Report on Short-Term Power Market in India: 2020-21

Economics Division
Central Electricity Regulatory Commission

Report on
Short-Term Power Market in India
2020-21

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Contents

S.No.	Particulars	Page No.
	Contents	i
	List of Tables	iii
	List of Figures	vi
	Preface	ix
	Abbreviations	xi
	Executive Summary	xvi
	Chapter-I: Overview of Power Sector	
1	**Generation**	1
2	**Transmission**	6
3	**Distribution**	9
	Chapter-II: Short-term Power Market in India	
1	**Introduction**	14
2	**Yearly Trends in Short-term Transactions of Electricity (2010-11 to 2020-21)**	16
2.1	Total Short-term Transactions of Electricity with respect to Total Electricity Generation	17
2.1.1	*Electricity Transacted through Traders and Power Exchanges*	18
2.1.2	*Electricity Transacted through DSM*	22
2.1.3	*Electricity Transacted Directly between DISCOMs*	23
3	**Monthly Trends in Short-term Transactions of Electricity (April 2020-March 2021)**	24
3.1	Volume of Short-term Transactions of Electricity	25
3.2	Price of Short-term Transactions of Electricity	29
3.3	Volume of Electricity Transacted in various Price Slabs	31
4	**Daily Trends in Short-term Transactions of Electricity (1st April 2020 to 31st March 2021)**	34
4.1	Volume of Short-term Transactions of Electricity	34
4.2	Price of Short-term Transactions of Electricity	35
4.2.1	*Price and its volatility in Power Exchanges*	35
4.2.2	*Price and its volatility in DSM*	37

S.No.	Particulars	Page No.
5	**Time of the Day Variation in Volume and Price of Electricity Transacted through Traders and Power Exchanges**	37
5.1	Time of the Day Variation in Volume and Price of Electricity Transacted through Traders	38
5.2	Time of the Day Variation in Volume and Price of Electricity Transacted through Power Exchanges	38
6	**Trading Margin Charged by Trading Licensees**	42
7	**Open Access Consumers on Power Exchanges**	44
7.1	Types of Participants in Power Exchanges	44
7.2	Analysis of Open Access Consumers on Power Exchanges	46
8	**Major Sellers and Buyers of Electricity in the Short-term market**	49
9	**Effect of Congestion on the Volume of Electricity Transacted through Power Exchanges**	56
10	**Ancillary Services Operations**	59
10.1	Background	59
10.2	Regulatory Framework of Ancillary Services	60
10.3	RRAS Instructions issued by Nodal Agency	62
10.4	RRAS Accounting and Settlement	62
	Chapter-III: Cross Border Trade of Electricity	
1	**Background**	66
2	**Cross Border Trade of Electricity**	67
	Chapter-IV: Tariff of Long-term Sources of Power	
1	**Background**	69
2	**Tariff of Central Public Sector power generating companies**	70
	Chapter-V: Trading of Renewable Energy Certificates	
1	**Renewable Energy Certificate Mechanism**	75
2	**Trading of Renewable Energy Certificates**	76
	Annexure-I: List of Transmission Licensees as on 31.03.2021	82
	Annexure-II: List of Trading Licensee as on 31.03.2021	84
	Annexure-III: Historical Volatility Formula	85
	Annexure-IV: Herfindahl-Hirschman Index	86

List of Tables

Table No.	Details	Page No.
Table-1	Installed Electricity Generation Capacity in India (GW), 2009-10 to 2020-21	1
Table-2	Sector-wise Growth of Installed Electricity Generation Capacity, 2009-10 to 2020-21	3
Table-3	Gross Electricity Generation in India (BU), 2009-10 to 2020-21	4
Table-4	Power Supply Position in India, 2009-10 to 2020-21	5
Table-5	Growth of Transmission System in India, 2009-10 to 2020-21	7
Table-6	Annual Transmission Charges, 2011-12 to 2020-21	8
Table-7	Growth of Electricity Consumption in India (Consumer category-wise) (BU), 2009-10 to 2019-20	10
Table-8	Average Cost of Supply and Average Revenue of State Power Utilities, 2009-10 to 2019-20	11
Table-9	Volume of Short-term Transactions of Electricity with respect to Total Electricity Generation, 2010-11 to 2020-21	17
Table-10	Volume of Electricity Transacted through Traders and Power Exchanges (BU), 2010-11 to 2020-21	18
Table-11	Electricity Transacted through Traders and Power Exchanges as % of Total Short-Term Transactions, 2010-11 to 2020-21	19
Table-12	Price of Electricity Transacted through Traders and Power Exchanges, 2010-11 to 2020-21	20
Table-13	Volume of Electricity Transacted through Traders and Power Exchanges (BU), 2010-11 to 2020-21	21
Table-14	Volume and Price of Electricity Transacted through DSM, 2010-11 to 2020-21	22
Table-15	Volume of Electricity Transacted Directly between DISCOMs	23
Table-16	Volume of Short-term Transactions of Electricity (BU), 2020-21	25
Table-17	Volume of Short-term Transactions of Electricity as % of Total Electricity Generation, 2020-21	26
Table-18	Share of Electricity Transacted by Traders and HHI, 2020-21	27

Table No.	Details	Page No.
Table-19	Price of Short-term Transactions of Electricity (₹/kWh), 2020-21	29
Table-20	Trading Margin Charged by Trading Licensees, 2010-11 to 2020-21	43
Table-21	Number of Open Access Consumers in Power Exchanges, 2010-11 to 2020-21	46
Table-22(a)	Volume of Purchase by Open Access Consumers in Day Ahead Market of Power Exchanges, 2010-11 to 2020-21	48
Table-22(b)	Volume of Purchase by Open Access Consumers in Real Time Market of Power Exchanges, 2020-21	49
Table-23	Major Sellers of Electricity through Traders, 2020-21	50
Table-24	Major Buyers of Electricity through Traders, 2020-21	50
Table-25(a)	Major Sellers of Electricity in Day Ahead Market of IEX, 2020-21	51
Table-25(b)	Major Sellers of Electricity in Real Time Market of IEX, 2020-21	52
Table-26(a)	Major Buyers of Electricity in Day Ahead Market of IEX, 2020-21	52
Table-26(b)	Major Buyer of Electricity in Real Time Market of IEX, 2020-21	53
Table-27(a)	Major Sellers of Electricity in Day Ahead Market of PXIL, 2020-21	54
Table-27(b)	Major Sellers of Electricity in Real Time Market of PXIL, 2020-21	54
Table-28(a)	Major Buyers of Electricity in Day Ahead Market of PXIL, 2020-21	55
Table-28(b)	Major Buyer of Electricity in Real Time Market of PXIL, 2020-21	55
Table-29	Effect of Congestion on the Volume of Electricity Transacted through Power Exchanges, 2010-11 to 2020-21	57
Table-30	Details of Congestion in Power Exchanges, 2020-21	57

Table No.	Details	Page No.
Table-31	Congestion Charges of Power Exchanges, 2010-11 to 2020-21	58
Table-32	Maximum Ancillary despatched in a Time Block (MW), 2020-21	62
Table-33	Energy Scheduled and Payments made for Ancillary Services, 2016-17 to 2020-21	63
Table-34	Cross Border Trade of Electricity between India and its Neighbouring Countries, 2013-14 to 2020-21 (BU)	67
Table-35	Tariff of Central Thermal Power Stations, 2020-21	70
Table-36	Composite Tariff of Central Hydro Power Stations, 2020-21	73
Table-37	Floor and Forbearance Price applicable for REC Transactions	76
Table-38	Growth of RECs transacted on Power Exchanges, 2011-12 to 2020-21	77
Table-39	Demand and Supply of RECs on Power Exchanges, 2012-13 to 2020-21	78
Table-40	Volume and Price of RECs transacted on Power Exchanges, 2012-13 to 2020-21	79
Table-41	Long-term Growth Trajectory of RPOs	81

List of Figures

Figure No.	Details	Page No.
Figure-1	Installed Electricity Generation Capacity in India (%), 2009-10 to 2020-21	2
Figure-2	Sector-wise Growth of Installed Electricity Generation Capacity (%), 2009-10 to 2020-21	4
Figure-3	Gross Electricity Generation in India (%), 2009-10 to 2020-21	5
Figure-4	Energy Deficit and Peak Deficit in India, 2009-10 to 2020-21	6
Figure-5	Growth of Transmission System in India, 2009-10 to 2020-21	8
Figure-6	Growth of Electricity Consumption in India (Consumer category-wise), 2009-10 to 2019-20	10
Figure-7	Average Cost of Supply and Average Revenue of State Power Utilities, 2009-10 to 2019-20	12
Figure-8	Volume of Electricity Transacted through Traders and Power Exchanges, 2010-11 to 2020-21	19
Figure-9	Price of Electricity Transacted through Traders and Power Exchanges, 2010-11 to 2020-21	21
Figure-10	Volume and Price of Electricity transacted through DSM	23
Figure-11	Volume of Electricity Transacted Directly between DISCOMs	24
Figure-12	Share of Market Segments in Total Electricity Generation, 2020-21	24
Figure-13	Share of Market Segments in Short-Term Transactions, 2020-21	25
Figure-14	Volume of Short-term Transactions of Electricity, 2020-21	26
Figure-15	Share of Electricity transacted by Traders, 2020-21	28
Figure-16	Concentration of Market Power in Bilateral Transactions through Traders, 2010-11 to 2020-21	29
Figure-17	Comparison of Price of Bilateral, Power Exchange and DSM Transactions in 2020-21	30
Figure-18	Price of Electricity Transacted through Traders during Round the Clock, Peak and Off Peak periods	31

Figure No.	Details	Page No.
Figure-19	Volume of Bilateral Transaction at different Price Slabs, 2020-21	32
Figure-20(a)	Volume of IEX Transactions in Day Ahead Market at different Price Slabs, 2020-21	32
Figure-20(b)	Volume of IEX Transactions in Real Time Market at different Price Slabs, 2020-21	33
Figure-21(a)	Volume of PXIL Transactions in Day Ahead Market at different Price Slabs, 2020-21	33
Figure-21(b)	Volume of PXIL Transactions in Real Time Market at different Price Slabs, 2020-21	34
Figure-22	Volume of Short-term Transactions of Electricity, 2020-21	34
Figure-23(a)	Price and its Volatility in DAM on IEX during 2020-21	35
Figure-23(b)	Price and its Volatility in RTM on IEX during 2020-21	35
Figure-24(a)	Price and its Volatility in DAM on PXIL during 2020-21	36
Figure-24(b)	Price and its Volatility in RTM on PXIL during 2020-21	36
Figure-25	Price and its Volatility in DSM during 2020-21	37
Figure-26	Volume and Price of Electricity Transacted through Traders during RTC, Peak and OTP, 2020-21	38
Figure-27(a)	Block-wise Market Clearing Volume and Price in DAM on IEX during 2020-21	39
Figure-27(b)	Block-wise Market Clearing Volume and Price in RTM on IEX during 2020-21	39
Figure-28(a)	Block-wise Market Clearing Volume and Price in DAM on PXIL during 2020-21	39
Figure-28(b)	Block-wise Market Clearing Volume and Price in RTM on PXIL during 2020-21	40
Figure-29(a)	Region-wise and Block-wise Price of Electricity Transacted in DAM through IEX, 2020-21	40
Figure-29(b)	Region-wise and Block-wise Price of Electricity Transacted in RTM through IEX, 2020-21	41
Figure-30(a)	Region-wise and Block-wise Price of Electricity Transacted	41

Figure No.	Details	Page No.
	in DAM through PXIL, 2020-21	
Figure-30(b)	Region-wise and Block-wise Price of Electricity Transacted in RTM through PXIL, 2020-21	41
Figure-31	Trading Margin Charged by Trading Licensees, 2010-11 to 2020-21	43
Figure-32(a)	Sell and Buy Volume of various types of Participants in DAM on IEX, 2020-21	44
Figure-32(b)	Sell and Buy Volume of various types of Participants in RTM on IEX, 2020-21	45
Figure-33(a)	Sell and Buy Volume of various types of Participants in DAM on PXIL, 2020-21	45
Figure-33(b)	Sell and Buy Volume of various types of Participants in RTM on PXIL, 2020-21	46
Figure-34	State-wise Number of Open Access Consumers in IEX, March 2021	47
Figure-35	State-wise Number of Open Access Consumers in PXIL, March 2021	48
Figure-36	Energy scheduled to/from Virtual Ancillary Entity under RRAS (MU), 2020-21	64

Preface

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

The Central Electricity Regulatory Commission sets the regulatory process in motion through Trading License Regulations, Open Access Regulations, Power Market Regulations, and Deviation Settlement Mechanism Regulations. Under these regulations, short-term power market covers contracts of less than a year for electricity transacted through Inter-State Trading Licensees and directly by the Distribution Licensees, Power Exchanges, and Deviation Settlement Mechanism. The short-term power market as an integral part of the power sector has been beneficial for meeting the short-term needs of the consumers, suppliers, and the sector as a whole. It constitutes about 10.6 per cent of the total electricity generation in India in the year 2020-21.

