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

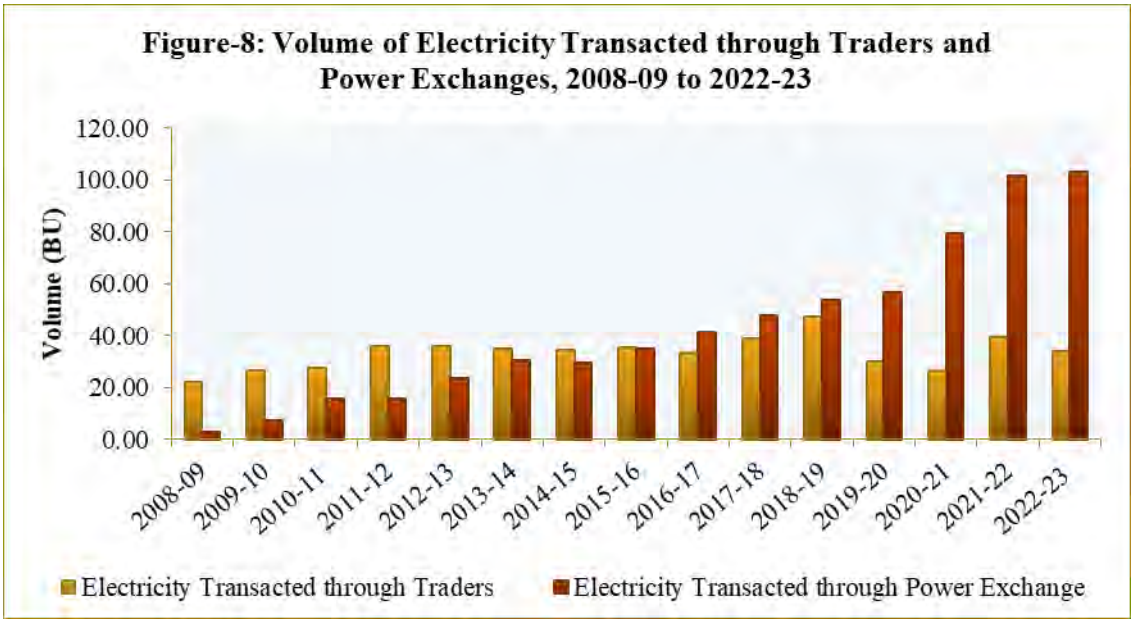
The volume of electricity transacted through all three power exchanges under different market segments increased from 2.77 BU in 2008-09 to 102.95 BU in 2022-23 (Table-10(b)). The CAGR in volume of this segment during 2008-09 to 2022-23 was 29.5%.

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

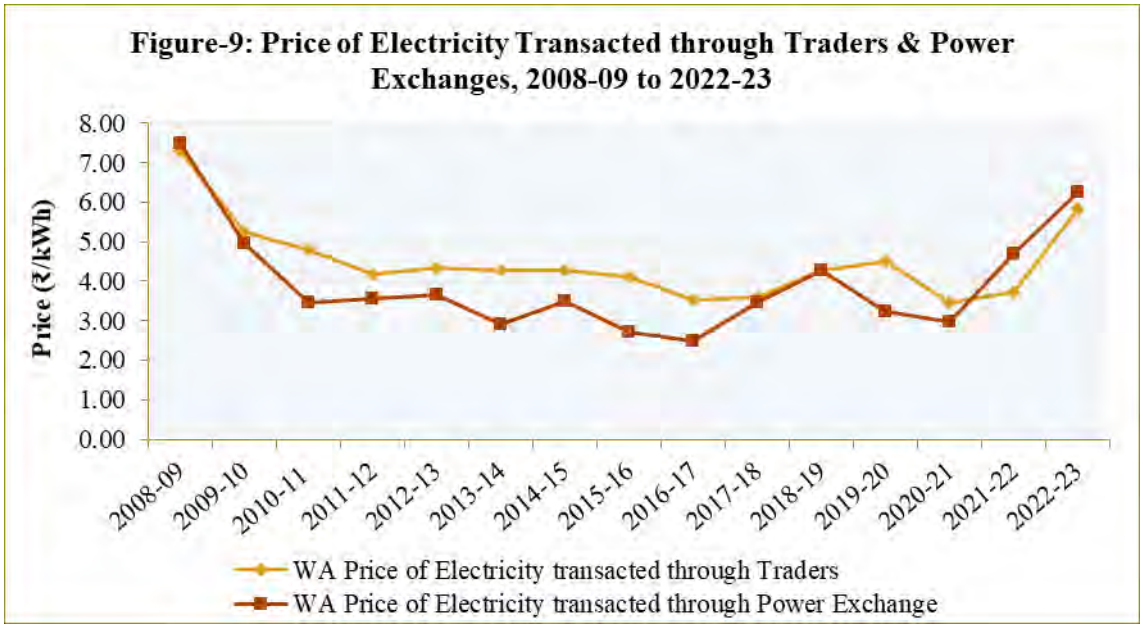
The prices of electricity transacted through traders and power exchanges are shown in Table-12 and Figure-9. The weighted average price of electricity transacted through traders and power exchanges has come down from ₹7.29/kWh and ₹7.49/kWh, respectively in 2008-09 to ₹5.85/kWh and ₹6.25/kWh, respectively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

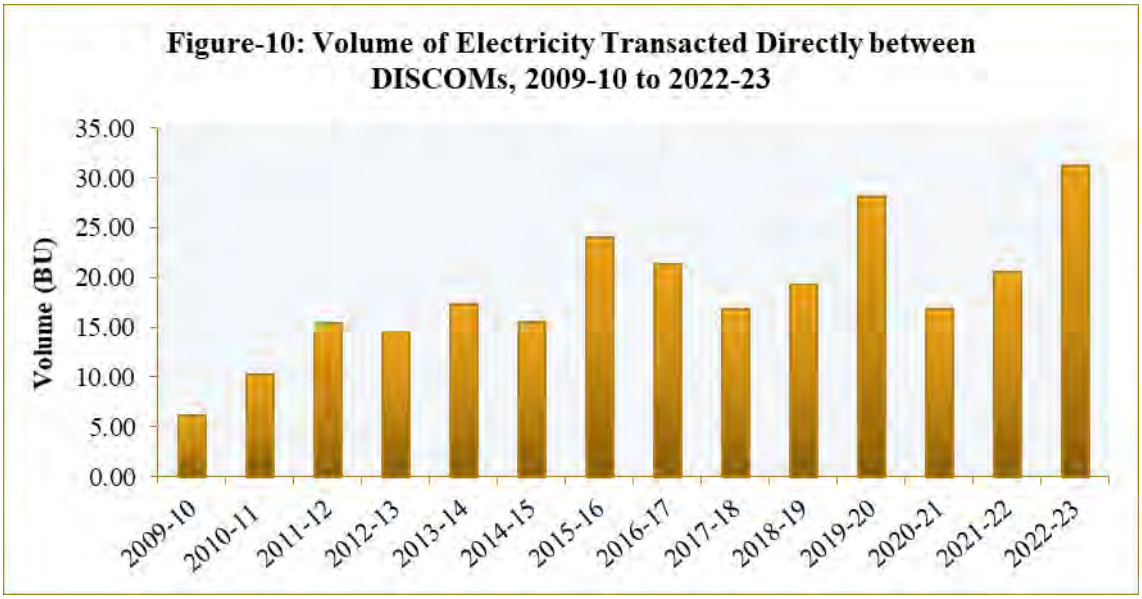
2.1.2 Electricity Transacted Directly between DISCOMs

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.

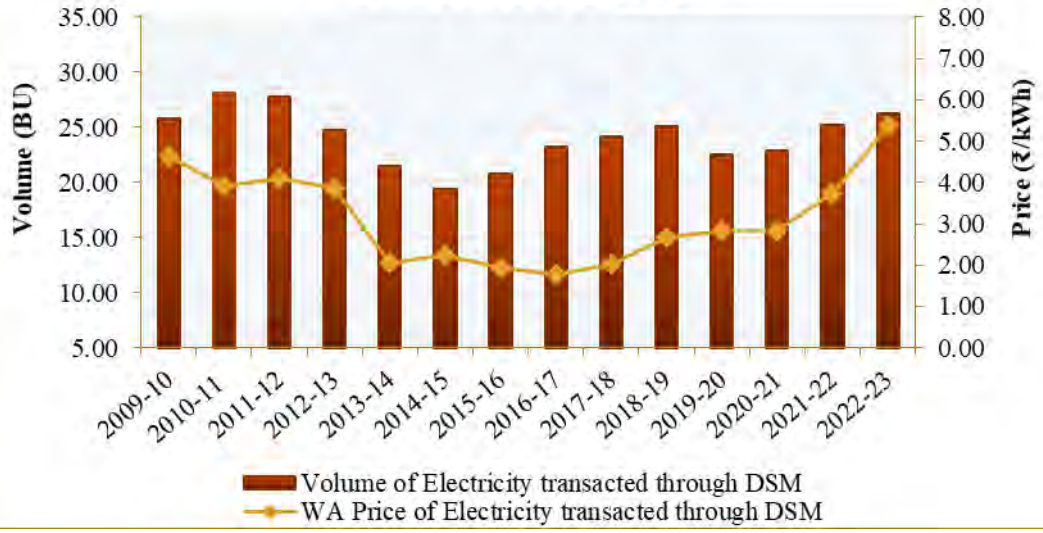
Table-15: Volume and Price of Electricity Transacted through DSM, 2009-10 to 2022-23

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

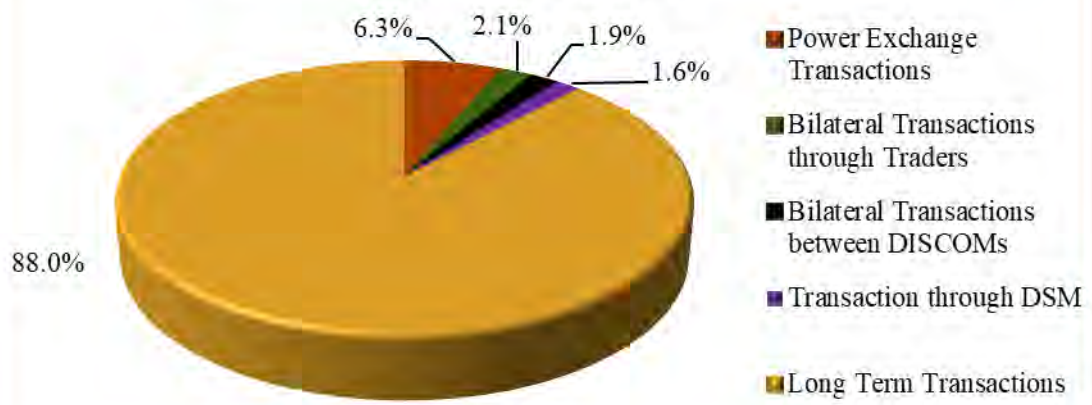
Figure-11: Volume and Price of Electricity transacted through DSM, 2009-10 to 2022-23



