634	21.71	1659	-	-	64.88	1642
2020-21*	5.78	1000	1.91	1000	-	-	7.69	1000
2021-22*	49.57	1000	21.41	1000	-	-	70.98	1000
2022-23 (upto Nov-22)	19.70	1000	9.70	1000	0.04	1000	29.43	1000
REC **								
2022-23 (Dec-22 to Mar-23)	21.24	1000	4.19	1000	0.89	1000	26.32	1000

** As per Hon'ble APTEL Order trading sessions of RECs at both the Power Exchanges was suspended from Jul'20 to Oct'21 and resumed from Nov'21 as per Hon'ble APTEL Order dated 09.11.2021*

*** The categorization of RECs has been dispensed with, on introduction of the concept of multiplier under the CERC REC Regulations, 2022 w.e.f. 05.12.2022. Accordingly, the power exchanges deactivated the Solar and Non-Solar REC contract for trading w.e.f. December 2022. A new contract named "REC" has been made available for trading.*

Source: CERC MMC Report (Data from Power Exchanges)

Table-44: Volume and Price of RECs transacted through Trading Licensees, 2022-23

Month	Volume of RECs (MWh) in Lakhs	Weighted Average Price of RECs (₹/MWh)
Dec-22	-	-
Jan-23	-	-
Feb-23	-	-
Mar-23	0.90	925.00
Total	**0.90**	**925.00**

Source: NLDC & Trading Licensees

3. Long-term Growth Trajectory of RPOs

In May 2018, the Ministry of New and Renewable Energy (MNRE), vide order dated 22.05.2018, created the RPO Compliance Cell, with a function to coordinate with States, CERC and SERCs on matters relating to RPO compliance and taking up non-compliance issues with appropriate authorities. MNRE has up-scaled the target of renewable energy capacity to 175 GW by 2022, which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-resources and 5 GW from small hydro-power. The generation target is also coupled with Renewable Purchase Obligation (RPO) to be met by distribution licensees and open-access consumers.

In order to accelerate the growth of hydropower sector, the Ministry of Power (MOP), on 08.03.2019, declared Large hydro Power Plants (LHPs) having installed capacity of more than 25 MW as renewable energy source. The Ministry notified Hydro Purchase Obligation (HPO) as a separate category to Non-Solar RPO for procuring power from LHPs. The Ministry also issued a revised trajectory of RPO for the year 2021-22, including long-term trajectory for HPO on 29.01.2021.

In furtherance, the MOP, on 22.07.2022, specified the RPO trajectory beyond 2021-22 (see Table-45) with the following conditions:

(a) Wind RPO shall be met only by energy produced from Wind Power projects commissioned after 31st March 2022.

(b) HPO shall be met only by energy produced from LHPs (including PSPs), commissioned after 8th March 2019

(c) Other RPO may be met by energy produced from any RE power project not mentioned in (a) and (b) above.

Table-45: Trajectory of RPOs beyond 2021-22

Year	Wind RPO	HPO	Other RPO	Total RPO
2022-23	0.81%	0.35%	23.44%	24.61%
2023-24	1.60%	0.66%	24.81%	27.08%
2024-25	2.46%	1.08%	26.37%	29.91%
2025-26	3.36%	1.48%	28.17%	33.01%
2026-27	4.29%	1.80%	29.86%	35.95%
2027-28	5.23%	2.15%	31.43%	38.81%
2028-29	6.16%	2.51%	32.69%	41.36%
2029-30	6.94%	2.82%	33.57%	43.33%

Source: Ministry of Power

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Annexure-I

List of Transmission Licensees as on 31.03.2023

S.No.	Name of Licensee	Date of grant of licence
1	Powerlinks Transmission Ltd.	13.11.2003
2	Torrent Power Grid Ltd	16.05.2007
3	Jaypee Powergrid Ltd	01.10.2007
4	Essar Power Transmission Company Ltd.	10.04.2008
5	Parbati Koldam Transmission Company Ltd	15.09.2008
6	Western Region Transmission (Maharashtra) (P) Ltd	30.12.2008
7	Western Region Transmission (Gujrat) (P) Ltd	30.12.2008
8	Teestavalley Power Transmission Ltd.	14.05.2009
9	North East Transmission Company Ltd.	16.06.2009
10	East - North Inter - Connection Company Ltd.	28.10.2010
11	Talcher - II Transmission Company Ltd.	08.11.2010
12	Cross Border Power Transmission Company Ltd.	01.12.2010
13	North Karanpura Transmission Company Ltd.	16.12.2010
14	Jindal Power Ltd	09.05.2011
15	Raichur Sholapur Transmission Company Ltd.	24.08.2011
16	Jabalpur Transmission Company Ltd.	12.10.2011
17	Bhopal Dhule Transmission Company Ltd.	12.10.2011
18	Powergrid NM Transmission Ltd.	20.06.2013
19	Torrent Energy Ltd.	16.07.2013
20	Adani Transmission (India) Ltd.	29.07.2013
21	Aravali Power Co. Ltd.	07.11.2013
22	Kudgi Transmission Ltd.	07.01.2014
23	Powergrid Vizag Transmission Ltd.	08.01.2014
24	Darbhanga - Motihari Transmission Company Ltd.	30.05.2014
25	Purulia & Kharagpur Transmission Company Ltd.	30.05.2014
26	Patran Transmission Company Ltd.	14.07.2014
27	Powergrid Unchahar Transmission Ltd.	21.07.2014
28	RAPP Transmission Company Ltd.	31.07.2014
29	NRSS XXXI (B) Transmission Ltd.	25.08.2014
30	Powergrid Kala Amb Transmission Ltd (NRSS XXXI (A) Transmission Ltd)	04.09.2014
31	NRSS XXIX Transmission Ltd. (Sterlite)	14.11.2014
32	Powergrid Jabalpur Transmission Ltd.	15.06.2015
33	Powergrid Parli Transmission Ltd (Gadarwara (B) Transmission Ltd.)	10.07.2015
34	POWERGRID Warora Transmission Ltd.	05.08.2015
35	Maheshwaram Transmission Ltd.	23.11.2015
36	Raipur-Rajandgaon-Warora Transmission Ltd.	29.02.2016