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

volume of electricity traded on power exchanges, and ancillary services operations. The report also covers cross border trade of electricity between India and its neighbouring countries, tariff of long-term sources of power and analysis on transactions of Renewable Energy Certificates.

In order to ensure ease of access, this report is also made available on the CERC website www.cercind.gov.in. We are confident that market participants and stakeholders will find the Report on Short-term Power Market in India, 2020-21 useful.

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Abbreviations

Abbreviation	Expanded Version
AC	Alternating Current
ACE	Area Control Error
AGC	Automatic Generation Control
APCPDCL	Andhra Pradesh Central Power Distribution Company Limited
APDCL	Assam Power Distribution Company Ltd
APL	Above Poverty Line
APPCC	Andhra Pradesh Power Coordination Committee
APSPDCL	Andhra Pradesh Southern Power Distribution Company Limited
APTEL	Appellate Tribunal for Electricity
AT&C	Aggregate Technical and Commercial
Block	15 Minutes Time Block
BSPHCL	Bihar State Power Holding Company Limited
BU	Billion Units (Billion kWh)
CAGR	Compound Annual Growth Rate
CBTE	Cross Border Trade of Electricity
CCGT	Combined Cycle Gas Turbine
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CGS	Central Generating Station
CGSEB	Chhattisgarh State Electricity Board
Ckm	Circuit km
CPP	Captive Power Producer/Plant
CSPDCL	Chhattisgarh State Power Distribution Company Limited
CTU	Central Transmission Utility
DAM	Day Ahead Market
DDUGJY	Deendayal Upadhyaya Gram Jyoti Yojana
DISCOMs	Distribution Companies
DSM	Deviation Settlement Mechanism
DVC	Damodar Valley Corporation
EDCL	Energy development Company Limited
ER	Eastern Region

Abbreviation	Expanded Version
ERSS	Eastern Region Strengthening Scheme
FCAS	Frequency Control Ancillary Services
FGUTPS	Firoz Gandhi Unchahar Thermal Power Station
FRAS	Fast Response Ancillary Services
GOHP/GoHP	Government of Himachal Pradesh
GPS	Gas Power Station
GRIDCO	GRIDCO Limited
GTAM	Green Term Ahead Market
GUVNL	Gujarat Urja Vikas Nigam Limited
GW	Giga Watts
HEP	Hydro Electric Project
HHI	Herfindahl-Hirschman Index
HP	Himachal Pradesh
HPO	Hydro Purchase Obligation
HPP	Hydroelectric Power Plant
HPSEB	Himachal Pradesh State Electricity Board
HVDC	High-Voltage Direct Current
IEGC	Indian Electricity Grid Code
IEX	Indian Energy Exchange
IPDS	Integrated Power Development Scheme
IPP	Independent Power Producers
ISGS	Inter State Generating Station
ISTS	Inter State Transmission System
J&K PDD	Jammu & Kashmir Power Development Department
JKPCL	Jammu Kashmir Power Corporation Ltd.
JBVNL	Jharkhand Bijli Vitran Nigam Limited
KSEB	Kerala State Electricity Board
KV	Kilovolt
kWh	Kilo Watt Hour
LDP	Low Dam Project
LTA	Long Term Access
Ltd	Limited
MCP	Market Clearing Price
MOP	Ministry of Power

Abbreviation	Expanded Version
MPDCL	Meghalaya Power Distribution Corporation Limited
MPP	Merchant Power Plant
MPPGCL	Madhya Pradesh Power Generating Company Limited
MPPMCL	MP Power Management Company Limited
MU	Million Units
MVA	Mega Volt Ampere
MW	Mega Watts
MWh	Mega Watt Hour
NCAS	Network Control Ancillary Services
NCTP	National Capital Thermal Power Plant
NEEPCO	North Eastern Electric Power Corporation Limited
NER	North Eastern Region
NEW Grid	North-East-North East-West Grid
NHDC	National Hydro Development Corporation Limited
NHPC	NHPC Limited
NLC	NLC India Limited
NLDC	National Load Dispatch Centre
NR	Northern Region
NRSS	Northern Region Strengthening Scheme
NSGM	National Smart Grid Mission
NTPC	NTPC Limited
NTPL	NLC Tamil Nadu Power Limited
OA	Open Access
OAC	Open Access Consumer
OTP	Other than RTC and Peak period
OTPC	ONGC Tripura Power Company
PCKL	Power Company of Karnataka Limited
PFC	Power Finance Corporation
PGCIL/POWERGRID	Power Grid Corporation of India Limited
POSOCO	Power System Operation Corporation Limited
PSPCL	Punjab State Power Corporation Limited
PX	Power Exchange
PXIL	Power Exchange India Limited

Abbreviation	Expanded Version
RE	Renewable Energy
REC	Renewable Energy Certificate
RES	Renewable Energy Sources
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
RGPS	Ratnagiri Gas Power Station
RLDC	Regional Load Despatch Centre
ROR	Run of River
RPC	Regional Power Committee
RPO	Renewable Purchase Obligation
RRAS	Reserves Regulation Ancillary Services
RTC	Round The Clock
RTM	Real Time Market
RUVNL	Rajasthan Urja Vikas Nigam Limited
S1	Southern Region 1
S2	Southern Region 2
S3	Southern Region 3
SAARC	South Asian Association for Regional Cooperation
SEB	State Electricity Board
SJVNL	Satluj Jal Vidyut Nigam Limited
SRAS	System Restart Ancillary Services
SR Grid	Southern Region Grid
St	Stage
STPP	Super Thermal Power Plant
STPS	Super Thermal Power Station
TAM	Term Ahead Market
TANGEDCO	Tamil Nadu Generation and Distribution Corporation
THDC	Tehri Hydro Development Corporation Limited
TNEB	Tamil Nadu Electricity Board
TPP	Thermal Power Plant
TPS	Thermal Power Station
TSSPDCL	Telangana Southern Power Distribution Company Limited
TSPCC	Telangana State Power Coordination Committee
UDAY	Ujwal DISCOM Assurance Yojana

Abbreviation	Expanded Version
UPPCL	Uttar Pradesh Power Corporation Limited
UPCL	Uttarakhand Power Corporation Limited
VAE	Virtual Ancillary Entity
W1	Western Region 1
W2	Western Region 2
WBSEDCL	West Bengal State Electricity Distribution Company Ltd
WR	Western Region
WRSS	Western Region Strengthening Scheme

Executive Summary

The report comprises of overview of power sector, trends in short-term power market in India, cross border trade of electricity, tariff of long-term sources of power and transactions of renewable energy certificates. The overview of power sector highlights electricity generation, transmission and distribution, including revenue gap of state electricity distribution companies (DISCOMs)/ SEBs and the measures taken by the Government of India in the recent years. The salient features of the power sector are as under:

1. Thermal energy (mainly from Coal) is an important source of electricity generation in India, contributing about 61.4% of the total installed generation capacity in 2020-21, followed by Renewable Energy Source (RES) (24.7%), Hydro (12.1%), and Nuclear (1.8%).

2. The Compound Annual Growth Rate (CAGR) of total installed generation capacity was 8.3% during the period from 2009-10 to 2020-21. The CAGR in RES was 17.8% whereas it was 6.5% in all other sources during the period.

3. During the period from 2009-10 to 2020-21, share of State sector in the total installed generation capacity declined from 52% to 27% and share of central sector has declined from 30% to 26%, while share of private sector increased from 18% to 47%. However, the public sector continues to be the largest owner, holding 53% share in 2020-21.

4. Gross electricity generation in India increased from 805.26 BU in 2009-10 to 1380.06 BU in 2020-21 and it increased at a CAGR of 5.0%.

5. The annual growth in gross electricity generation was relatively low (5.0%) when compared with the annual installed electricity generation capacity (8.3%). This could be mainly due to (i) increase in capacity from RES with low utilization factor; and (ii) decrease in PLF of thermal generation.

6. Increase in the installed capacity resulted in decrease in the demand shortage (energy and peak shortage). The energy shortage decreased from 10.1% in 2009-10 to about 0.4% in 2020-21. During the period, the peak shortage decreased from 12.7% to 0.4%.

7. During 2009-10 to 2020-21, the annual growth in the bulk transmission was 6%, while the annual growth in the transmission capacity of substations was 11%.

8. The annual transmission charges increased at CAGR of 18.75% during the period from 2011-12 to 2020-21.

9. The total electricity consumption increased from 653.24 BU in 2009-10 to 1291.49 BU in 2019-20 (Estimated) registering an annual growth of 7.1%. During the period, per-capita consumption of electricity also increased from 779 kWh to 1208 kWh at an annual growth of 4.5%.

10. All India average cost of supply and average revenue (without subsidy) of state power utilities increased from ₹3.55/kWh and ₹2.68/kwh, respectively, in 2009-10 to ₹6.15/kWh and ₹4.93/kWh, respectively, in 2020-21. During the latest 5 years, the revenue as percentage of cost was varying between 78% and 81%. This means, the weighted average tariff for all categories of consumers was about 20% lower than the weighted average cost of supply.

'Short-term transactions of electricity' refers to contracts of less than one year period for electricity transacted under bilateral transactions through Inter-State Trading Licensees (only inter-State part) and directly by the Distribution Licensees (also referred as Distribution Companies or DISCOMs), Power Exchanges {Indian Energy Exchange Ltd. (IEX) and Power Exchange India Ltd. (PXIL)}, and Deviation Settlement Mechanism (DSM). The analysis of short-term power market includes: (i) yearly/monthly/daily trends in short-term transactions of electricity; (ii) time of the day variation in volume and price of electricity transacted through traders and power exchanges; (iii) trading margin charged by trading licensees for bilateral transactions (iv) analysis of open access consumers on power exchanges; (v) major sellers and buyers of electricity in the short term market; (vi) effect of congestion on volume of electricity transacted through power exchanges; and (vii) ancillary services operations. Salient features of the short-term power market are as under:

1. Of the total electricity procured in India in 2020-21, the short-term power market comprised about 10.6%. The balance 89.4% of generation was procured mainly by distribution companies through long-term contracts and short-term intra-State transactions.

2. During 2010-11 to 2020-21, the volume of short-term transactions of electricity increased at a higher rate (CAGR of 6.0%) when compared with the gross electricity generation (CAGR of 4.9%).

3. In terms of volume, the size of the short-term market in India was 146.01 BU in the year 2020-21. As compared to the volume of electricity transacted through short-term market in the year 2019-20 (137.16 BU), this was about 6.5% higher.

4. Excluding DSM and direct bilateral sale between the DISCOMs, the volume of electricity transacted was 106.26 BU in 2020-21. This was about 23% higher than in 2019-20. In monetary terms, the size of this segment of the short-term market was ₹32,976 crore in the year 2020-21[1], which was 4% more than in the year 2019-20. The increase in size of the market was mainly due to significantly increased volumes transacted through both traders and power exchanges in 2020-21.

5. The volume of electricity transacted through power exchanges increased at a CAGR of 18%, whereas the volume of electricity transacted through traders registered a decline of 0.4% during 2010-11 to 2020-21.

6. The volume of DSM in 2020-21 increased marginally by 1% over that in 2019-20. The share of DSM as a percentage of total volume of short-term transactions of electricity continued a downward trend in past years and it declined from 34.4% in 2010-11 to 15.7% in 2020-21.

7. In terms of volume, the direct bilateral transactions between DISCOMs witnessed a decrease of about 40% in 2020-21 as compared to 2019-20. The share of direct

[1]*Excluding transactions pertaining to banking transactions.*

bilateral transactions between DISCOMs as a percentage of total short term transaction volume decreased from 12.6% in 2010-11 to 11.5% in 2020-21. This shows the increasing reliance of DISCOMs on the market for their power requirement.

8. The weighted average price of electricity transacted through power exchanges was ₹2.98/kWh and through trading licensees it was ₹3.47/kWh in 2020-21. The corresponding values for the year 2019-20 were ₹3.24/kWh and ₹4.51/kWh, respectively. Two new market segments were introduced on the power exchanges – Real Time Market (June 2020 onwards) and Green Term Ahead Market (August 2020 onwards) in 2020-21. In the year 2020-21, the weighted average prices of electricity transacted through Day Ahead Market, Real Time Market, Term Ahead Market and Green Term Ahead Market sub-segment of the power exchanges were ₹2.99/kWh, ₹3.06/kWh, ₹2.82/kWh and ₹3.81/kWh, respectively.