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

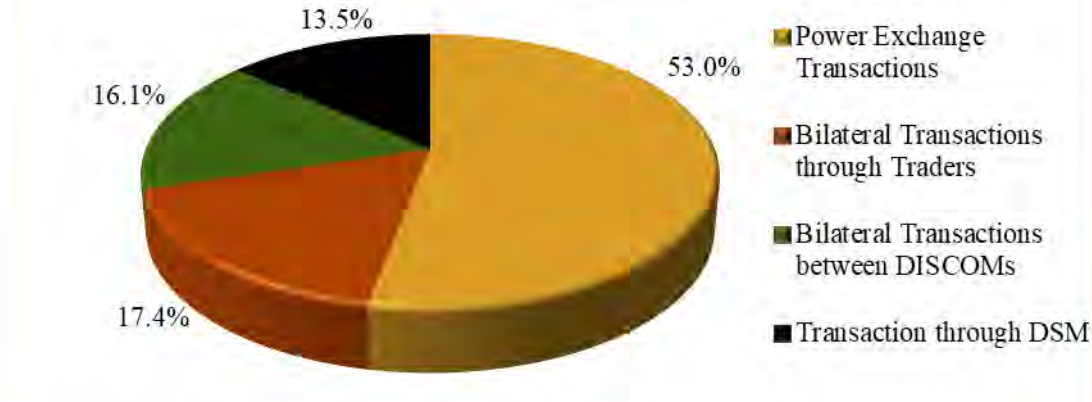
During 2022-23, the share of total short-term transactions and DSM transactions, as a percentage of total electricity generation in the country was about 12% (Figure-12).

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

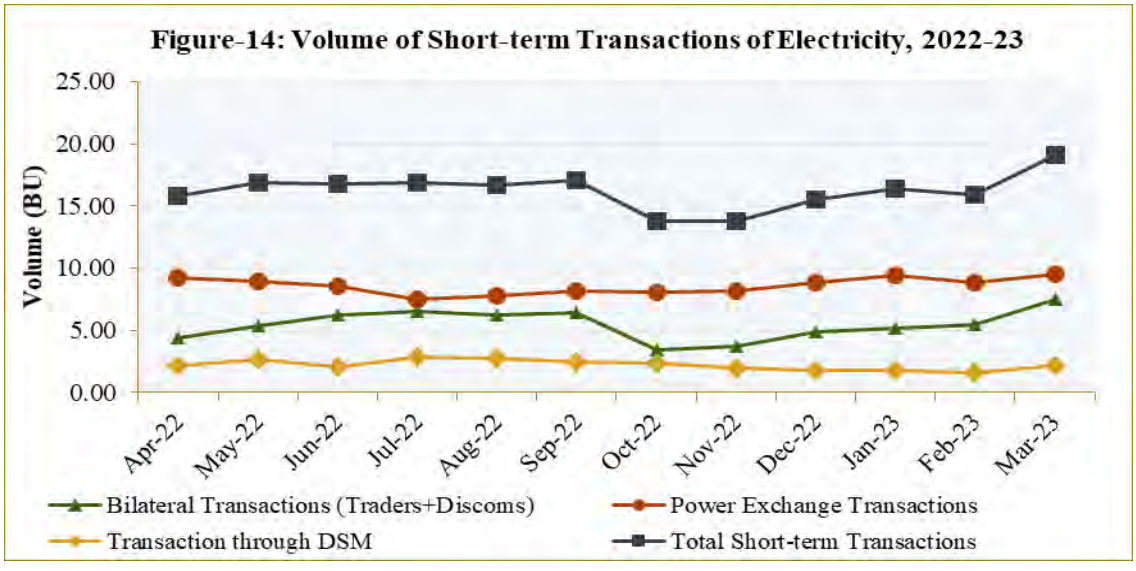
The volume of short-term transactions of electricity during different months of 2022-23 with break-up for different market segments is shown in Table-16 and Figure-14.

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.

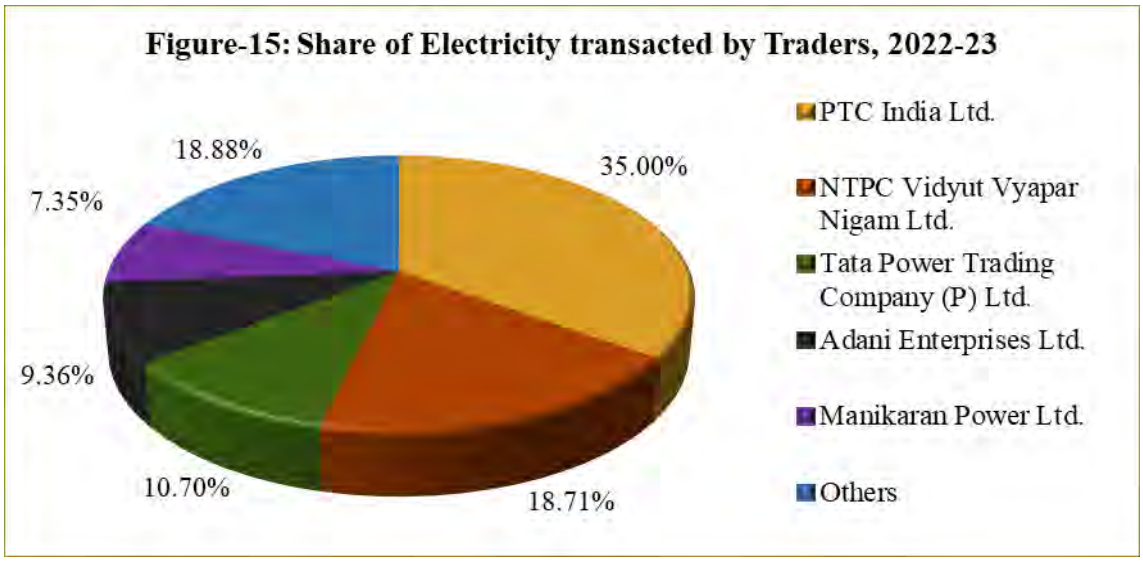
Table-18: Share of Electricity Transacted by Traders and HHI, 2022-23

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%**	

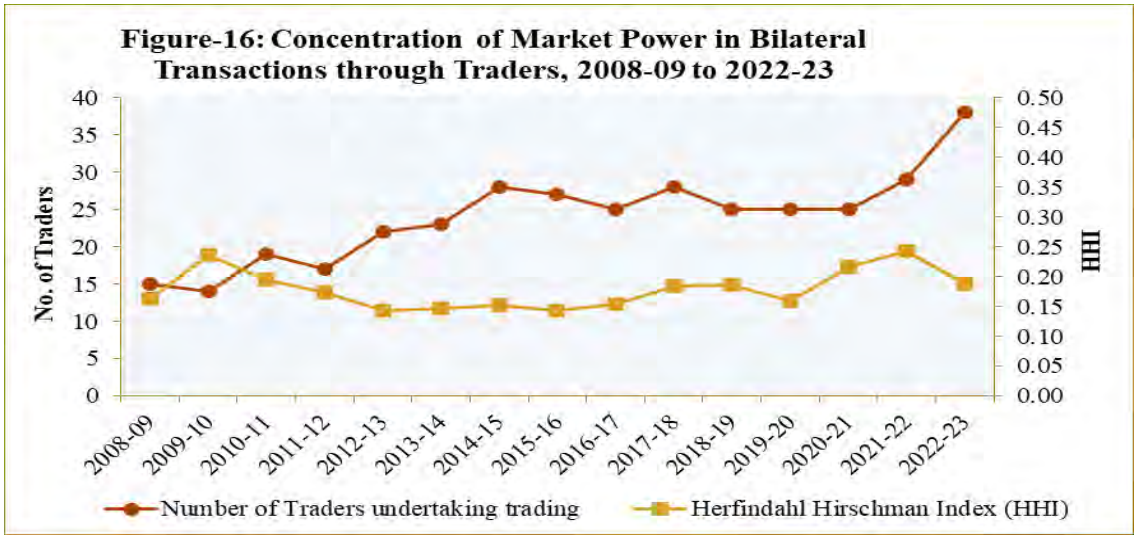
Note: Percentage share in total volume traded by Licensees in 2022-23 is computed based on the volume which includes the volume traded by inter-state trading licensees through bilateral and power exchanges.

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.



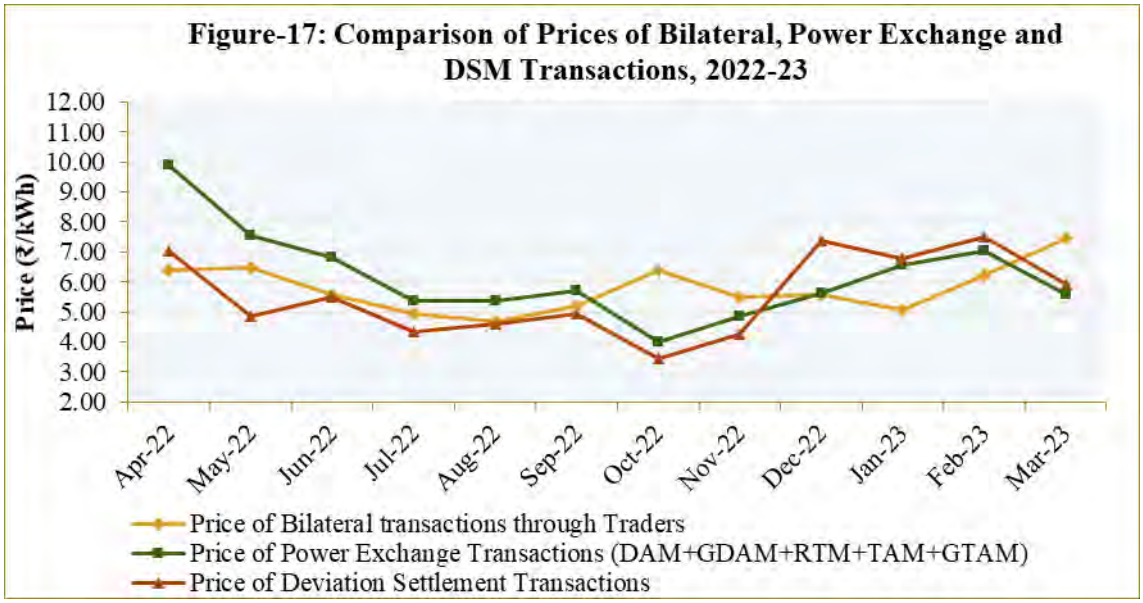
3.2 Price of Short-term Transactions of Electricity