37	Chhattisgarh-WR Transmission Ltd.	29.02.2016
38	Sipat Transmission Ltd.	07.03.2016
39	POWERGRID Southern Interconnector Transmission System Ltd	14.03.2016
40	Alipurduar Transmission Ltd.	21.03.2016
41	Odisha Generation Phase-II Transmission Ltd.	30.06.2016
42	Gurgaon Palwal Transmission Ltd.	29.09.2016
43	Warora-Kurnool Transmission Ltd.	29.09.2016
44	North Karanpura Transco Ltd.	29.09.2016
45	Khargone Transmission Ltd.	17.11.2016
46	NRSS XXXVI Transmission Ltd.	07.12.2016
47	NER-II Transmission Ltd.	20.06.2017
48	Powergrid Medinipur Jeerat Transmission Ltd.	20.06.2017
49	Kohima-Mariani Transmission Ltd.	10.07.2017
50	Powergrid Mithilanchal Transmission Limited (ERSS XXI Transmission Ltd)	24.04.2018
51	Goa - Tamnar Transmission Project Ltd.	13.07.2018
52	Fatehgarh-Bhadla Transmission Ltd.	27.08.2018
53	Powergrid Varanasi Transmission Ltd (WR-NR Power Transmission Ltd)	27.08.2018
54	Powergrid Khetri Transmission System Ltd.	19.12.2019
55	Bikaner-Khetri Transmission Ltd.	27.12.2019
56	Udupi Kasargode Transmission Ltd. (UKTL)	24.01.2020
57	WRSS XXI (A) Transco Ltd.	24.01.2020
58	Power Grid Bhuj Transmission Ltd. (PBTL)	03.03.2020
59	Lakadia Banaskantha Transco Ltd.	03.03.2020
60	Powergrid Ajmer Phagi Transmission Ltd. (PAPTL)	04.03.2020
61	Powergrid Fatehgarh Transmission Ltd. (PFTL)	04.03.2020
62	Lakadia Vadodara Transmission Project Ltd. (LVTPL)	04.03.2020
63	Jam Khambhaliya Transco Ltd.	24.03.2020
64	Vapi-II North Lakhimpur Transmission Ltd.	01.04.2021
65	Powergrid Ramgarh New Transmission Ltd.	31.05.2021
66	Powergrid Bikaner Transmission System Limited (Bikaner-II Bhiwadi Transco Ltd.)	15.07.2021
67	NRSS XXXI (A) Transmission Ltd., (Now known as Powergrid Kala Amb Transmission Limited - on the RTM route)	22.03.2022
68	Koppal-Narendra Transmission Ltd.	28.03.2022
69	Powergrid Sikar Transmission Ltd.	27.05.2022
70	POWERGRID Aligarh Sikar Transmission Ltd.	28.05.2022
71	Karur Transmission Ltd.	16.06.2022
72	Khavda-Bhuj Transmission Ltd.	16.06.2022
73	Kallam Transmission Ltd.	18.07.2022

74	POWERGRID Southern Interconnector Transmission System Limited (RTM Route)	18.07.2022
75	Gadag Transmission Ltd.	18.07.2022
76	Nangalbibra-Bongaigaon Transmission Ltd.	28.07.2022
77	Rajgarh Transmission Ltd. (RTL)	13.09.2022
78	Warora Kurnool Transmission Ltd. (RTM Route)	13.09.2022
79	Powergrid Narela Transmission Ltd.	26.09.2022
80	POWERGRID Bikaner Transmission System Ltd. (RTM Route)	21.11.2022
81	Power Grid Bhadla Transmission Ltd.	25.11.2022
82	POWERGRID Neemuch Transmission System Ltd.	27.12.2022
83	Khandukhal Rampura Transmission Ltd.	27.01.2023
84	POWERGRID ER NER Transmission Ltd.	04.02.2023
85	Gadag II-A Transmission Ltd.	26.02.2023