9. The average price of DSM increased from December 2018 onwards as the DSM price vector was linked to daily average Area Clearing Price of power exchanges through CERC Deviation Settlement Mechanism and Related Matters (Fourth Amendment) Regulations, issued in November 2018. These regulations came into force with effect from 1st January 2019. The price of DSM decreased from ₹2.85/kWh in 2019-20 to ₹2.82/kWh in 2020-21.

10. During 2020-21, about 100% of the volume of electricity transacted through traders was at a price less than ₹6/kWh. About 75% of the volume was transacted at a price less than ₹4/kWh.

11. In Day Ahead Market, during 2020-21, IEX transacted 98% of the volume of electricity at a price less than ₹6/kWh while about 88% of the volume was transacted at a price less than ₹4/kWh. While, PXIL transacted 100% of the volume of electricity at a price less than ₹6/kWh while about 90% of the volume was transacted at less than ₹4/kWh.

12. In Real Time Market, during 2020-21, IEX transacted 96% of the volume of electricity at a price less than ₹6/kWh while about 88% of the volume was transacted at a price

less than ₹4/kWh. While, PXIL transacted 100% of the volume of electricity at a price less than ₹6/kWh while about 80% of the volume was transacted at less than ₹4/kWh.

13. During 2020-21, of the total electricity bought under bilateral transactions from traders, 58% was on round the clock (RTC) basis, followed by 40% in periods other than RTC and peak (OTP) and 2% was during peak hours. The per unit price of electricity procured during Peak period was high (₹ 4.00/kWh) when compared with the price during RTC (₹3.38/kWh) and OTP (₹3.50/kWh).

14. It is observed from the block-wise and region-wise prices of electricity transacted through power exchanges in 2020-21, that the price of electricity in Southern Region was marginally higher than the price in other regions during peak period.

15. During 2010-11 to 2020-21, number of traders who were undertaking trading increased from 19 to 25. HHI, based on volume of electricity transacted in short-term through traders, declined marginally from 0.1944 in 2010-11 to 0.2161 in 2020-21. The concentration of market power was moderate during the period. The competition among the traders resulted in an increase in volume and decrease in prices in the short-term bilateral market.

16. The weighted average trading margin charged by the trading licensees in 2020-21 was ₹0.024/kWh, which is in line with the CERC Trading License Regulations, 2020.

17. The procurement of power by the industrial consumers through power exchanges began in the year 2009. In both the Power Exchanges, Open Access industrial consumers bought 15.16 BU of electricity, which formed 22% of the total day ahead and real time market volume transacted in the power exchanges during 2020-21.

18. The weighted average price of electricity bought by open access consumers at IEX and PXIL was lower (₹2.64/kWh and ₹2.78/kWh respectively) compared to the weighted average price of total electricity transacted through IEX and PXIL (₹3.00/kWh and ₹2.98/kWh respectively) in 2020-21.

19. The year witnessed very few constraints on the volume of electricity transacted through power exchanges, mainly due to transmission congestion. During 2020-21, the actual transacted volume was about 0.06% less than the unconstrained volume. Because of congestion and the splitting of market at both the power exchanges, the congestion amount collected during the year was ₹70.96 crore.

20. The energy scheduled under Regulation UP of RRAS decreased from 2212.28 MU in 2016-17 to 1649.50 MU in 2020-21. The energy scheduled under Regulation DOWN of RRAS increased from 286.00 MU in 2016-17 to 2940.01 MU in 2020-21.

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

1. India has been importing electricity from Bhutan and exporting electricity to Bangladesh, Nepal, and Myanmar. India was net importer of electricity from 2013-14 to 2015-16 and net exporter of electricity from 2016-17 to 2020-21.

2. During 2020-21, no trading session of RECs was held since July 2020 as the latest Order of CERC notifying the floor and forbearance price was sub-judice. In 2020-21, till July 2020, the number of Solar RECs transacted on power exchanges were 1.52 lakh and the weighted average market clearing price of these RECs was ₹1447/MWh. During the same period, the number of Non-Solar RECs transacted on power exchanges were 7.69 lakh and the weighted average market clearing price of these RECs was ₹1000/MWh.

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Chapter-I

Overview of Power Sector

The dynamics of Indian power sector have evolved over the years. Growing needs of economy have led to increase in electricity demand which has been catered to by the continual addition in generation and transmission capacities. The entire electricity supply chain has undergone a phase of transformation in the process of advancing reforms in the sector. The focus remains on ensuring universal supply of electricity in an efficient and competitive manner, while increasing emphasis on renewable energy.

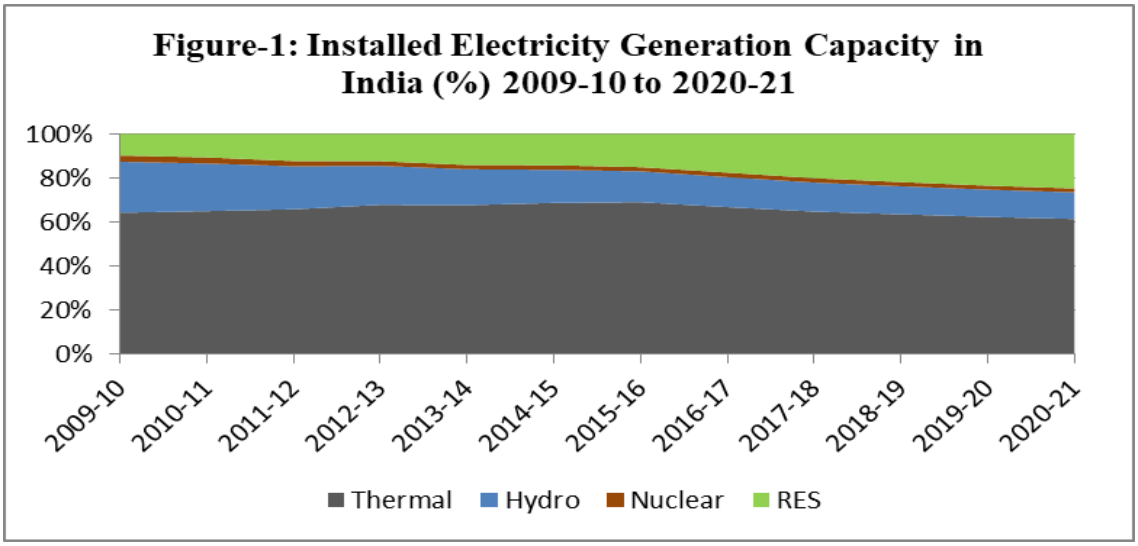
1. Generation

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

Table-1: Installed Electricity Generation Capacity in India (GW), 2009-10 to 2020-21

Year	Thermal	Hydro	Nuclear	RES	Total
2009-10	102.45	36.86	4.56	15.52	159.40
2010-11	112.82	37.57	4.78	18.45	173.63
2011-12	131.60	38.99	4.78	24.50	199.88
2012-13	151.53	39.49	4.78	27.54	223.34
2013-14	168.26	40.53	4.78	34.99	248.55
2014-15	188.90	41.27	5.78	38.96	274.90
2015-16	210.68	42.78	5.78	45.92	305.16
2016-17	218.33	44.48	6.78	57.24	326.83
2017-18	222.91	45.29	6.78	69.02	344.00
2018-19	226.28	45.40	6.78	77.64	356.10
2019-20	230.81	45.70	6.78	86.76	370.05
2020-21*	234.73	46.21	6.78	94.43	382.15

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



As can be seen in Figure-1, thermal is the most important source of electricity generation in India, contributing about 61.4% of the total capacity of generation in 2020-21, followed by Renewable Energy Source (RES) (24.7%), Hydro (12.1%) and Nuclear (1.8%). The percentage share of thermal based generation capacity increased from 64.3% in 2009-10 to 69.0% in 2015-16 and then gradually declined to 61.4% by 2020-21. During the period from 2009-10 to 2020-21, the share of hydro based generation capacity decreased from 23.1% to 12.1%, whereas renewables-based generation capacity witnessed an increase from 9.7% to 24.7%. The CAGR of total installed electricity generation capacity was about 8.3% during the period as compared to 17.8% in RES and 6.5% in all other sources.

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

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

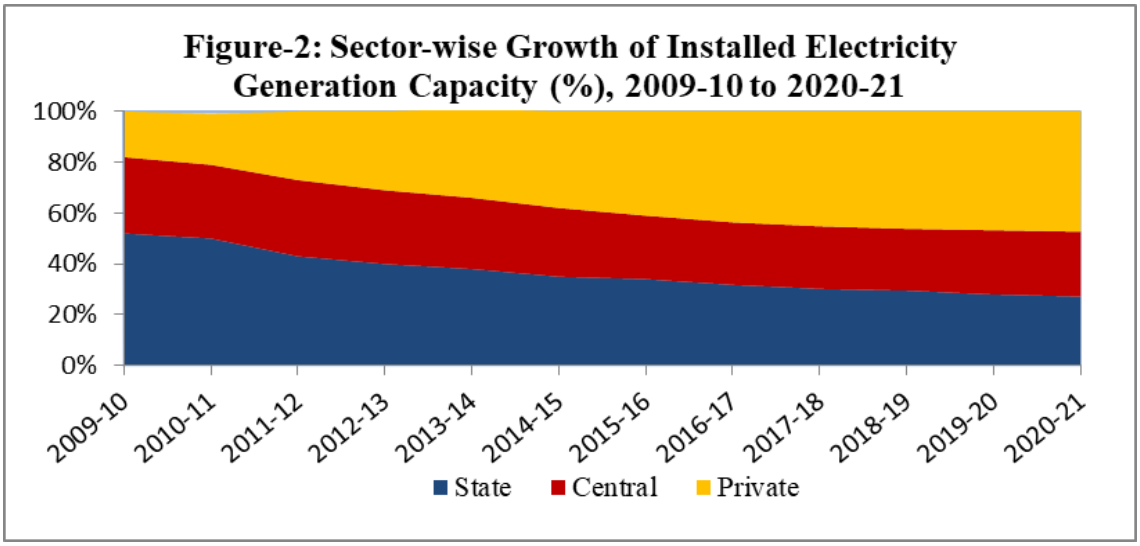
Sector-wise growth of installed generation capacity is shown in Table-2 and Figure-2. It can be observed from the table that the CAGR of total installed generation capacity was about 8.3% during the period from 2009-10 to 2020-21. During the period, the share of state sector in the total installed generation capacity has declined from 52% to 27% and the share of central sector has declined from 30% to 26%, whereas the share of private sector has increased significantly, i.e., from 18% to 47%. However, the public sector, including state and central continues to be the largest owner, holding 53% share in total installed generation capacity.

Table-2: Sector-wise Growth of Installed Electricity Generation Capacity, 2009-10 to 2020-21

Year	Installed Generation Capacity (GW)			
	State	Central	Private	Total
2009-10	82.91	47.48	29.01	159.40
2010-11	87.42	50.76	35.45	173.63
2011-12	85.92	59.68	54.28	199.88
2012-13	89.13	65.36	68.86	223.34
2013-14	92.27	68.13	84.87	245.26
2014-15	95.08	72.52	104.12	271.72
2015-16	101.79	76.30	124.00	302.09
2016-17	103.97	80.26	142.62	326.85
2017-18	103.97	84.52	155.51	344.00
2018-19	105.08	86.60	164.43	356.10
2019-20	103.53	93.48	173.04	370.05
2020-21*	103.87	97.51	180.77	382.15

* *Provisional*

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



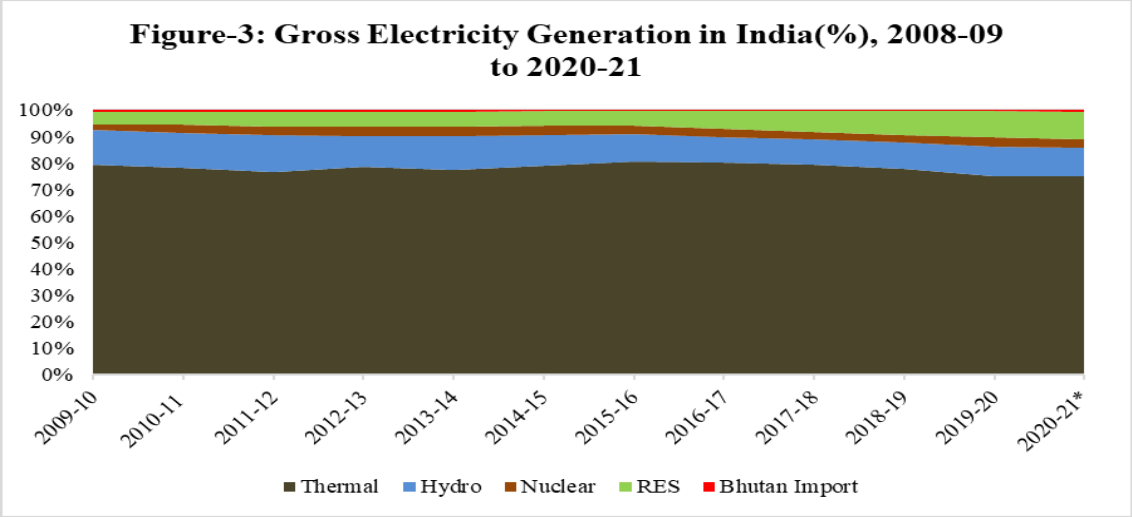
Source-wise gross electricity generation in India is shown in Table-3 and Figure-3. As may be observed from the Table-3, gross electricity generation in India has increased from 805.26 BU in 2009-10 to 1380.06 BU in 2020-21 at a CAGR of about 5.0%. The growth in gross electricity generation was low (5.0%) when compared with the growth in annual installed electricity generation capacity (8.3%). This may be primarily due to increase in capacity from RES with low utilization factor and decrease in PLF of thermal generation.