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

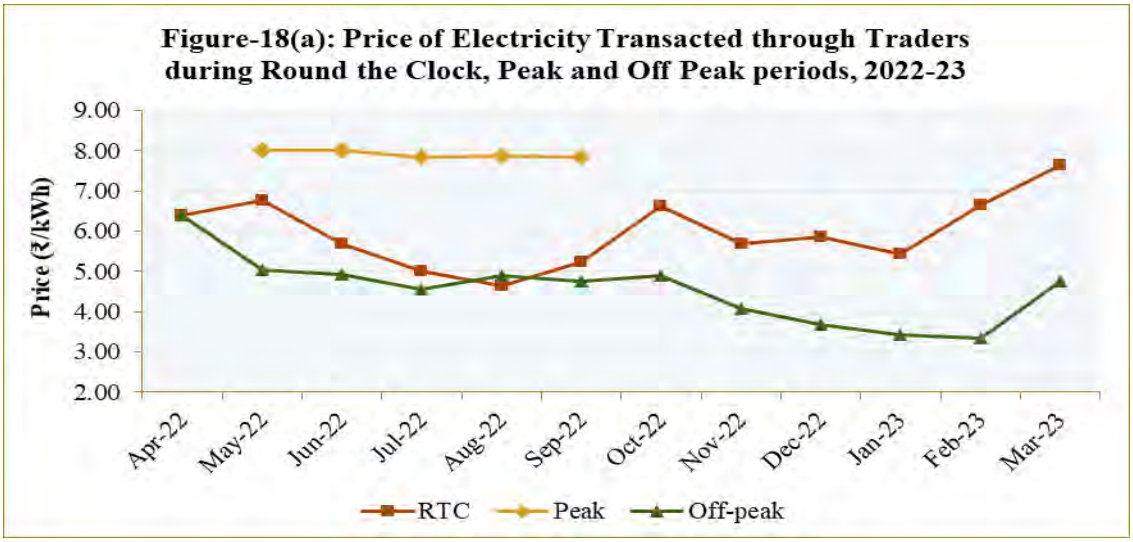
Month	Bilateral through Traders				Power Exchange	DSM
	RTC	Peak	Off-peak	Weighted Average	Weighted Average	All India Grid
Apr-22	6.41	-	6.41	6.41	9.89	7.05
May-22	6.75	8.00	5.04	6.49	7.56	4.87
Jun-22	5.70	8.00	4.92	5.59	6.82	5.48
Jul-22	5.02	7.84	4.56	4.93	5.35	4.35
Aug-22	4.63	7.88	4.89	4.70	5.35	4.60
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.

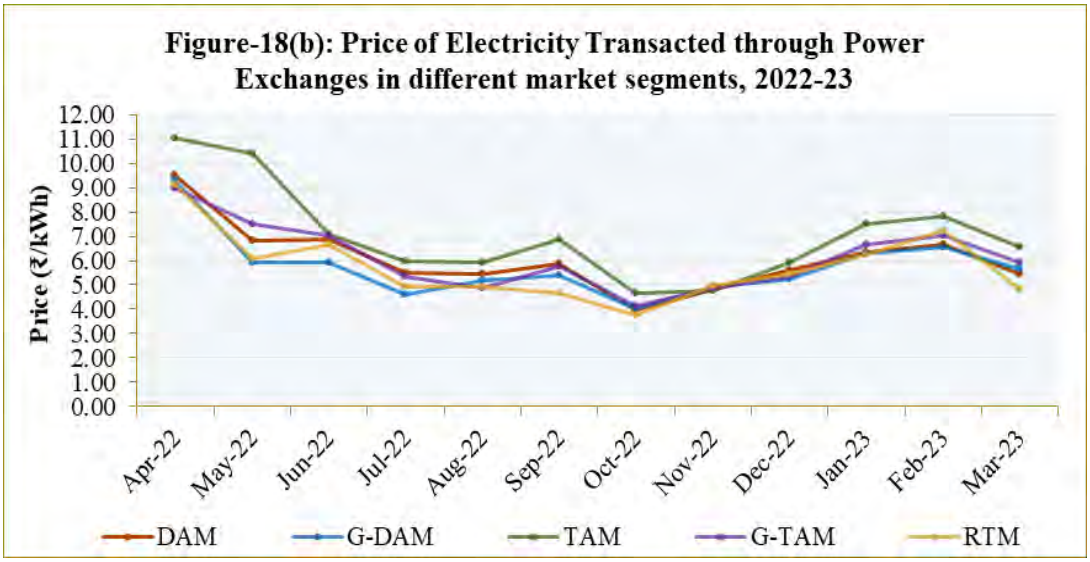
The trend in the price of electricity transacted through traders during RTC, Peak and Off-peak periods are shown in Table-19(a) above and Figure-18(a). There is no price mentioned for electricity transacted during peak for some of the months in 2022-23 because there was no volume of electricity transacted 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

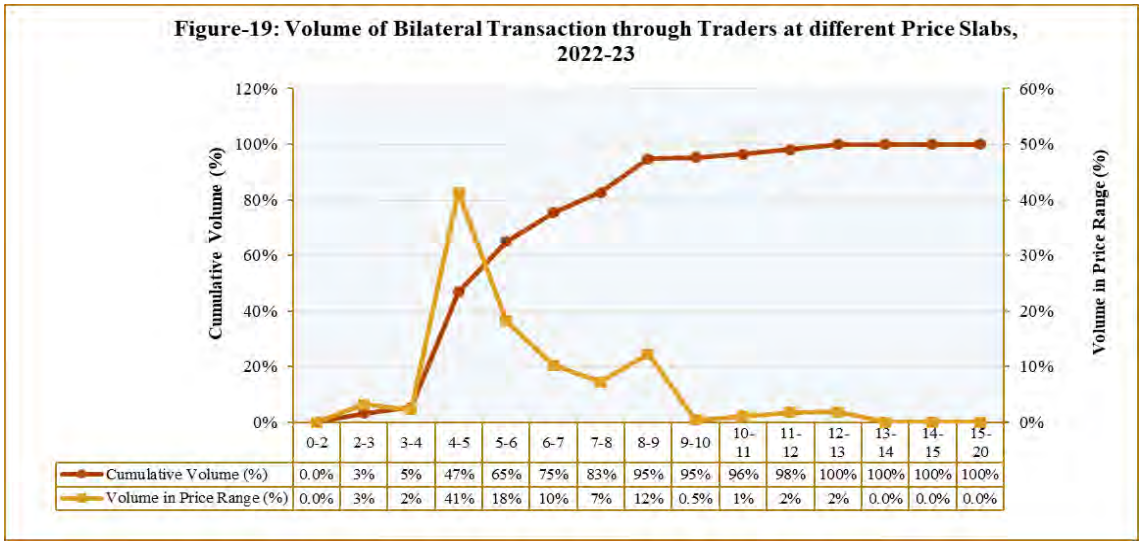
Month	Power Exchange					
	DAM	G-DAM	TAM	G-TAM	RTM	Weighted Average
Apr-22	9.52	9.29	11.01	8.95	9.12	9.89
May-22	6.80	5.91	10.41	7.51	6.10	7.56
Jun-22	6.87	5.94	7.07	7.02	6.67	6.82
Jul-22	5.50	4.63	5.97	5.36	4.92	5.35
Aug-22	5.44	5.20	5.94	4.88	4.90	5.35
Sep-22	5.87	5.42	6.85	5.74	4.68	5.71
Oct-22	3.96	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.

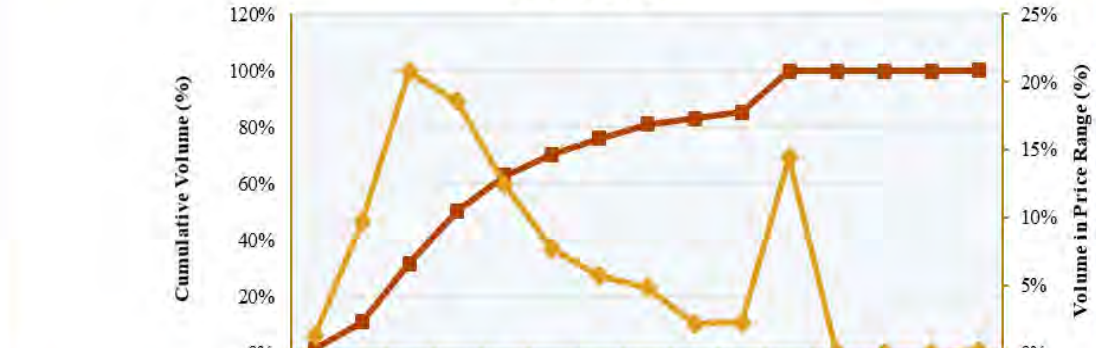
The volume of bilateral transactions at different price slabs in 2022-23 is depicted in Figure-19. The figure shows that about 47% of the volume of electricity was transacted through traders at less than ₹5/kWh and 95% of the volume of electricity was transacted through traders at less than ₹10/kWh.



	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%

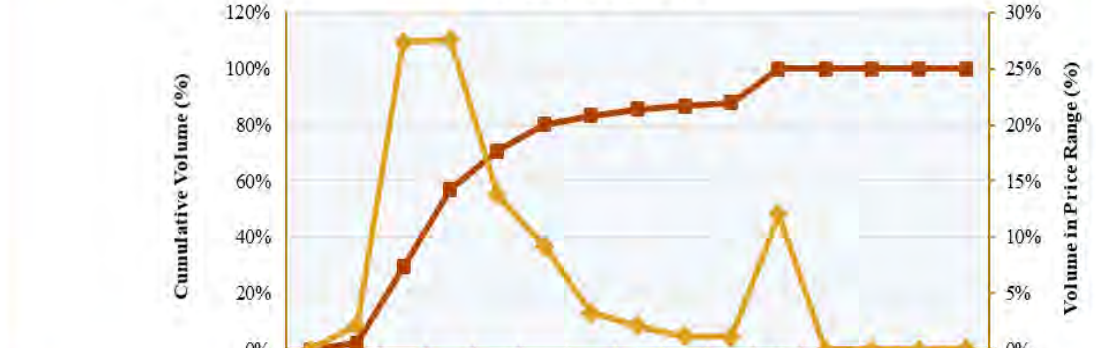
The volume of electricity transacted in IEX at different price slabs in DAM, G-DAM and RTM segments during 2022-23 are depicted in Figure-20(a), 20(b) and 20(c) respectively. The figure shows that 50% of the volume of electricity in DAM was transacted at less than ₹5/kWh and 83% of the volume of electricity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