List of Trading Licensee as on 31.03.2023

Sr. No.	Name of Trading Licensee	Date of Issue of License	Category of License
1	Tata Power Trading Company Ltd.	09.06.2004	I
2	Adani Enterprises Ltd.	09.06.2004	I
3	PTC India Ltd.	30.06.2004	I
4	NTPC Vidyut Vyapar Nigam Ltd.	23.07.2004	I
5	National Energy Trading & Services Ltd.	23.07.2004	III
6	Instinct Infra & Power Ltd.	07.09.2005	III
7	Essar Electric Power Development Corporation Ltd.*	14.12.2005	-
8	JSW Power Trading Company Ltd.	25.04.2006	IV
9	Greenko Energies (P) Ltd.	22.01.2008	III
10	Ambitious Power Trading Company Ltd.	16.09.2008	IV
11	RPG Power Trading Company Ltd.	23.09.2008	II
12	GMR Energy Trading Ltd.	14.10.2008	I
13	Knowledge Infrastructure Systems (P) Ltd.	18.12.2008	IV
14	Kreate Energy (I) Pvt. Ltd.	12.02.2009	II
15	Shree Cement Ltd.	16.03.2010	IV
16	ABJA Power Pvt. Ltd.	26.04.2011	III
17	Customised Energy Solutions India (P) Ltd.	08.06.2011	V
18	Statkraft Markets (P) Ltd.	21.06.2012	I
19	Manikaran Power Ltd.	29.06.2012	I
20	Arunachal Pradesh Power Corporation (P) Ltd.	11.09.2012	II
21	Vedprakash Power (P) Ltd.*	19.08.2013	-
22	Solar Energy Corporation of India	01.04.2014	I
23	Saranyu Power Trading Private Limited*	10.02.2015	-
24	Gita Power & Infrastructure (P) Ltd.	20.10.2015	V
25	Phillip Commodities India Pvt. Ltd.	21.01.2016	IV
26	Atria Energy Services Private Ltd.	20.06.2017	V
27	NHPC Ltd.	23.04.2018	I
28	NLC India Ltd.	13.07.2018	I
29	Refex Energy Ltd.	30.08.2018	I
30	NTPC Ltd.	08.07.2019	I
31	Amp Energy Markets India Pvt. Ltd.	15.04.2021	V
32	Altilium Energies Pvt. Ltd.	23.05.2021	V
33	Shubheksha Advisors Pvt. Ltd.	31.07.2021	V
34	Reneurja Power LLP	31.07.2021	V
35	ReNew Energy markets Pvt. Ltd.	28.11.2021	IV
36	Shell Energy Marketing and Trading India Pvt. Ltd.	22.12.2021	V

37	SJVN Ltd.	10.01.2022	I
38	Instant Ventures Pvt. Ltd.	09.02.2022	V
39	Refex Industries Ltd.	21.03.2022	I
40	Ideal Energy Solutions Pvt. Ltd.	22.03.2022	V
41	AEI New Energy Trading Pvt. Ltd.	25.03.2022	III
42	Kundan International Private Ltd.	29.04.2022	II
43	Saini Power Transactor	06.07.2022	V
44	Powerfull Energy Trading Private Ltd.	09.08.2022	V
45	Visual Percept Solar Projects Private Ltd.	27.11.2022	III
46	REL Power Trading LLP	13.12.2022	V
47	VEH Global India Private Ltd.	26.12.2022	IV

** License category is under review*

Historical Volatility Formula:

$$\sigma = \sqrt{\frac{1}{(n-1)}\sum_{y=1}^{n}(\ln\frac{y_i}{y_{i-1}} - \mu)^2}$$

$$\mu = \frac{1}{n}\sum_{y=1}^{n}(\ln\frac{y_i}{y_{i-1}})$$

where

1. Daily prices returns = Ln (y_i / y_{i-1}).
2. y_i is price for today; y_{i-1} is price on previous day.
3. Ln is natural logarithm
4. n is the number of observations
5. u is the average daily returns

Herfindahl-Hirschman Index (HHI)

Formula for computing the HHI is as under:

$$HHI = \sum_{i=1}^{N} s_i^2$$

where, s_i is the market share of firm i in the market, and N is the number of firms.

The Herfindahl-Hirschman Index (HHI) ranges from 1/N to 1, where N is the number of firms in the market. Equivalently, if percentages are used as whole numbers, as in 75 instead of 0.75, the index can range up to 100^2 or 10,000.

- HHI below 0.01 (or 100) indicates a highly competitive index.
- HHI below 0.15 (or 1,500) indicates an unconcentrated index.
- HHI between 0.15 to 0.25 (or 1,500 to 2,500) indicates moderate concentration.
- HHI above 0.25 (above 2,500) indicates high concentration.

There is also a normalized Herfindahl index. Whereas, the Herfindahl index ranges from 1/N to 1, the normalized Herfindahl index ranges from 0 to 1.

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