Table-3: Gross Electricity Generation in India (BU), 2009-10 to 2020-21

Year	Thermal	Hydro	Nuclear	RES	Bhutan Import	Total
2009-10	640.21	104.06	18.64	36.95	5.40	805.26
2010-11	665.00	114.30	26.30	41.15	5.60	852.35
2011-12	708.43	130.51	32.29	51.23	5.30	927.76
2012-13	760.45	113.72	32.87	57.45	4.80	969.29
2013-14	792.05	134.85	34.23	59.62	5.60	1026.35
2014-15	877.94	129.24	36.10	61.79	5.00	1110.07
2015-16	943.01	121.38	37.41	65.78	5.20	1172.78
2016-17	994.22	122.31	37.66	81.87	5.64	1241.70
2017-18	1037.06	126.12	38.35	101.84	4.78	1308.15
2018-19	1072.00	135.00	37.70	126.76	4.40	1375.86
2019-20	1044.45	155.67	46.38	138.32	5.81	1390.63
2020-21*	1032.51	150.30	43.03	145.45	8.77	1380.06

**Provisional*

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



Of all the sources, electricity generation from thermal source (mainly coal) plays a dominant role in the energy-mix, with a share of about 75% in 2020-21. Though its relative share continues to be the highest, it has shown a declining trend over the last few years mainly on account of increasing emphasis on renewable energy sources. The amount of electricity generated from RES increased from 4.6% in 2009-10 to 10.5% in 2020-21.

The increase in installed electricity generation capacity as shown in Table-1, had a positive impact on the power supply position. Both energy requirement and peak demand increased from 830.59 BU and 119.17 GW respectively in 2009-10 to 1275.53 BU and 190.20 GW, respectively in 2020-21 (Table-4). Increase in the installed capacity resulted in decrease in the energy and peak deficit from 10.1% and 12.7% respectively in 2009-10 to about 0.4% and 0.4%, respectively in 2020-21 (Figure-4).

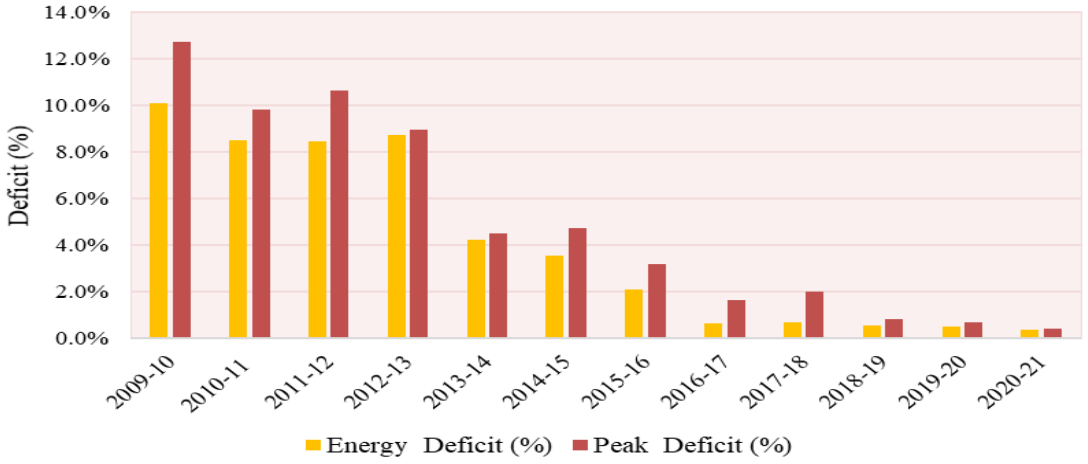
Table-4: Power Supply Position in India, 2009-10 to 2020-21

Year	Energy (BU)			Peak (GW)		
	Require-ment	Availability	Deficit (%)	Peak Demand	Peak Met	Deficit (%)
2009-10	830.59	746.64	10.1%	119.17	104.01	12.7%
2010-11	861.59	788.36	8.5%	122.29	110.26	9.8%
2011-12	937.20	857.89	8.5%	130.01	116.19	10.6%
2012-13	995.56	908.65	8.7%	135.45	123.29	9.0%
2013-14	1002.26	959.83	4.2%	135.92	129.82	4.5%

2014-15	1068.92	1030.79	3.6%	148.17	141.16	4.7%
2015-16	1114.41	1090.85	2.1%	153.37	148.46	3.2%
2016-17	1142.93	1135.33	0.7%	159.54	156.93	1.6%
2017-18	1213.33	1204.70	0.7%	164.07	160.75	2.0%
2018-19	1274.60	1267.53	0.6%	177.02	175.53	0.8%
2019-20	1291.01	1284.44	0.5%	183.80	182.53	0.7%
2020-21	1275.53	1270.66	0.4%	190.20	189.40	0.4%

Source: Ministry of Power

Figure-4: Energy Deficit and Peak Deficit in India, 2009-10 to 2020-21



2. Transmission

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

Open Access refers to the right to generators of electricity [Captive Power Plants[2] (CPP)/Independent Power Producers (IPP)] and bulk consumers[3] to sell the generated electricity at a certain transmission surcharge and to access the transmission and distribution networks of any generator without any discrimination by the distribution/transmission line owners. The principle of open access is based on the premise that while it is uneconomical to lay down multiple transmission lines in the same region because of the large sunk costs involved, it is still best to give consumers a choice to decide which firm's electricity they want to consume.

The growth of transmission system (transmission lines and transformation capacity) in India during 2009-10 to 2020-21 is shown in Table-5 and Figure-5.

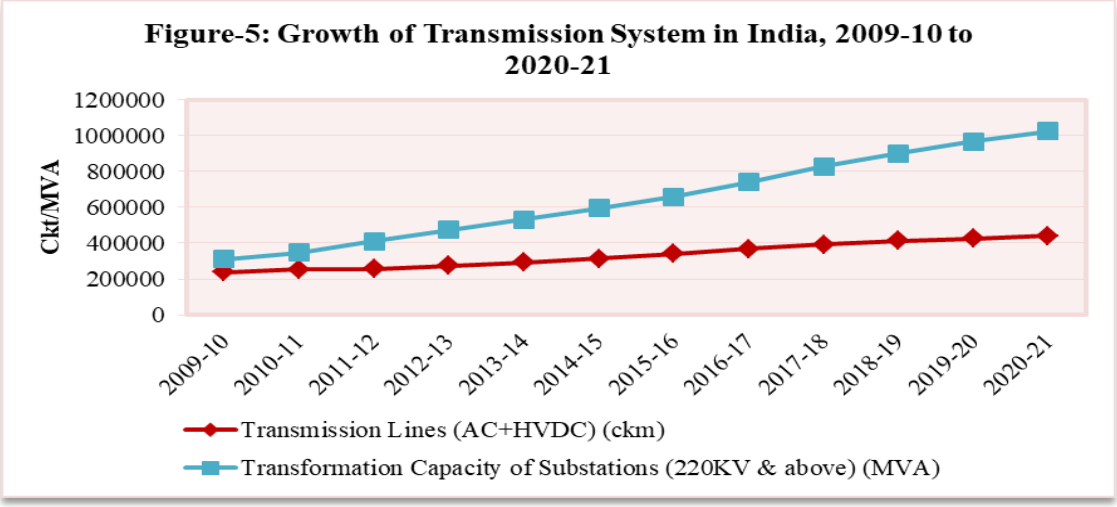
Table-5: Growth of Transmission System in India, 2009-10 to 2020-21

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

Source: CEA, Monthly Reports

[2]*Captive Power refers to generation from a unit set up by industry for its own consumption*

[3] *Bulk consumers are consumers with power requirement of 1MW or above*



It can be observed from Table-5 that bulk transmission (transmission lines 220 kV & above) has increased from 2.36 lakh ckm in 2009-10 to 4.42 lakh ckm in 2020-21. During the period, the transformation capacity of sub-stations has also increased from 3.10 lakh MVA to 10.25 lakh MVA. The CAGR during the period in the transmission lines and transformation capacity of sub-stations was 6% and 11% respectively. Table-6 provides the data on annual transmission charges (transmission charges applicable for transmission lines owned by PGCIL and other ISTS licensees) for the period from 2011-12 to 2020-21. The annual transmission charges increased at a CAGR of 18.75% during the period. There are various reasons for increase in annual transmission charges, like the growth of transmission lines (especially at higher voltage levels), waiver of transmission charges for inter-state renewable energy generators and relinquishment of long-term access (LTA).

Table-6: Annual Transmission Charges, 2011-12 to 2020-21

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

Source: POSOCO

Notes: (i) New Sharing of ISTS Charges & Losses Regulations have been notified by CERC, w.e.f 01.11.2020. Thereafter NLDC, instead of CERC, notifies the Transmission pricing every month. The Notification for billing month May 2021 has been used for obtaining the approved Yearly Transmission Charges for March 2021, (ii) The above transmission charges are the same as used for computation of POC Charges.

Transmission sector is having a natural monopoly, as is involves high sunk costs in investing in the infrastructure needed to transmit electricity, such as transmission lines. Because of these characteristics, non-public entities face entry barriers, and private investments are allowed in transmission projects only after the approval from CERC. Although the transmission market is largely dominated by the public sector, there are many lines including High-Voltage Direct Current (HVDC) lines owned by private players. There are about 64 Inter-state transmission licensees as on 31.3.2021 granted by CERC **(Annexure-I).**

3. Distribution

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

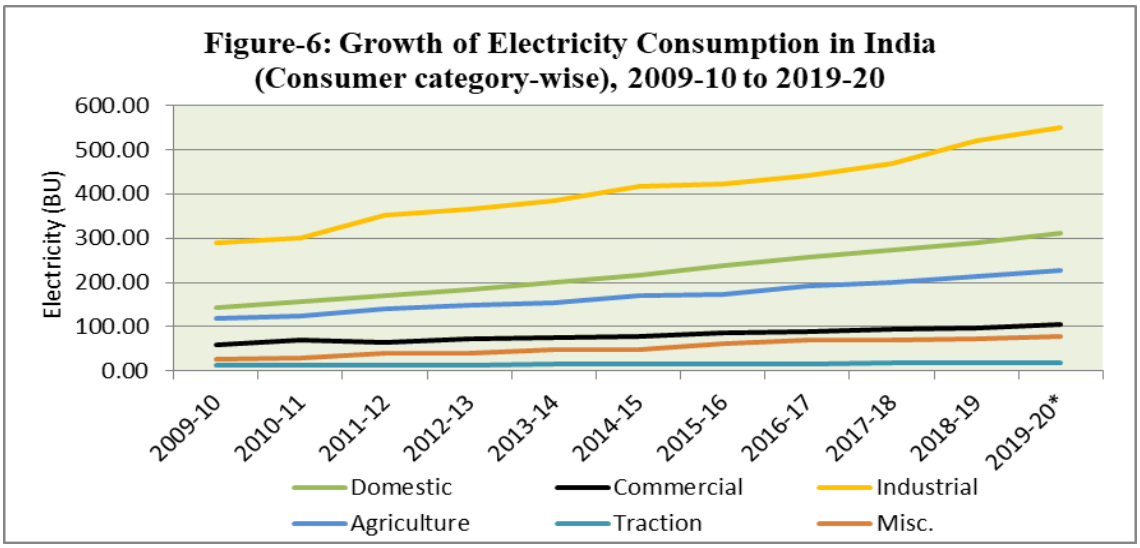
The growth in electricity consumption (consumer category-wise) is provided in Table-7 & Figure-6. The total electricity consumption increased from 653.24 BU in 2009-10 to 1291.49 BU in 2019-20 (estimated) at a CAGR of 7.1%. During the period, per capita consumption of electricity in India has increased from 779 kWh to 1208 kWh, registering an annual growth rate of 4.5%. Despite this considerable growth, the level of per capita energy consumption in India is low as compared to the international average of around 3152 kWh for 2017 (latest available year).