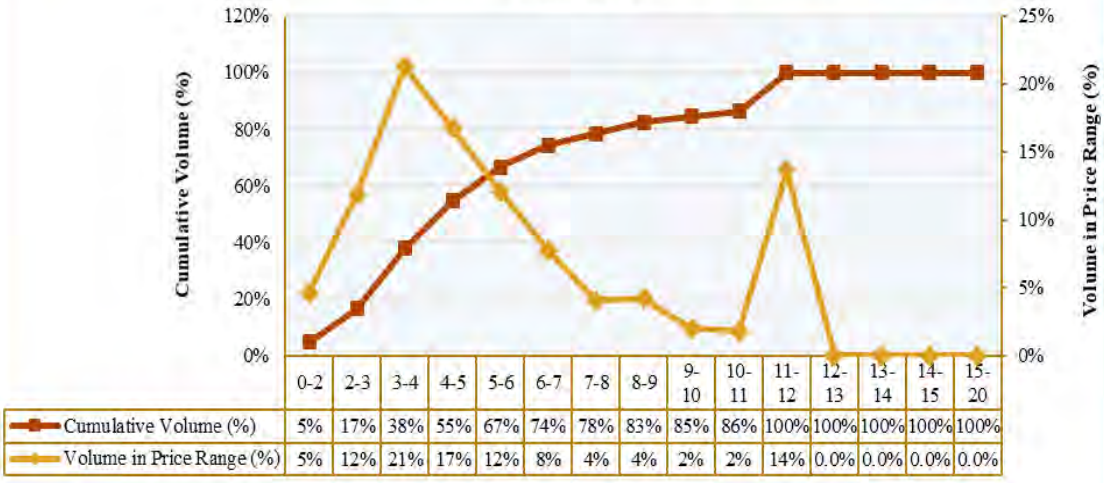
	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-20
Cumulative Volume (%)	1%	11%	32%	50%	63%	70%	76%	81%	83%	85%	100%	100%	100%	100%	100%
Volume in Price Range (%)	1%	10%	21%	19%	12%	8%	6%	5%	2%	2%	14%	0.0%	0.0%	0.0%	0.2%

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%

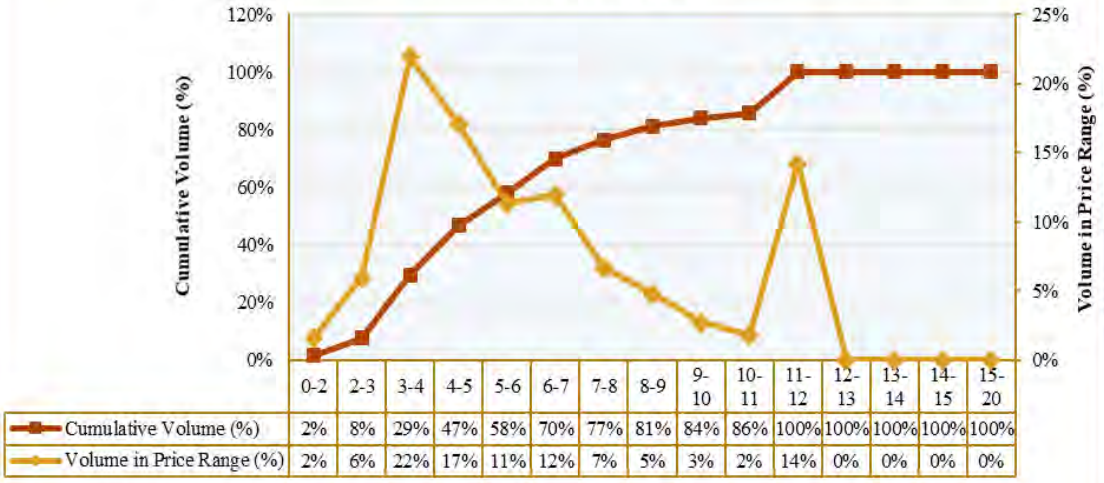
Figure-20 (c): Volume of IEX Transactions in Real Time Market at different Price Slabs, 2022-23



	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%

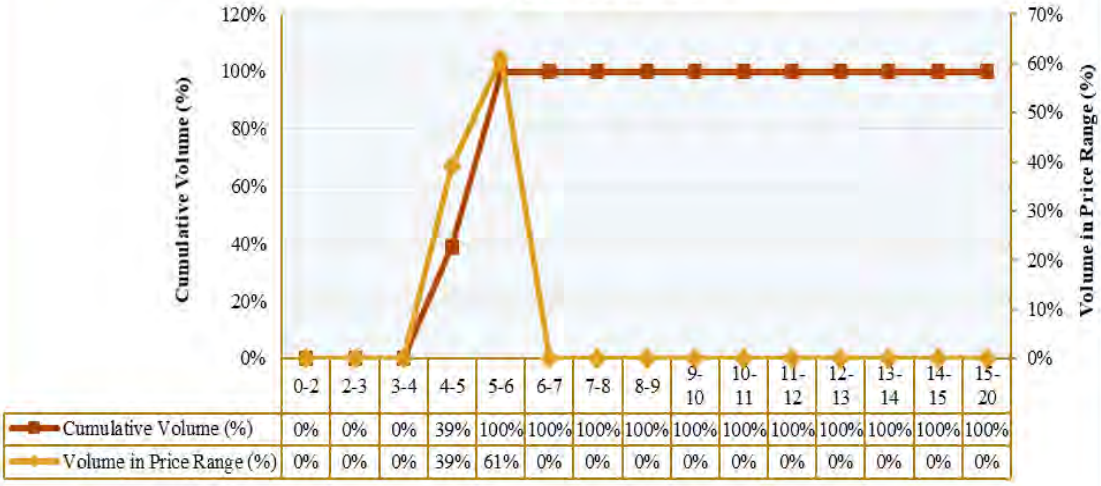
The volume of electricity transacted in PXIL at different price slabs in DAM, GDAM and RTM is depicted in Figure-21(a), 21(b) and 21(c) respectively. The figure shows that 47% of the volume of electricity in DAM was transacted at less than ₹5/kWh, and about 84% of the volume of electricity was transacted 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



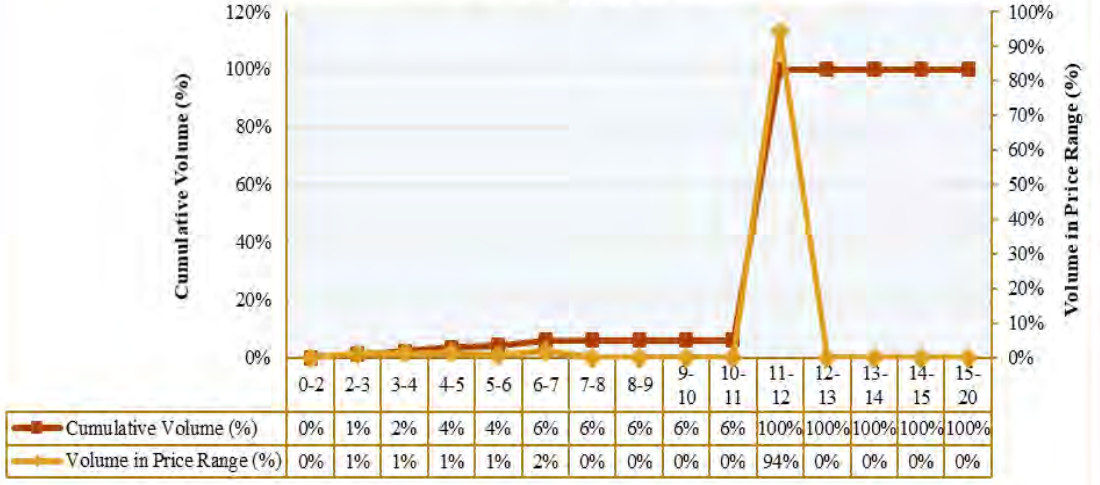
	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-20
Cumulative Volume (%)	2%	8%	29%	47%	58%	70%	77%	81%	84%	86%	100%	100%	100%	100%	100%
Volume in Price Range (%)	2%	6%	22%	17%	11%	12%	7%	5%	3%	2%	14%	0%	0%	0%	0%

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%

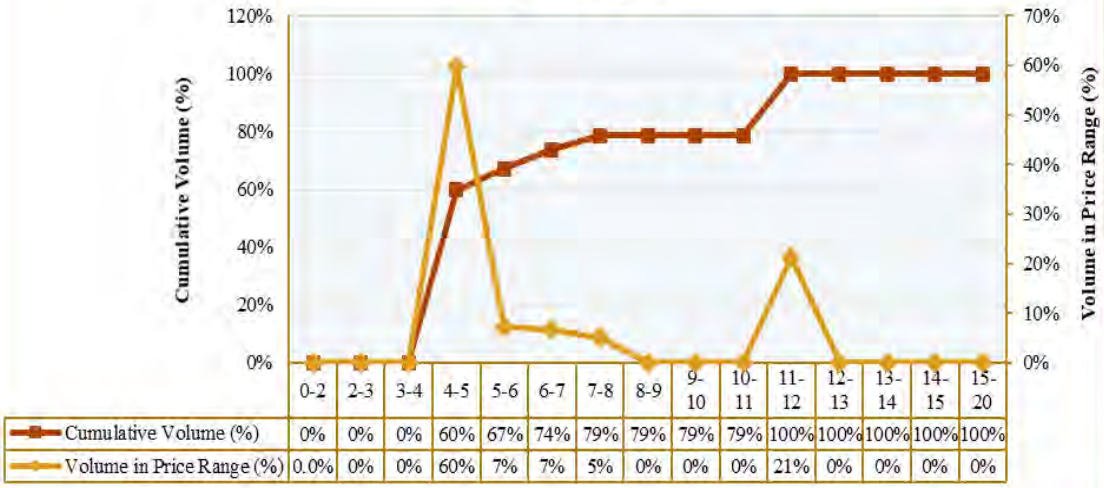
Figure-21(c): Volume of PXIL Transactions in Real Time Market at different Price Slabs, 2022-23



	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

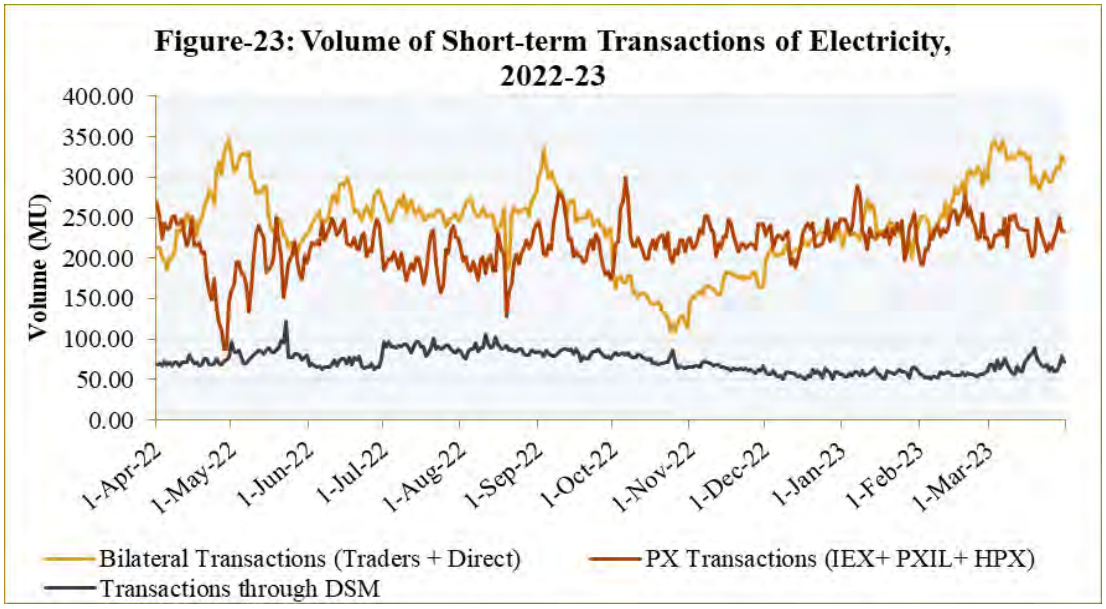


	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-20
Cumulative Volume (%)	0%	0%	0%	60%	67%	74%	79%	79%	79%	79%	100%	100%	100%	100%	100%
Volume in Price Range (%)	0.0%	0%	0%	60%	7%	7%	5%	0%	0%	0%	21%	0%	0%	0%	0%

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.

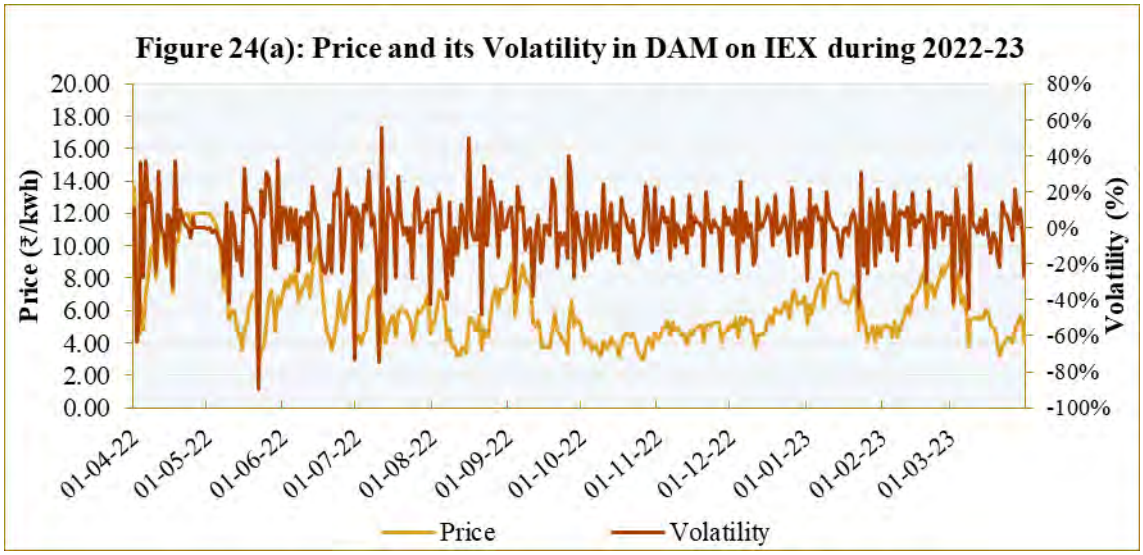


Figure 24(a): Price and its Volatility in DAM on IEX during 2022-23
Price (₹/kwh)
Volatility (%)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
01-04-22
01-05-22
01-06-22
01-07-22
01-08-22
01-09-22
01-10-22
01-11-22
01-12-22
01-01-23
01-02-23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

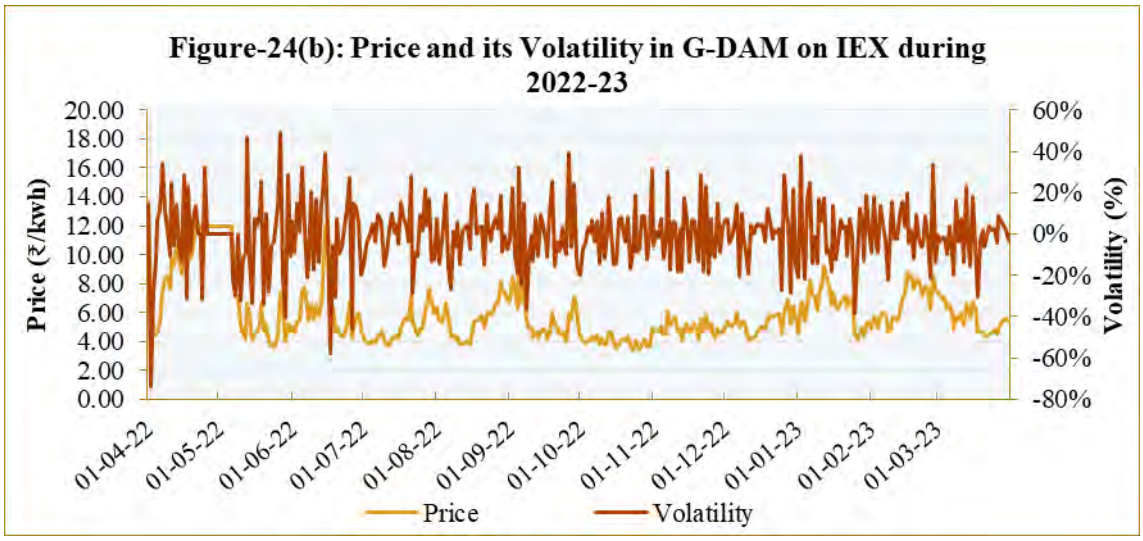


Figure-24(b): Price and its Volatility in G-DAM on IEX during 2022-23
Price (₹/kwh)
Volatility (%)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
60%
40%
20%
0%
-20%
-40%
-60%
-80%
01-04-22
01-05-22
01-06-22
01-07-22
01-08-22
01-09-22
01-10-22
01-11-22
01-12-22
01-01-23
01-02-23
01-03-23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

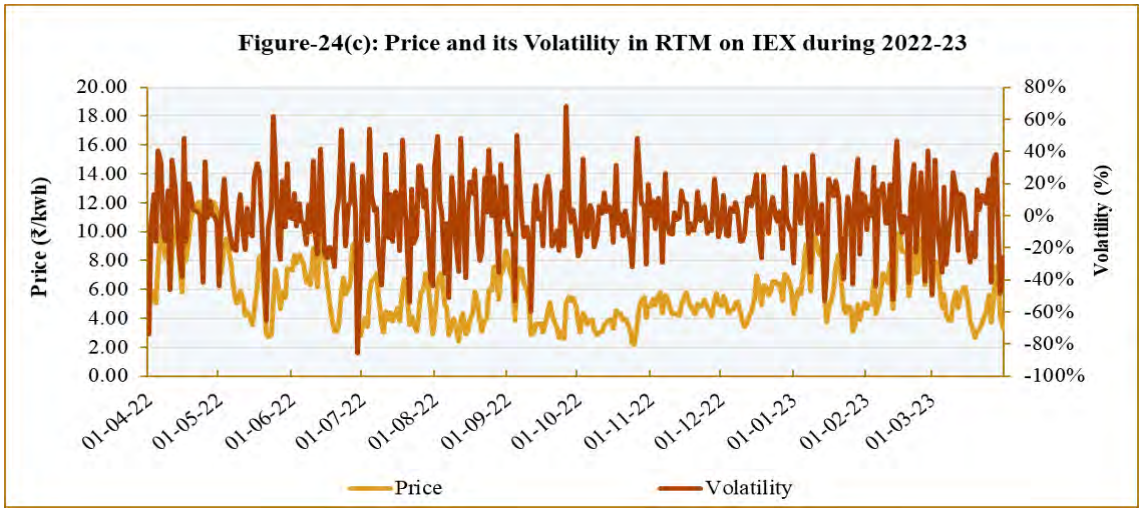


Figure-24(c): Price and its Volatility in RTM on IEX during 2022-23
Price (₹/kwh)
Volatility (%)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
01-04-22
01-05-22
01-06-22
01-07-22
01-08-22
01-09-22
01-10-22
01-11-22
01-12-22
01-01-23
01-02-23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

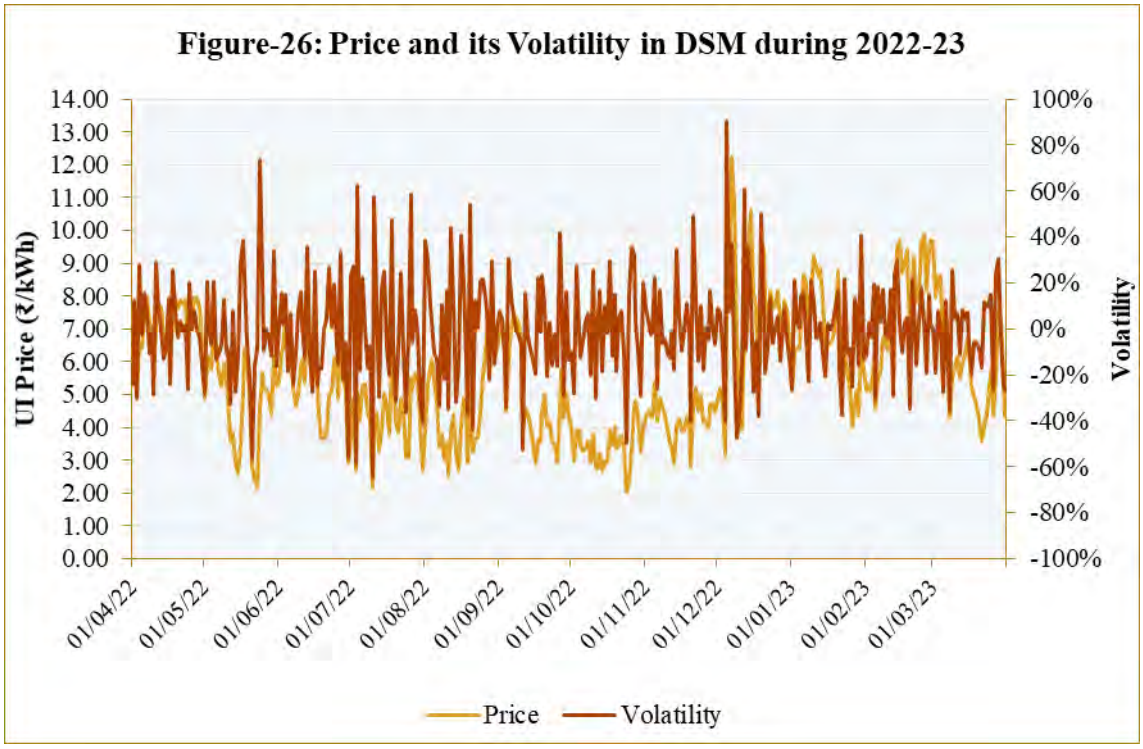
The weighted average price of electricity transacted through PXIL in DAM and its Volatility are shown in Figure-25. The price and its volatility for the electricity transacted through PXIL in GDAM and RTM has not been depicted here due to low liquidity and transactions took place only on few days in 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