Table-7: Growth of Electricity Consumption in India (Consumer category-wise) (BU), 2009-10 to 2019-20

Year	Domestic	Commer-cial	Indus-trial	Agri-culture	Traction	Misc.	Total
2009-10	144.25	59.30	290.26	119.32	12.41	27.71	653.24
2010-11	156.02	68.72	301.26	123.39	13.09	29.93	692.40
2011-12	171.10	65.38	352.29	140.96	14.21	41.25	785.19
2012-13	183.70	72.79	365.99	147.46	14.10	40.26	824.30
2013-14	199.84	74.25	384.42	152.74	15.54	47.42	874.21
2014-15	217.41	78.39	418.35	168.91	16.18	49.29	948.52
2015-16	238.88	86.04	423.52	173.19	16.59	62.98	1001.19
2016-17	255.83	89.83	440.21	191.15	15.68	68.49	1061.18
2017-18	273.55	93.76	468.61	199.25	17.43	70.83	1123.43
2018-19	288.24	98.23	519.20	213.41	18.84	72.06	1209.97
2019-20*	310.15	103.88	551.36	228.17	19.58	78.35	1291.49

* Estimated

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



As per the 'Report on Performance of State Power Utilities- 2019-20' by Power Finance Corporation Ltd (PFC), the average all-India AT&C losses have come down to about 20.93% in 2019-20[4]. More than 90% of these losses can be attributed to Transmission and Distribution Losses, which correspond to electricity produced but not paid for.

The electricity tariffs charged by the DISCOMs are not cost reflective. The DISCOMs sell electricity below cost or provide electricity at free/subsidized rates for

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

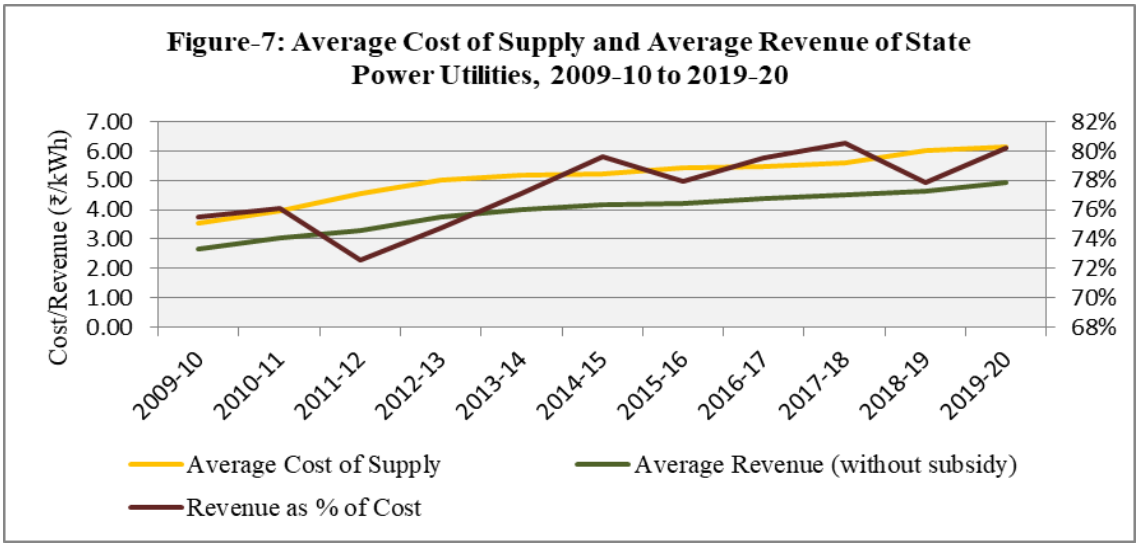
agriculture and domestic consumers. The tariffs for residential and agricultural consumers are subsidized by overcharging industrial and commercial users. Average cost of supply and average revenue of all state power utilities has been provided for the period from 2009-10 to 2019-20 in Table-8 and Figure-7.

The all-India average cost of supply and average revenue (without subsidy) increased from ₹3.55/kWh and ₹2.68/kWh respectively in 2009-10 to ₹6.15/kWh and ₹4.93/kWh, respectively, in 2019-20. Here the average revenue includes revenue from operations, regulatory income, revenue grants under UDAY and other income and revenue grants. The gap between the cost of supply and revenue has increased from 0.87 kWh to 1.22 kWh during the period. The revenue as percentage of cost of supply varied between 78% to 81% during the period from 2014-15 to 2019-20 which indicates that the average revenue was about 20% lower than the average cost of supply and this gap is financed through budgetary support as subsidy by the Government.

Table-8: Average Cost of Supply and Average Revenue of State Power Utilities, 2009-10 to 2019-20

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

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



The DISCOMs in the country are trapped in a vicious cycle with huge operational losses and outstanding debt due to legacy issues. Financially stressed DISCOMs are not able to supply adequate power at affordable rates. To improve their financial health, several policy initiatives have been taken by the Union Government during the last few years, including implementation of Ujwal DISCOM Assurance Yojana (UDAY, launched in 2015), Integrated Power Development Scheme (IPDS, launched in 2014), National Smart Grid Mission (NSGM), etc. UDAY is being implemented in various States for the financial turnaround and revival of the DISCOMs through four initiatives (i) improving operational efficiencies of DISCOMs; (ii) reduction of cost of power purchase; (iii) reduction in interest cost of DISCOMs; and (iv) enforcing financial discipline on DISCOMs through alignment with State finances.

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

The Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya Scheme) was launched in September 2017, to provide free electricity connections to all households,

for above poverty line (APL) & poor families in rural areas and poor families in urban areas. All DISCOMs, including Private Sector DISCOMs, State Power Departments and Renewable Energy Cooperative Societies shall be eligible for financial assistance under the scheme in line with DDUGJY.

The implementation of the above discussed schemes and programmes has led to a considerable improvement in the distribution segment.

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Chapter-II

Short-term Power Market in India

1. Introduction

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

Over the past decade, the Indian power sector has undergone many developments like increased volume of electricity traded on power exchanges, introduction of new type of energy procurement & sale contracts, cross border trade of electricity, etc. Considering the developments, the Commission notified the CERC (Procedure, Terms and Conditions for grant of Trading Licence and other related matters) Regulations, 2020 in the Official Gazette 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 and the Green Term Ahead Market, in the year 2020-21.

The Real Time Market 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. The auction sessions are conducted every half an hour with power to be delivered after four (4) time blocks or an hour after gate closure of the auction. Gate Closure refers to the time after which bids submitted to the Power exchange cannot be modified.

Providing a new avenue for renewable energy generators to sell power and for obligated entities to fulfill their RPOs, the Green Term Ahead Market 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 transactions are bilateral in nature and price discovery takes place on a continuous basis. The segment features contracts such as Green-Intraday, Green-Day-ahead Contingency, Green-Daily and Green-Weekly.

The Chapter, in the following sections, provides a brief analysis of short-term[5] transactions of electricity in India during the year 2020-21. Here, "short-term

[5]*Although Deviation Settlement Mechanism (DSM) is not a market mechanism, electricity transacted under DSM is often considered a part of short-term transaction. Also, electricity transacted bilaterally directly between the distribution companies (without involving trading licensees or power exchanges) is considered a part of short-term market. In the year 2020-21, the volume of DSM was about 22.91 BU and that between distribution companies was about 16.84 BU.*

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 (Indian Energy Exchange Ltd (IEX) and Power Exchange India Ltd (PXIL))

(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 (2010-11 to 2020-21)

The analysis on 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 and Term Ahead Markets, Real Time Market and Green Term Ahead Market;
- DSM segment; and
- Direct transactions of electricity between DISCOMs.

Inter-state trading licensees (traders) have been undertaking trading in electricity since 2004 and the power exchanges started operating since 2008. The two power exchanges namely, IEX and PXIL have started their operations in June 2008 and October 2008 respectively. As on 31st March 2021, there were total 33 inter-state trading licensees (refer **Annexure-II**) and two power exchanges operating in the country.

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

Total volume of short-term transactions of electricity increased from 81.56 BU in 2010-11 to 146.01 BU in 2020-21. During the period, the volume of short-term transactions of electricity increased at a higher rate (CAGR of 6.0%) as compared to the total electricity generation[6] (CAGR of 4.9%). The volume of short-term transactions of electricity as percentage of total electricity generation varied from 8.9% to 10.6% during the period (Table-9).

Table-9: Volume of Short-term Transactions of Electricity with respect to Total Electricity Generation, 2010-11 to 2020-21

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
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%

**Provisional*
Source: NLDC & CEA

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

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

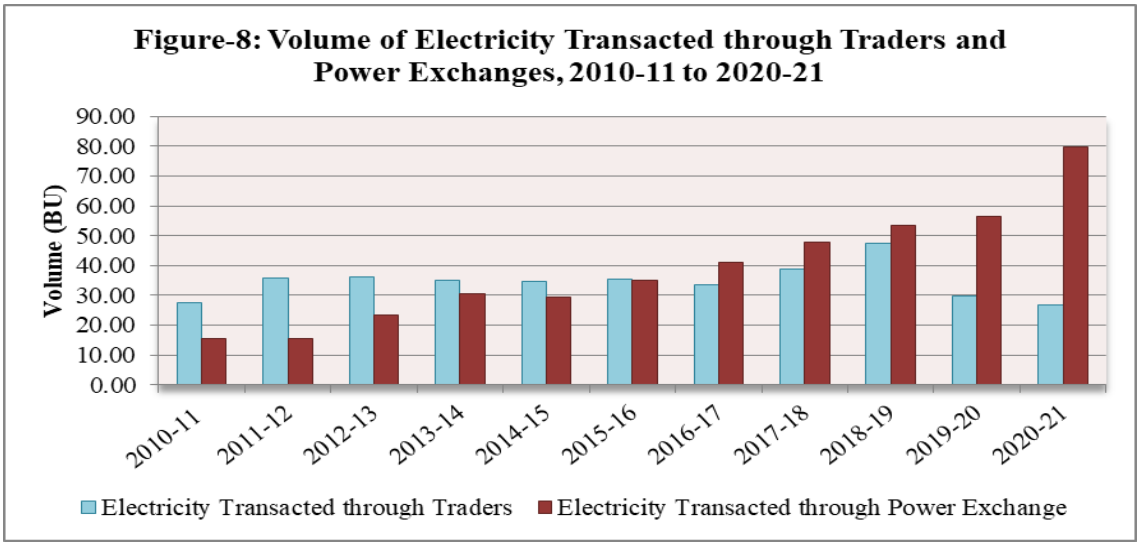
2.1.1 Electricity Transacted through Traders and Power Exchanges

Table-10, Table-11 and Figure-8 show details of volume of electricity transacted through traders under bilateral transactions and through power exchanges for the period from 2010-11 to 2020-21. The volume of electricity transacted through traders and power exchanges increased from 43.22 BU in 2010-11 to 106.26 BU in 2020-21. The share of electricity transacted through traders and power exchanges as a percentage of total short-term transactions of electricity increased from about 53% in 2010-11 to 73% in 2020-21 (Table-11). The CAGR in volume of this segment during 2010-11 to 2020-21 was 9.4%.

Table-10: Volume of Electricity Transacted through Traders and Power Exchanges (BU), 2010-11 to 2020-21

Year	Electricity Transacted through Traders	Electricity Transacted through IEX				Electricity Transacted through PXIL				Electricity Transacted through Power Exchange	Total
		DAM	TAM	RTM	G-TAM	DAM	TAM	RTM	G-TAM		
2010-11	27.70	11.80	0.91	-	-	1.74	1.07	-	-	15.52	43.22
2011-12	35.84	13.79	0.62	-	-	1.03	0.11	-	-	15.54	51.38
2012-13	36.12	22.35	0.48	-	-	0.68	0.04	-	-	23.54	59.66
2013-14	35.11	28.92	0.34	-	-	1.11	0.30	-	-	30.67	65.78
2014-15	34.56	28.12	0.22	-	-	0.34	0.72	-	-	29.40	63.96
2015-16	35.43	33.96	0.33	-	-	0.14	0.58	-	-	35.01	70.43
2016-17	33.51	39.78	0.74	-	-	0.25	0.35	-	-	41.12	74.63
2017-18	38.94	44.84	1.37	-	-	0.73	0.75	-	-	47.70	86.64
2018-19	47.32	50.06	2.10	-	-	0.09	1.26	-	-	53.52	100.84
2019-20	29.95	49.11	4.77	-	-	0.05	2.52	-	-	56.45	86.40
2020-21	26.67	60.38	3.27	9.47	0.79	0.24	5.45	0.002	0.0004	79.59	106.26

Note1: Real Time Market and Green Term Ahead Market were introduced in June 2020 and August 2020 respectively
Source: NLDC and Power Exchanges data



A comparison between the volume of electricity transacted through traders and power exchanges is shown in Figure-8. It can be observed that the volume of electricity transacted through traders was relatively high during the period from 2010-11 to 2015-16. However, from 2016-17 onwards, the share of electricity transacted through power exchanges increased significantly, which is indicative of more demand for electricity through power exchanges than the bilateral transactions through traders. The volume of electricity transacted through power exchanges increased at a CAGR of around 18%, whereas the volume of electricity transacted through traders registered a decline of 0.4% during 2010-11 to 2020-21.

Table-11: Electricity Transacted through Traders and Power Exchanges as percentage of Total Short-term Transactions, 2010-11 to 2020-21

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
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%

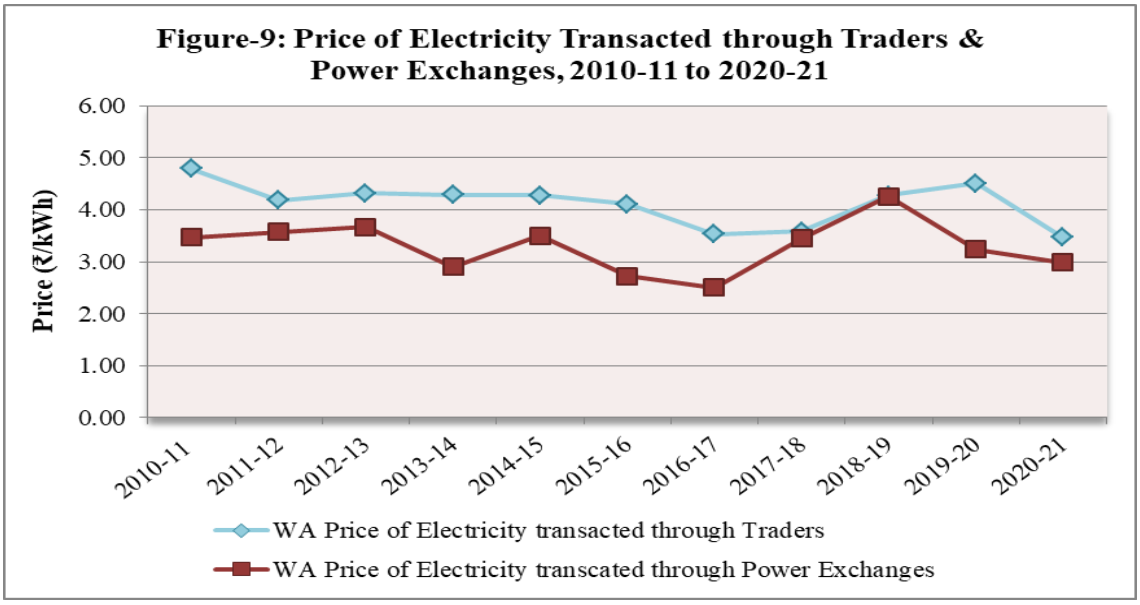
Source: NLDC and Power Exchanges data

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 declined from ₹4.79/kWh and ₹3.47/kWh respectively in 2010-11 to ₹3.47/kWh and ₹2.98/kWh respectively in 2020-21. As may be seen in the Table, the weighted average price of electricity transacted through traders was relatively high when compared with the price of electricity transacted through power exchanges. This could be attributed to reasons 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 and 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. Thus, the nature and duration of contract influence the price of electricity.

Table-12: Price of Electricity Transacted through Traders and Power Exchanges, 2010-11 to 2020-21

Year	Weighted Average Price of Electricity transacted through Traders (₹/kWh)	Weighted Average Price of Electricity transacted through Power Exchanges (DAM +TAM +RTM +GTAM) (₹/kWh)
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

Source: Traders and Power Exchanges data



The size of the bilateral and power exchange market increased from ₹18654 crore in 2010-11 to ₹32976 crore in 2020-21, at a CAGR of 5.9%. The variation in volume and price affected the size of bilateral and power exchange market. During 2010-11 to 2020-21, while the volume of electricity transacted bilaterally registered a decline of 0.4%, the volume of transactions through power exchange increased at a CAGR of around 18%. However, the price of electricity transacted through both bilateral and power exchange registered a negative growth of (-) 3.2% and (-) 1.5% respectively.

Table-13: Volume of Electricity Transacted through Traders and Power Exchanges (BU), 2010-11 to 2020-21

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 IEX and PXIL (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
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

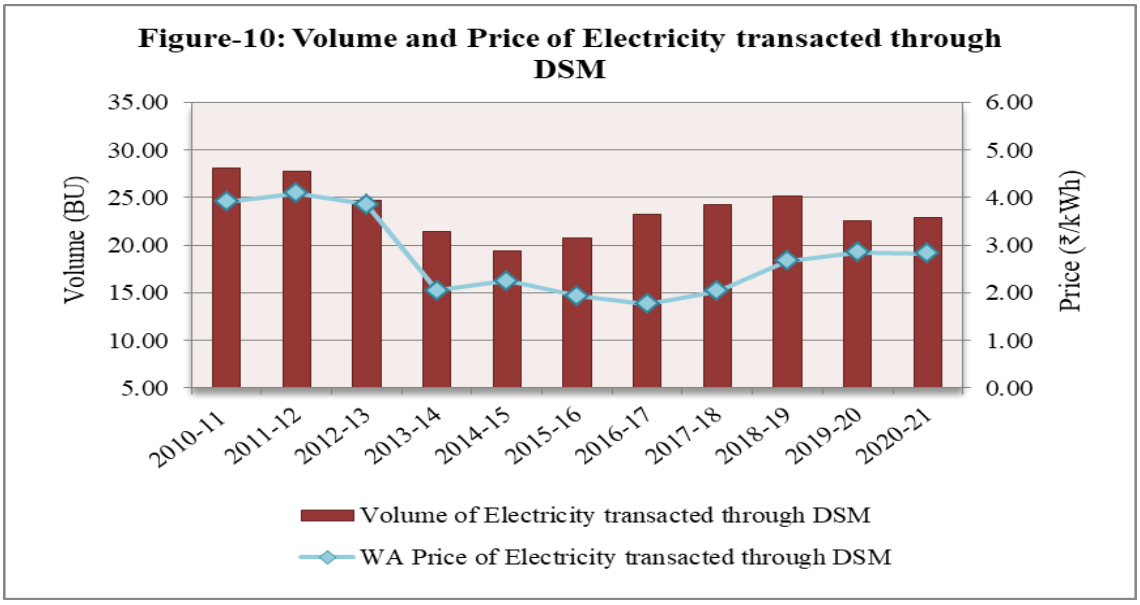
2.1.2 Electricity Transacted through DSM

The volume and price of electricity transacted through DSM is shown in Table-14 and Figure-10. The volume of electricity transacted through DSM showed an uneven trend during the period from 2010-11 to 2020-21; with a declining trend from 2010-11 to 2014-15 followed by an uptick till 2018-19, before starting to fall again. However, the volume of DSM as a percentage of total short-term volume declined significantly from its high of 34.4% in 2010-11 to 15.7% in 2020-21. Since the DSM is not a market mechanism, the decline in DSM volume is good for the market. So far as the electricity market is concerned, the volume in this segment of the short-term 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, the average price of DSM declined from ₹3.91/kWh in 2010-11 to ₹2.82/kWh in 2020-21. This may be attributed to the changes in DSM regulations by CERC from time to time.

Table-14: Volume and Price of Electricity Transacted through DSM, 2010-11 to 2020-21

Year	Volume of Electricity Transacted through DSM (BU)	Total Volume of Short-term Transactions (BU)	Volume of DSM as % of Short-term Transactions	Price of Electricity Transacted through DSM (₹/kWh)
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

Source: NLDC

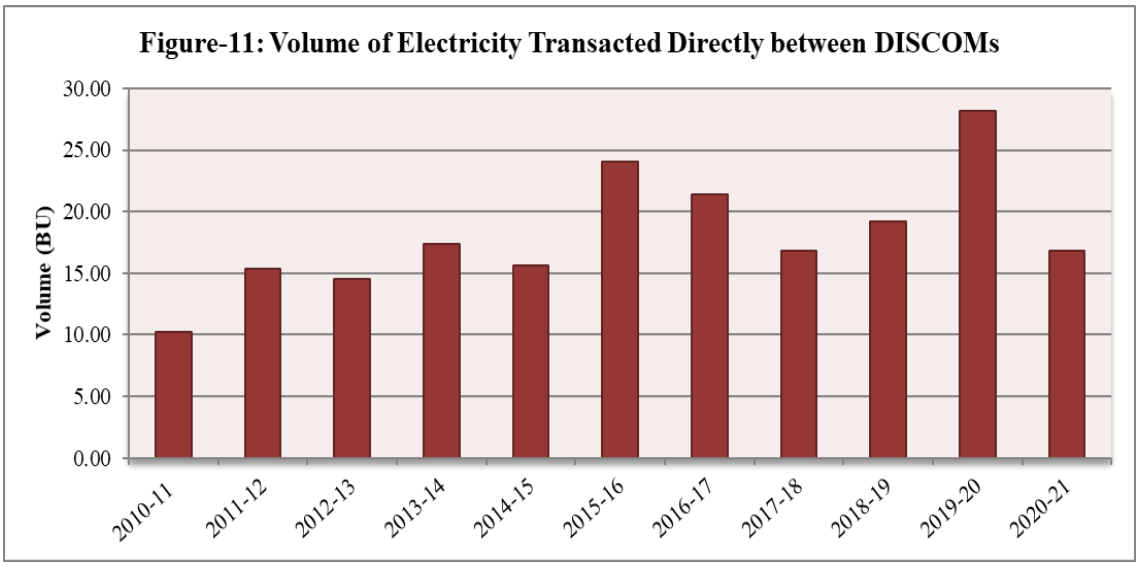


2.1.3 Electricity Transacted Directly between DISCOMs

The volume of electricity transacted directly between DISCOMs is shown in Table-15 and Figure-11. As may be seen from the Table, the volume of electricity transacted directly between DISCOMs increased from 10.25 BU in 2010-11 to its all-time high of 28.17 BU in 2019-20 and then declined to 16.84 BU in 2020-21. The volume of electricity transacted directly between DISCOMs as percentage to total volume of short-term transactions of electricity hovered in the range of 11.5% to 20.9% during the period.

Table-15: Volume of Electricity Transacted Directly between DISCOMs

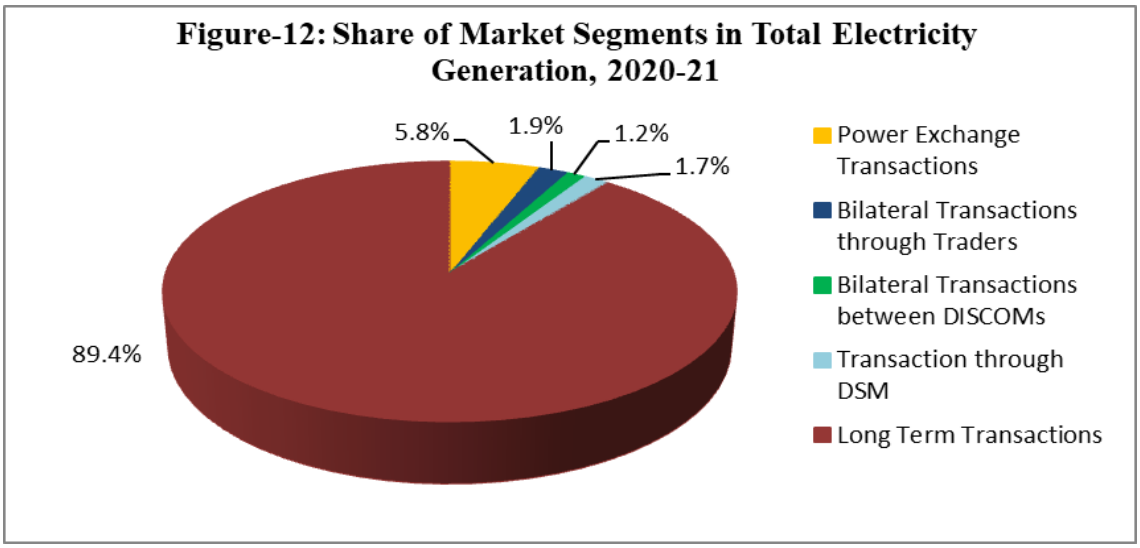
Year	Volume of Electricity Transacted Directly between DISCOMs (BU)	Total Volume of Short-term Transactions (BU)	Volume of Bilateral Direct as % of total volume of Short term
2010-11	10.25	81.56	12.6%
2011-12	15.37	94.51	16.3%
2012-13	14.52	98.94	14.7%
2013-14	17.38	104.64	16.6%
2014-15	15.58	98.99	15.7%
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%



The increasing trend in the volume of electricity transacted directly by DISCOMs as witnessed during the period from 2010-11 to 2019-20 was indicative of the fact that the DISCOMs have independently managed the volume of electricity that they require to buy/sell instead of relying on traders and power exchanges.