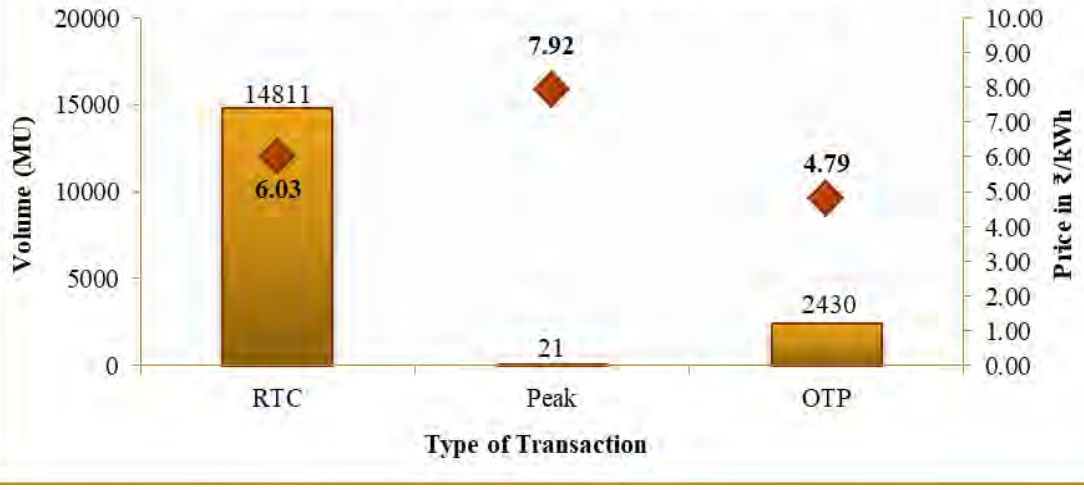
In this section, time of the day variation in volume and price of electricity transacted through traders has been illustrated for RTC (Round the Clock), Peak period and other than RTC & Peak period. Time of the day variation in volume and price of electricity transacted through power exchanges is shown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



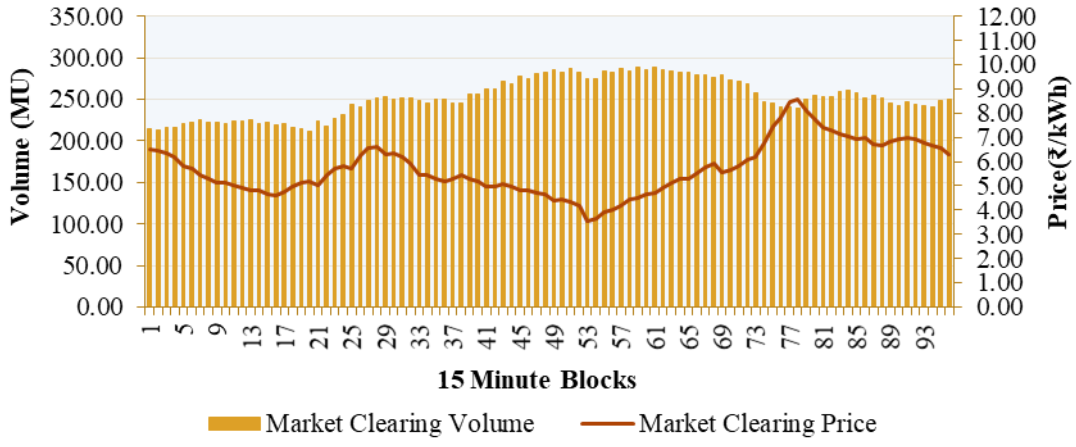
5.2 Time of the Day Variation in Volume and Price of Electricity Transacted through Power Exchanges

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



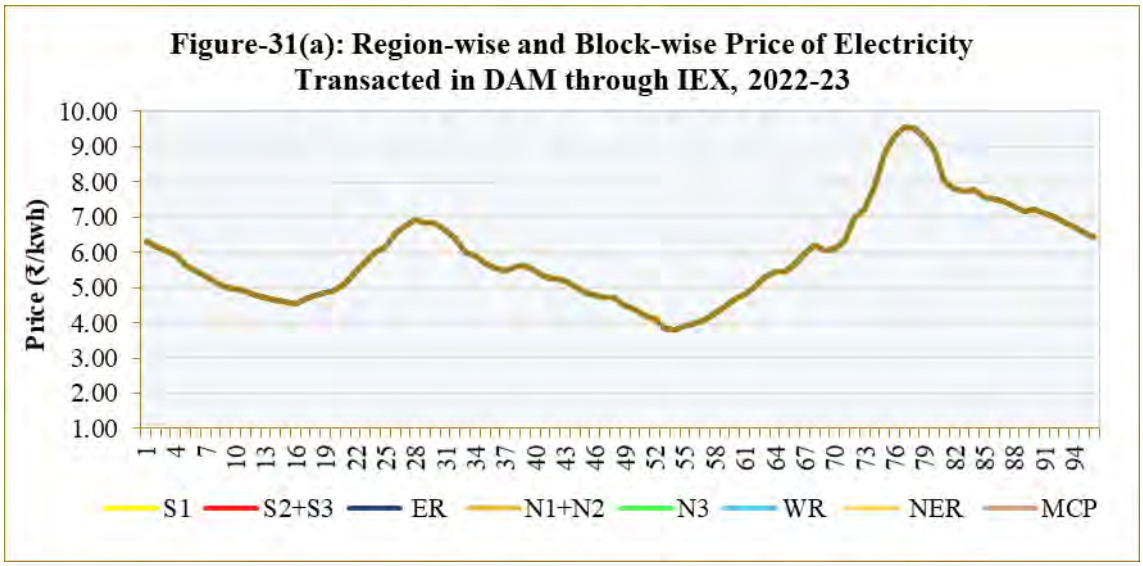
Time of the day variation in volume and price of electricity transacted through DAM on PXIL during 2022-23 is shown block-wise in Figure-29. It may be observed from the figure that the prices in DAM remained subdued during solar hours and increased in the peak evening hours. Due to very limited number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

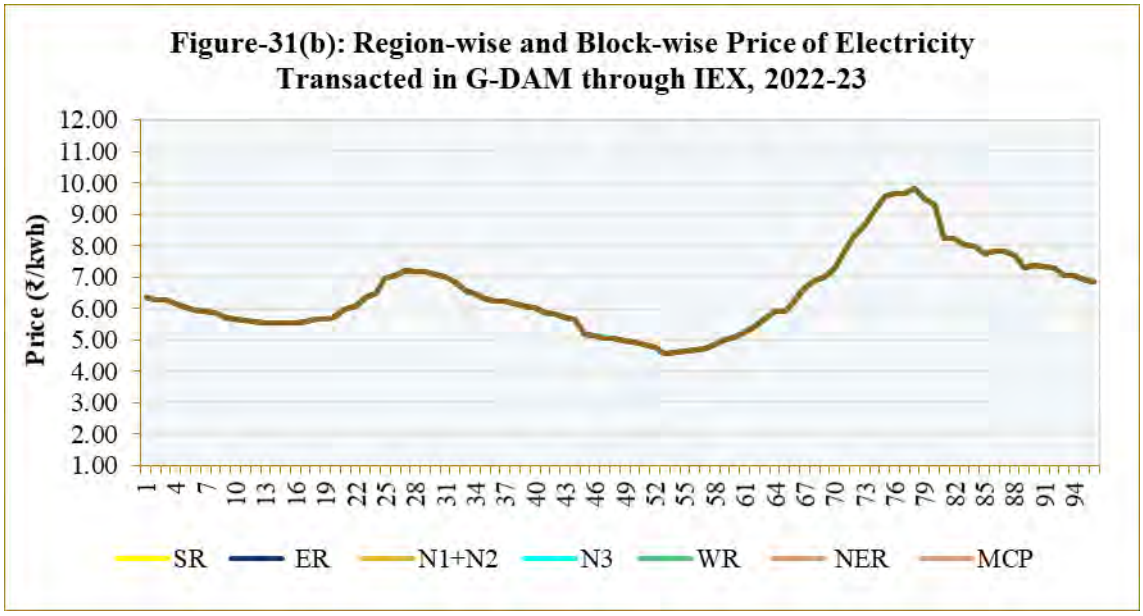
Figure-29: Block-wise Market Clearing Volume and Price in DAM on PXIL during 2022-23

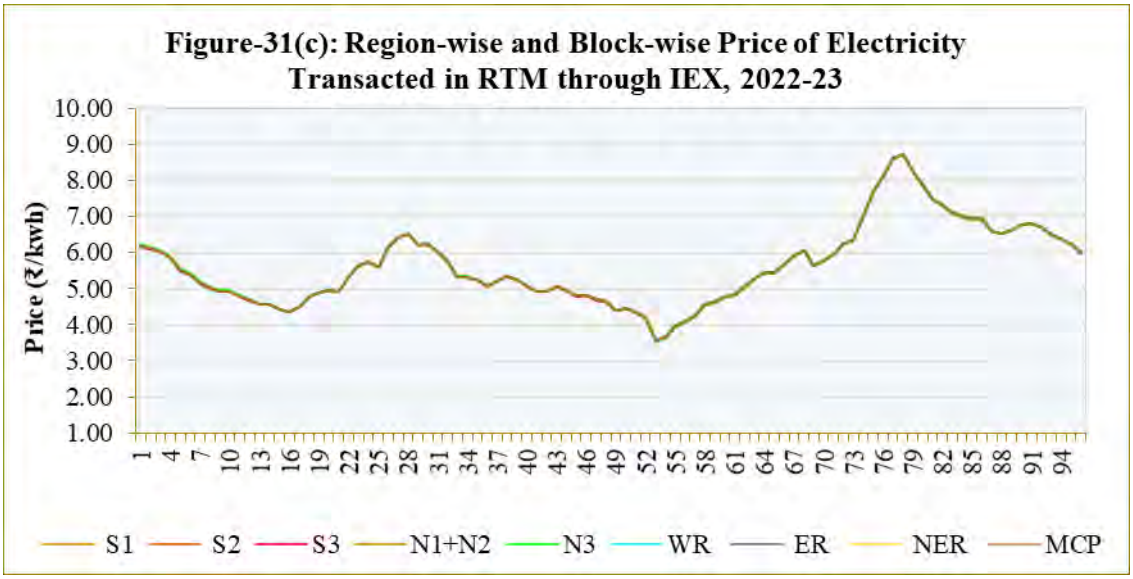
Time of the day variation in volume and price of electricity transacted through DAM at HPX during 2022-23 is shown block-wise in Figure-30. Transactions took

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.