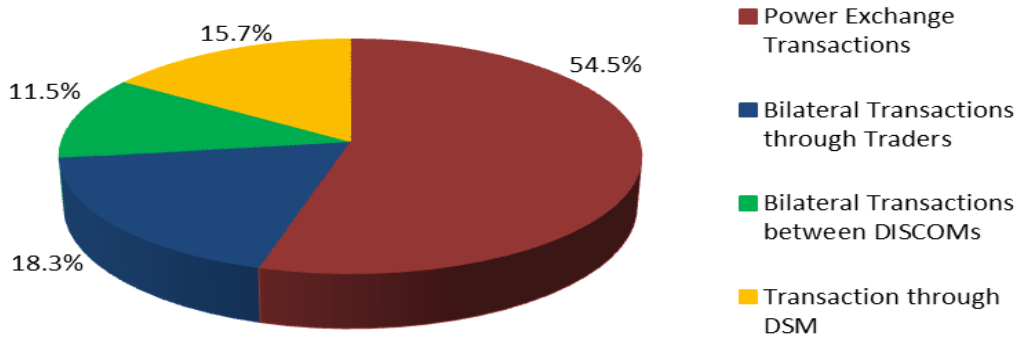
3. Monthly Trends in Short-term Transactions of Electricity (April 2020-March 2021)

During 2020-21, the share of total short-term transactions in volume terms, including DSM, as a percentage of total electricity generation in the country was about 11% (Figure-12 and Table-16).



The share of different market segments within the total short-term transactions in 2020-21 is shown in the Figure-13 below.

Figure-13: Share of Market Segments in Short Term Transactions, 2020-21



Of the total short-term transactions in 2020-21, the volume of electricity transacted through power exchanges was maximum at 54.5%, followed by bilateral transactions through traders at 18.3%, transactions through DSM at 15.7% and bilateral transactions between DISCOMs at 11.5%.

3.1 Volume of Short-term Transactions of Electricity

The volume of short-term transactions of electricity during different months of 2020-21 with break-up for different segments is shown in Table-16 and Figure-14.

Table-16: Volume of Short-term Transactions of Electricity (BU), 2020-21

Month	Bilateral through Traders	Bilateral between DISCOMs	Total Bilateral	Power Exchange Transactions (DAM +TAM +RTM +GTAM)	Transac-tions through DSM	Total Short-term Transac-tions	Total Electricity Generation*
Apr-20	1.42	1.04	2.46	4.24	1.62	8.32	91.68
May-20	1.63	1.17	2.80	6.31	1.96	11.08	110.08
Jun-20	3.18	1.22	4.40	4.88	2.08	11.36	114.17
Jul-20	2.56	1.77	4.33	5.36	2.13	11.83	121.54
Aug-20	2.62	1.53	4.15	5.80	2.07	12.02	118.90
Sep-20	2.07	1.36	3.42	6.20	1.93	11.55	120.64

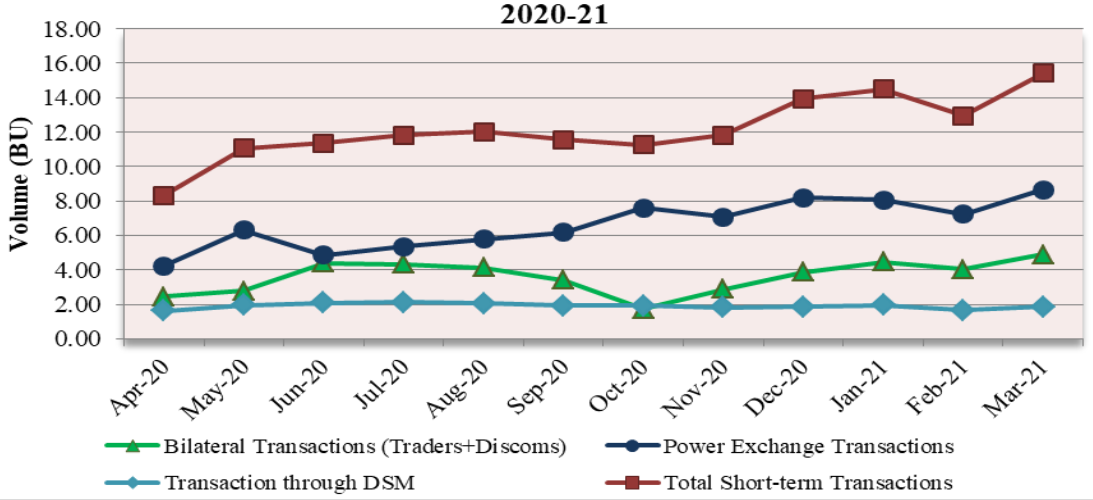
Oct-20	0.96	0.79	1.75	7.59	1.91	11.25	117.75
Nov-20	1.27	1.62	2.89	7.08	1.84	11.81	105.85
Dec-20	2.11	1.78	3.89	8.19	1.85	13.93	115.43
Jan-21	2.45	2.02	4.48	8.05	1.97	14.49	120.02
Feb-21	2.53	1.51	4.04	7.23	1.68	12.95	112.47
Mar-21	3.87	1.03	4.90	8.65	1.87	15.41	131.54
Total	**26.67**	**16.84**	**43.50**	**79.59**	**22.91**	**146.01**	**1380.06**

** Provisional*

Source: NLDC & CEA

As may be observed from Figure-14, there is a cyclical trend in the monthly volume of short-term transactions of electricity and a similar trend is observed in the power exchange transactions. As expected, there is no cyclical trend in the transactions through DSM since these transactions do not move by seasonal variations.

Figure-14: Volume of Short-term Transactions of Electricity, 2020-21



The volume of short-term transactions of electricity as percentage of total electricity generation varied between 9.1% and 12.1% during April 2020 to March 2021 (Table-17).

Table-17: Volume of Short-term Transactions of Electricity as % of Total Electricity Generation, 2020-21

Period	Short-term Transactions as % of Total Electricity Generation
Apr-20	9.1%
May-20	10.1%
Jun-20	10.0%

Jul-20	9.7%
Aug-20	10.1%
Sep-20	9.6%
Oct-20	9.6%
Nov-20	11.2%
Dec-20	12.1%
Jan-21	12.1%
Feb-21	11.5%
Mar-21	11.7%

As on 31.3.2021, there were a total of 33 inter-state trading licensees; of which, 25 trading licensees actively undertook trading during the year 2020-21 (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 2020-21 was 0.2161, which indicates moderate concentration of market power among the traders. As compared to 2019-20 with HHI value of 0.1587, the level of market concentration has increased in 2020-21.

Table-18: Share of Electricity Transacted by Traders and HHI, 2020-21

Sr No	Name of the Trading Licensee	Share of Electricity traded by Licensees	Herfindahl-Hirschman Index (HHI)
1	PTC India Ltd.	41.88%	0.1754
2	Adani Enterprises Ltd.	12.02%	0.0144
3	GMR Energy Trading Ltd.	7.80%	0.0061
4	Manikaran Power Ltd.	7.49%	0.0056
5	NTPC Vidyut Vyapar Nigam Ltd.	7.44%	0.0055
6	Tata Power Trading Company (P) Ltd.	6.61%	0.0044
7	Kreate Energy (I) Pvt. Ltd.	4.75%	0.0023
8	Arunachal Pradesh Power Corporation (P) ltd	4.16%	0.0017
9	Essar Electric Power Development Corp. Ltd.	1.64%	0.0003
10	National Energy Trading & Services Ltd.	1.08%	0.0001

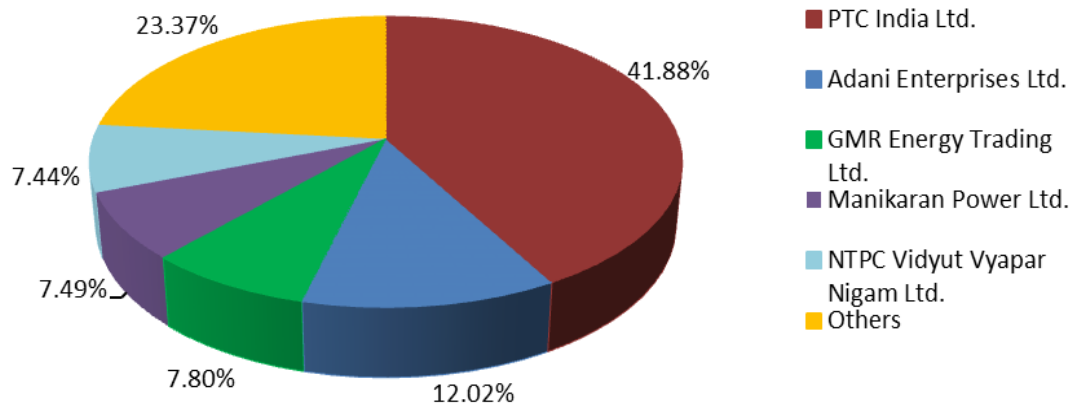
11	Knowledge Infrastructure Systems (P) Ltd	0.90%	0.0001
12	Statkraft Markets Pvt. Ltd.	0.73%	0.0001
13	JSW Power Trading Company Ltd	0.62%	0.0000
14	RPG Power Trading Company Ltd.	0.62%	0.0000
15	Instinct Infra & Power Ltd.	0.58%	0.0000
16	NHPC Limited	0.53%	0.0000
17	Gita Power & Infrastructure Private Limited	0.50%	0.0000
18	Abja Power Private Limited	0.13%	0.0000
19	NLC India Ltd.	0.13%	0.0000
20	IPCL Power Trading Pvt. Ltd.	0.11%	0.0000
21	Refex Energy Limited	0.10%	0.0000
22	Customized Energy Solutions India (P) Ltd.	0.08%	0.0000
23	Shree Cement Ltd.	0.06%	0.0000
24	Phillip Commodities India (P) Ltd.	0.03%	0.0000
25	Ambitious Power Trading Company Ltd.	0.02%	0.0000
Total Volume		**100.00%**	**0.2161**
Share of the Top 5 Trading		**76.63%**	

Note: Percentage share in total volume traded by Licensees in 2020-21 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.

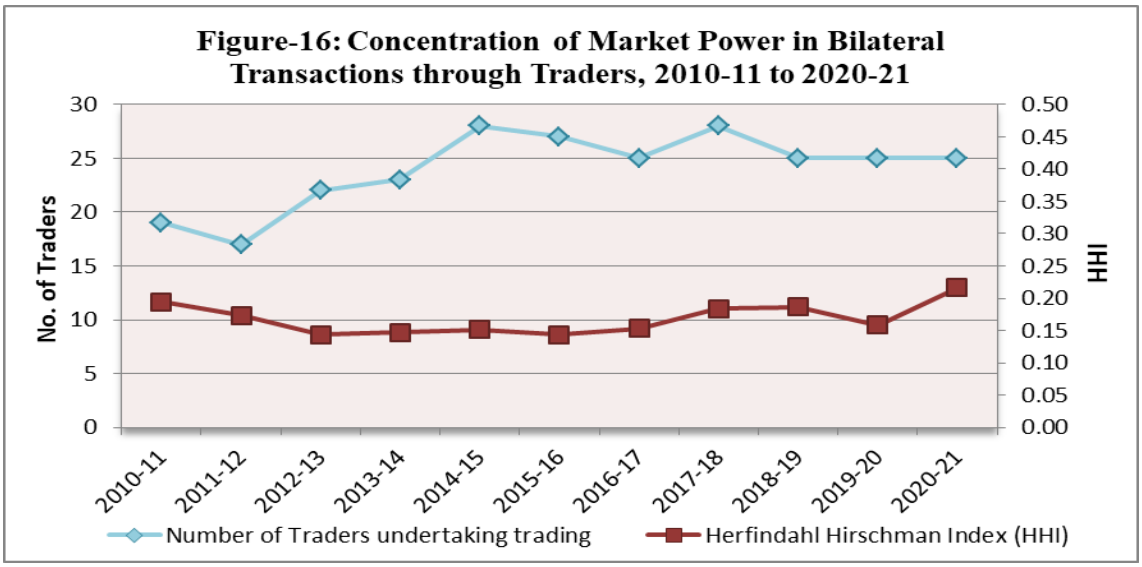
The percentage share of electricity transacted by major traders in the total volume of electricity transacted by all the traders is shown in Figure-15.