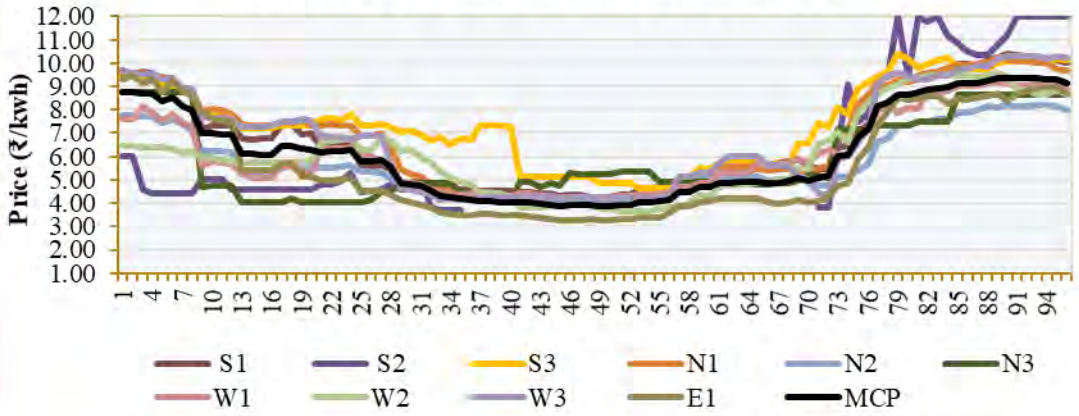






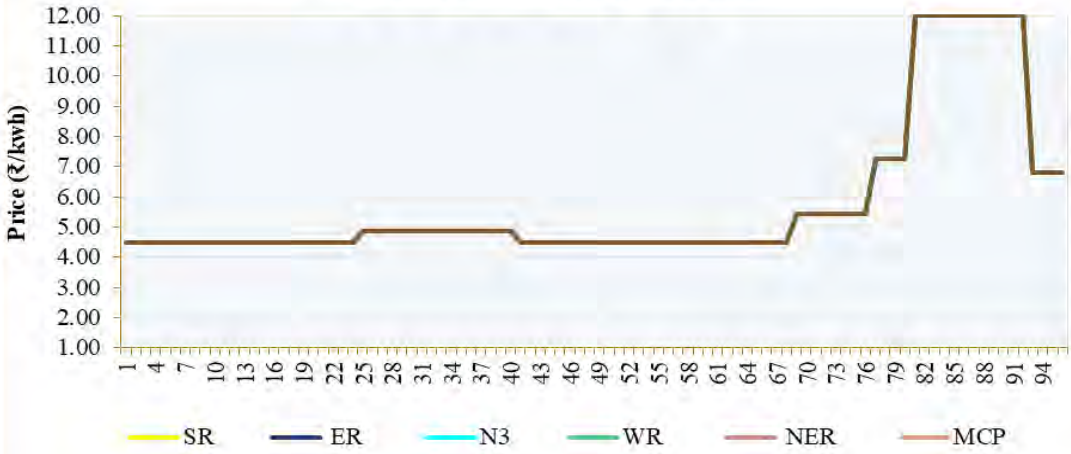
Region-wise and hour-wise prices of electricity transacted through PXIL in DAM are shown in Figure-32. Though no consistent trend has been observed in price in different regions, price of electricity in southern region was relatively high when compared with the prices in other regions. There were very 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

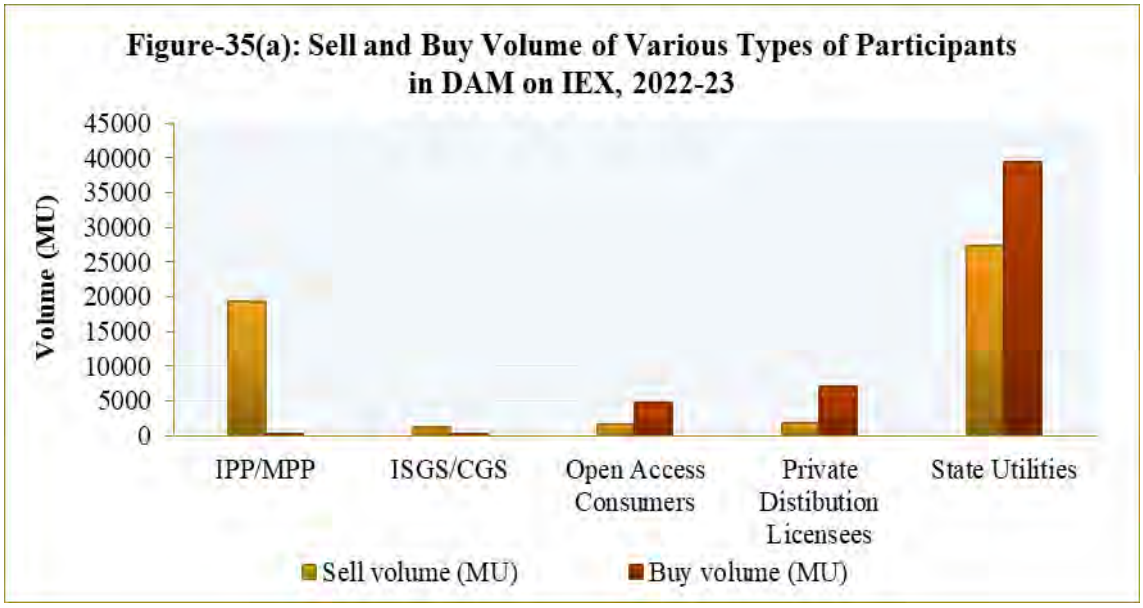
It can be observed from the above figure that the trading margin charged by the trading licensees, in general, witnessed a downward trend over the years. This may be attributed to the increasing competition among the trading licensees.

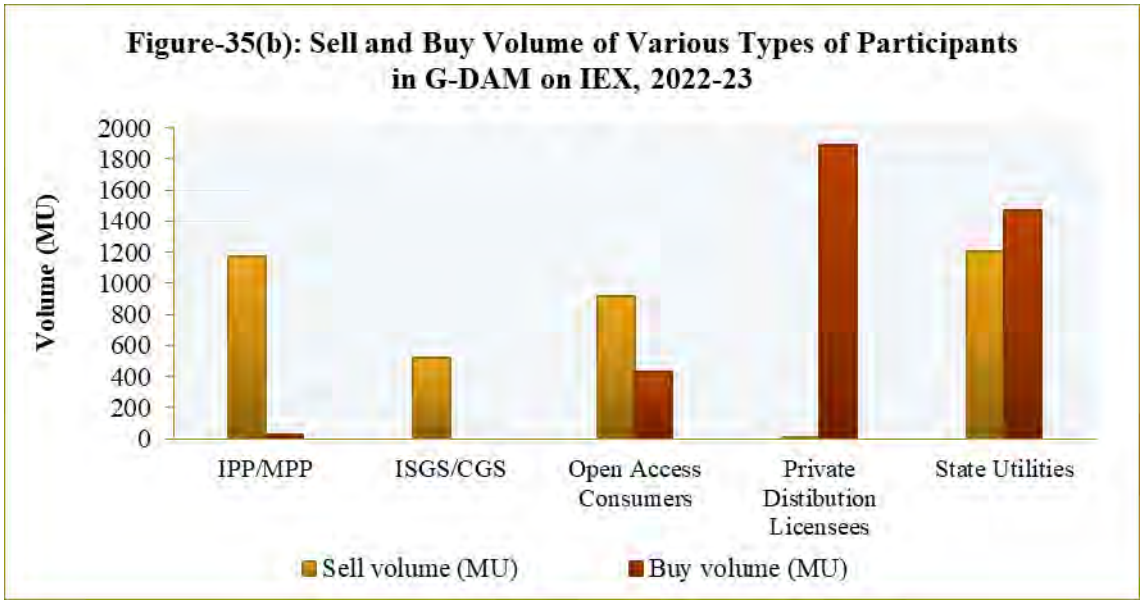
7. Open Access Consumers on Power Exchanges

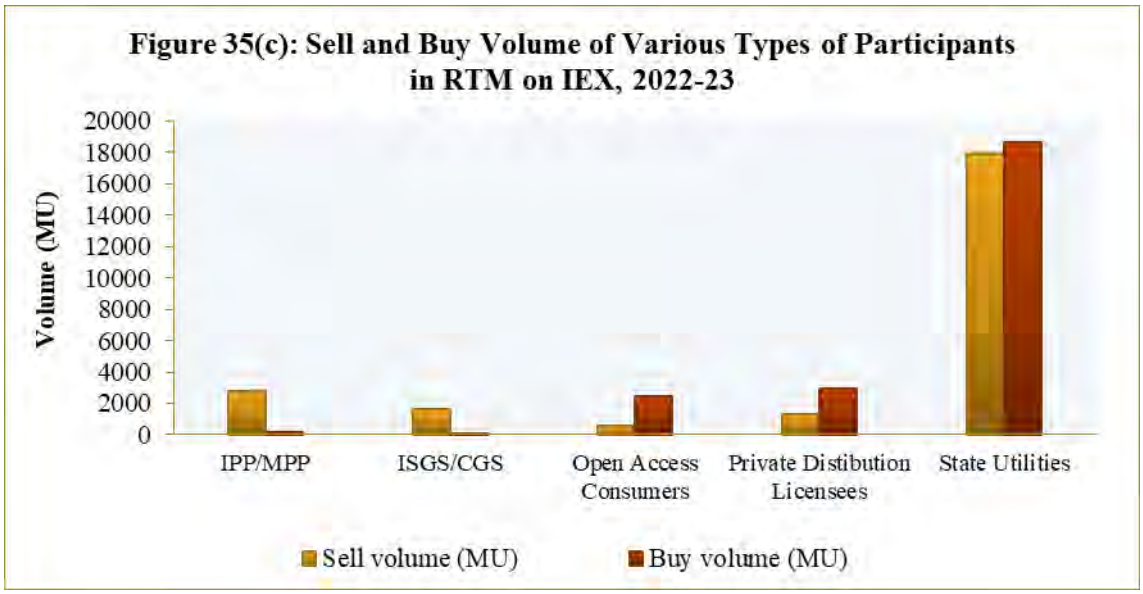
This section discusses the various types of participants in power exchanges and provides analysis of open access consumers in DAM, G-DAM and RTM segments of power exchanges (Open Access consumers include Industrial Consumers and Captive Power Plants).

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

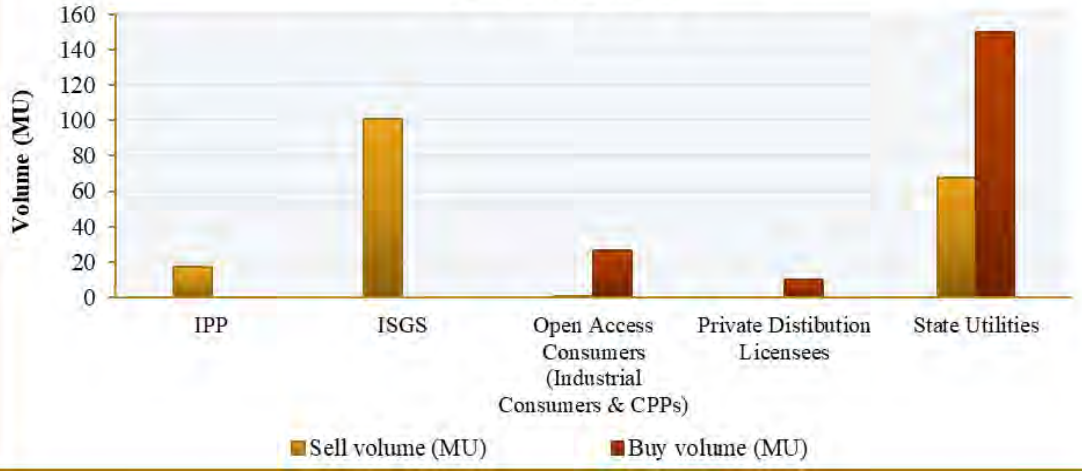


Figure-36(b): Sell and Buy Volume of Various Types of Participants in GDAM on PXIL, 2022-23

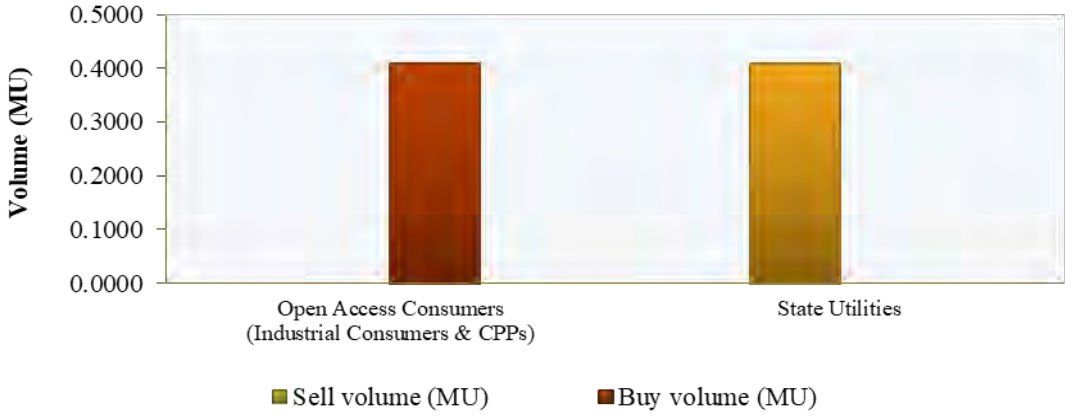
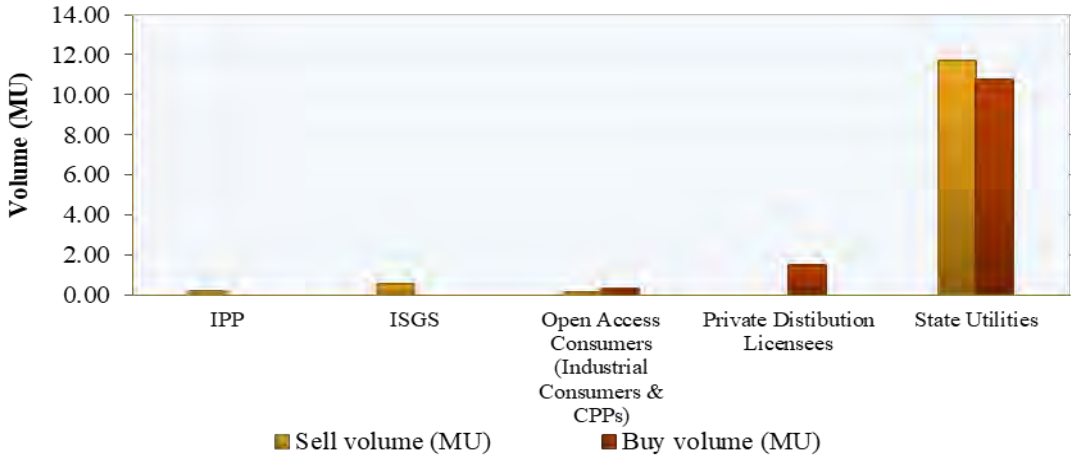
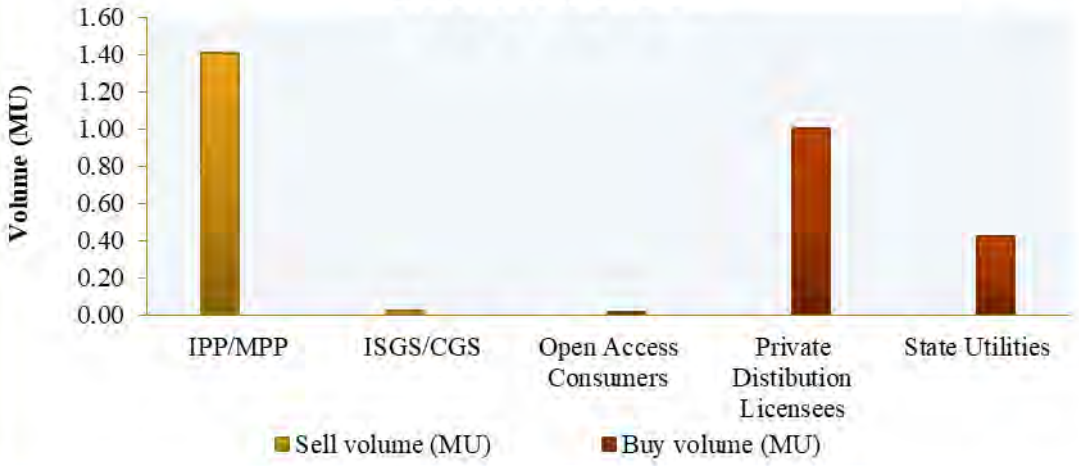


Figure-36(c): Sell and Buy Volume of Various Types of Participants in RTM on PXIL, 2022-23



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.

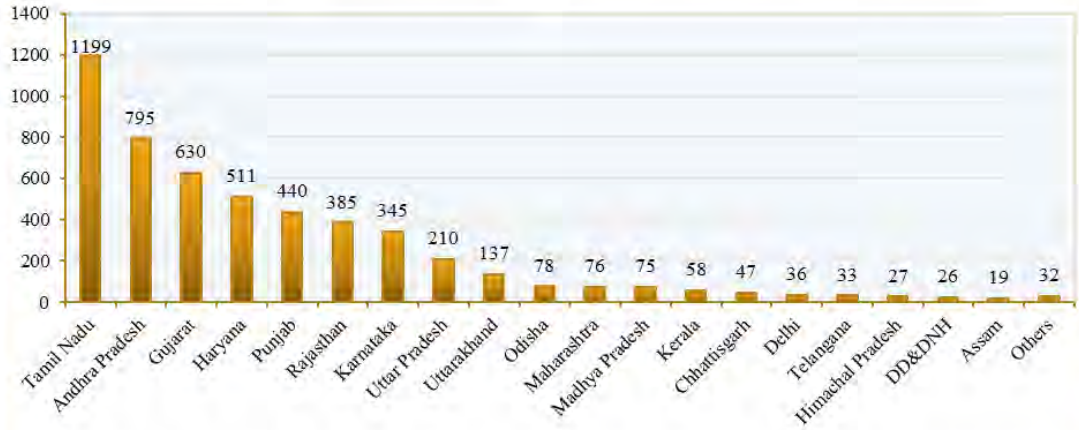
Table-21: Number of Open Access Consumers in Power Exchanges, 2010-11 to 2022-23

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

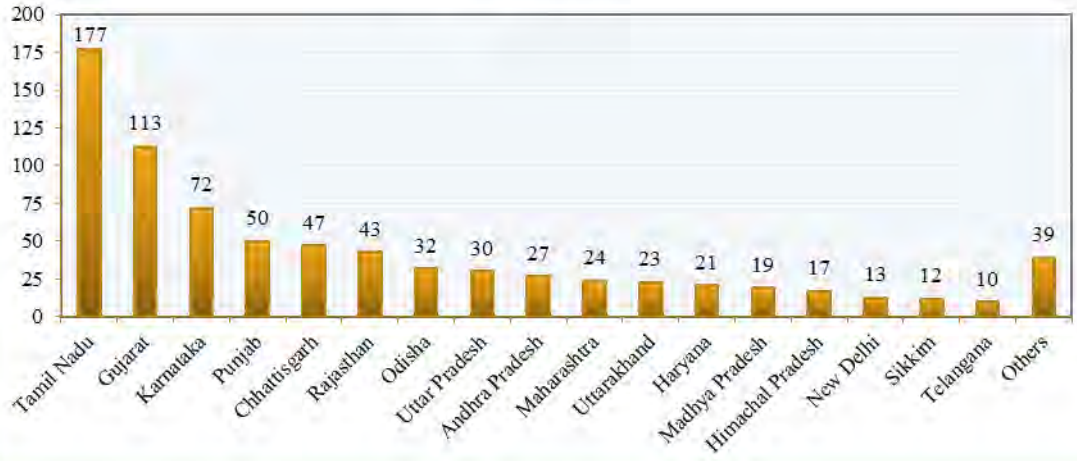
As on March 2023, there were about 5159 OA consumers at IEX. These consumers were mostly located in Tamil Nadu, Andhra Pradesh, Gujarat, Haryana and Punjab (Figure-38). The weighted average price of electricity bought by OA consumers at IEX (₹3.92/kWh) was lower when compared to the weighted average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

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



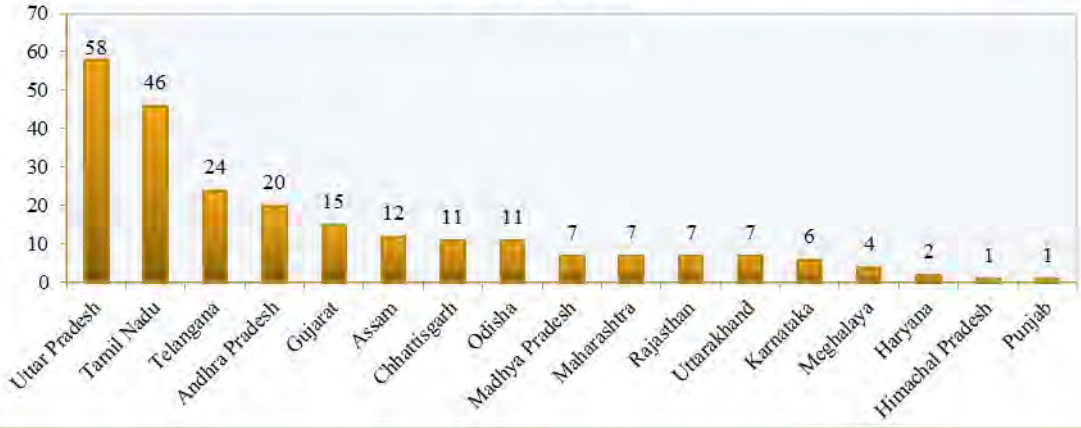
As on March 2023, there were about 769 OA consumers at PXIL. These consumers were mostly located in Tamil Nadu, Gujarat, Karnataka, Punjab, Chhattisgarh (Figure-39). The weighted average price of electricity bought by open access consumers at PXIL (₹4.06/kWh) was lower when compared to the weighted average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