Figure-15: Share of Electricity transacted by Traders, 2020-21



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 19 in 2010-11 to 25 in 2020-

21. The competition among the traders resulted into an increase in volume and decrease in prices in the short-term bilateral market (Table-13).



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 mainly 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.

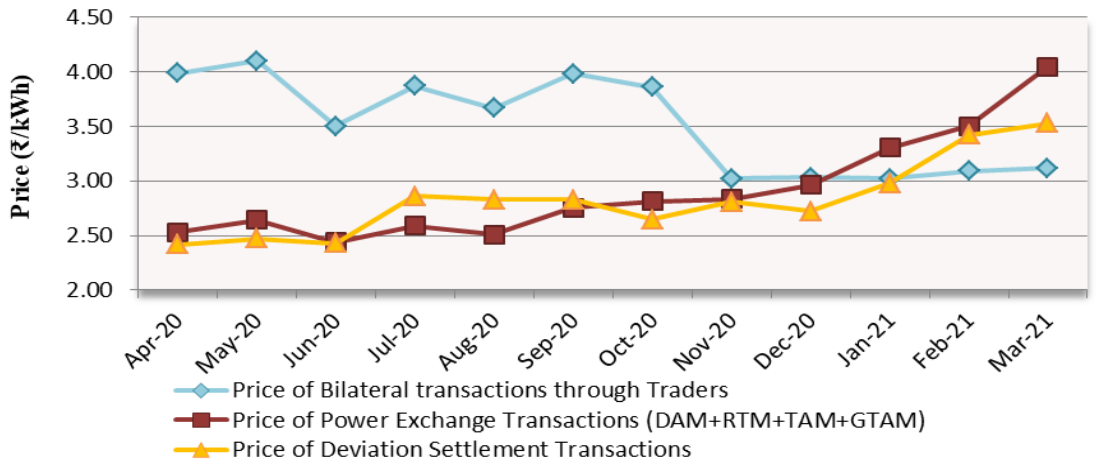
Table-19: Price of Short-term Transactions of Electricity (₹/kWh), 2020-21

Month	Bilateral through Traders				Power Exchange					DSM
	RTC	Peak	Off-peak	Weighted Avg	IEX		PXIL		Weighted Avg	All India Grid
					DAM	RTM	DAM	RTM		
Apr-20	3.97	-	4.77	3.99	2.47	-	-	-	2.47	2.42
May-20	4.20	4.04	4.01	4.10	2.62	-	2.72	-	2.62	2.47
Jun-20	3.32	3.54	3.66	3.50	2.41	2.46	2.53	2.61	2.42	2.43
Jul-20	3.93	4.52	3.77	3.87	2.56	2.67	-	2.61	2.58	2.86
Aug-20	3.76	4.18	3.54	3.67	2.53	2.36	2.79	-	2.50	2.83

Sep-20	3.62	4.89	4.37	3.98	2.77	2.67	2.87	-	2.76	2.83
Oct-20	3.12	4.89	4.26	3.86	2.83	2.78	2.84	-	2.82	2.65
Nov-20	3.00	-	3.03	3.02	2.86	2.85	2.99	-	2.86	2.81
Dec-20	2.91	-	3.10	3.03	3.01	3.11	3.16	-	3.03	2.72
Jan-21	2.93	-	3.11	3.02	3.41	3.27	4.16	-	3.39	2.98
Feb-21	3.11	3.73	3.01	3.09	3.56	3.50	3.73	-	3.55	3.42
Mar-21	3.14	-	2.87	3.12	4.11	3.85	4.19	-	4.06	3.53

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

Figure-17: Comparison of Prices of Bilateral, Power Exchange and DSM Transactions in 2020-21

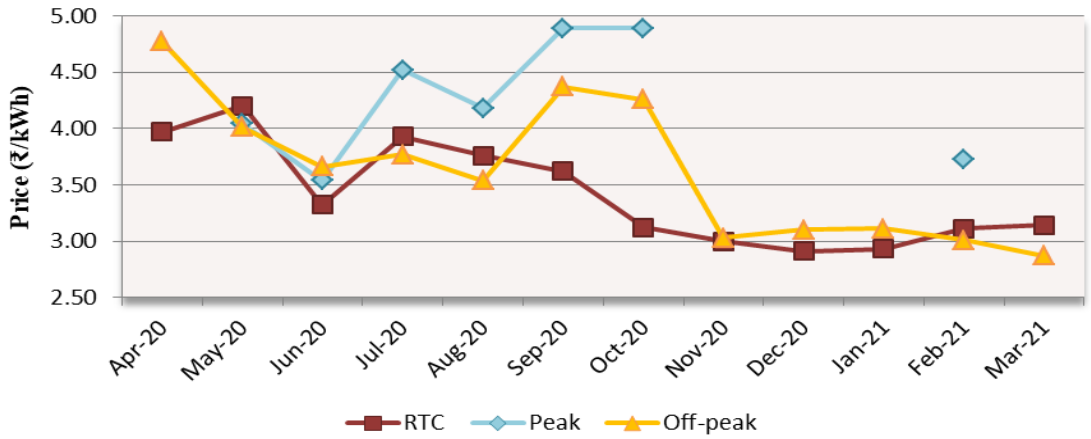


It can be observed from the above figure that the price of electricity transacted through traders was relatively high when compared with the price of electricity transacted through power exchanges[7] in most of the months during 2020-21, except from Jan-Mar 2021. Power exchanges witnessed steep increase in price in these months as the economic & commercial activities were reviving from the slowdown due to pandemic & lockdown condition. Thus, the prices were driven higher by the higher demand. Also, the month of March 2021 witnessed higher congestion in the grid, leading to higher price discovery.

[7]*The comparison between the price of power exchanges and the price of bilateral transactions should also be seen in the light that the delivery point for transactions of power exchanges is the periphery of regional transmission system in which the grid connected entity is located whereas the delivery point for bilateral transactions may vary from transaction to transaction. The delivery point may be state or regional periphery or any other point as per the contract executed.*

The trend in price of electricity transacted by traders during RTC, Peak and Off-peak periods are shown in Table-19 & Figure-18. There is no price for electricity transacted during peak for some of the months in 2020-21 because there is no volume of electricity transacted exclusively during the peak period in these months.

Figure-18: Price of Electricity Transacted through Traders during Round the Clock, Peak and Off Peak periods

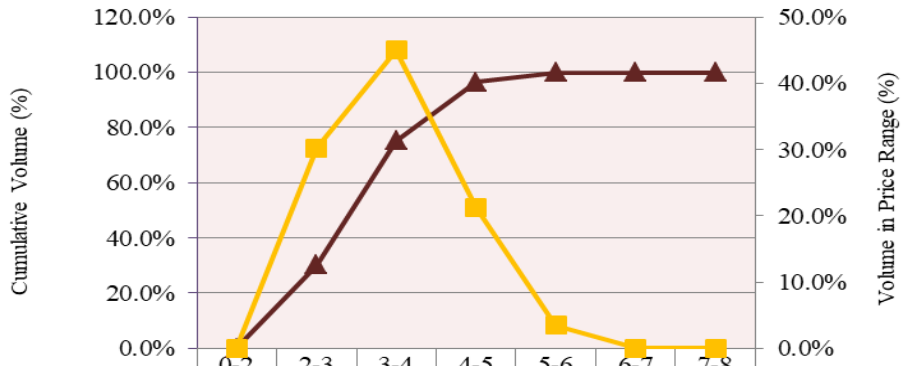


3.3 Volume of Electricity Transacted in various Price Slabs

Volume of electricity transacted in various price slabs is shown for bilateral trader segment and power exchange segment separately. In the case of power exchanges, Day Ahead Market and Real Time Market segments have been considered.

Volume of bilateral transactions at different price slabs in 2020-21 is depicted in Figure-19. The figure shows that about 75.2% of the volume of electricity was transacted through traders at less than ₹4/kWh and 100.0% of the volume was transacted through traders at less than ₹6/kWh.

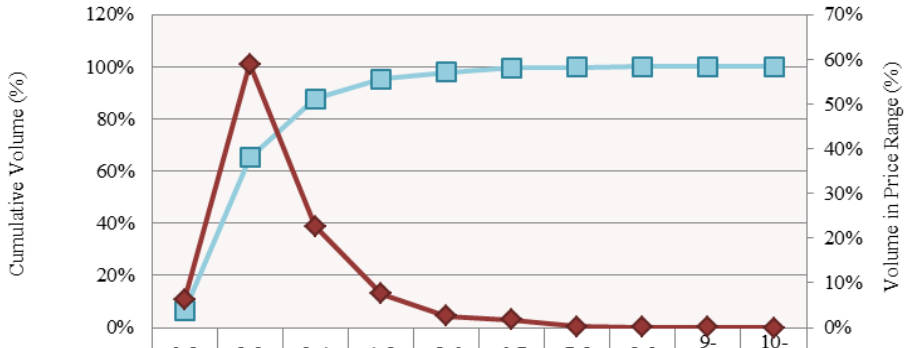
Figure-19: Volume of Bilateral Transaction at different Price Slabs, 2020-21



	0-2	2-3	3-4	4-5	5-6	6-7	7-8
Cumulative Volume (%)	0.0%	30.2%	75.2%	96.5%	100.0%	100.0%	100.0%
Volume in Price Range (%)	0.0%	30.2%	45.0%	21.2%	3.5%	0.0%	0.0%

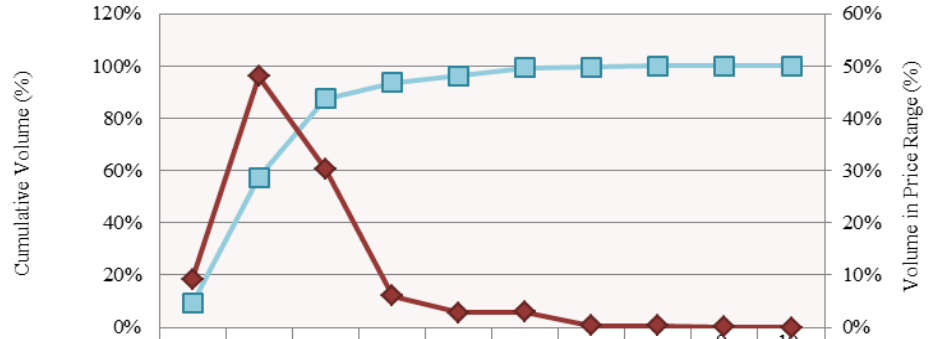
Volume of IEX transactions at different price slabs in DAM and RTM segments during 2020-21 are depicted in Figure-20 (a) and 20 (b) respectively. The figure shows that 88% of the volume of electricity in DAM was transacted at less than ₹4/kWh and 98% of the volume was transacted through IEX at less than ₹6/kWh. Similarly, under RTM segment, 88% of the volume of electricity was transacted at less than ₹4/kWh and 96% of the volume was transacted at less than ₹6/kWh.

Figure-20 (a): Volume of IEX Transactions in Day Ahead Market at different Price Slabs, 2020-21



	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-20
Cumulative Volume (%)	6%	65%	88%	95%	98%	100%	100%	100%	100%	100%
Volume in Price Range (%)	6%	59%	23%	8%	3%	2%	0%	0%	0%	0%

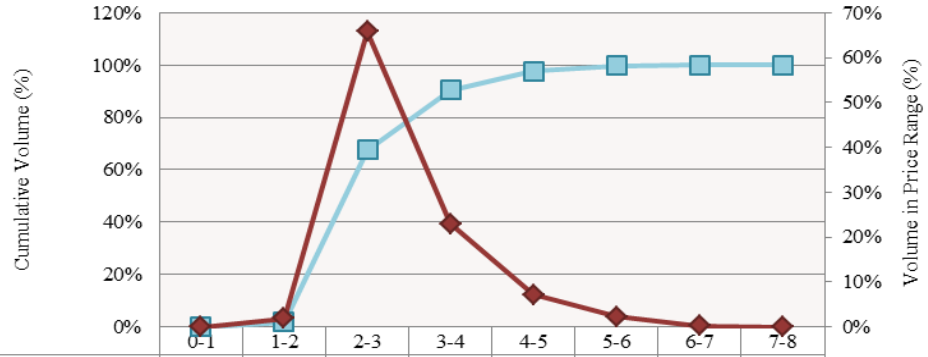
Figure- 20 (b): Volume of IEX Transactions in Real Time Market at different Price Slabs, 2020-21



	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-20
Cumulative Volume (%)	9%	57%	88%	93%	96%	99%	100%	100%	100%	100%
Volume in Price Range (%)	9%	48%	30%	6%	3%	3%	0%	0%	0%	0%

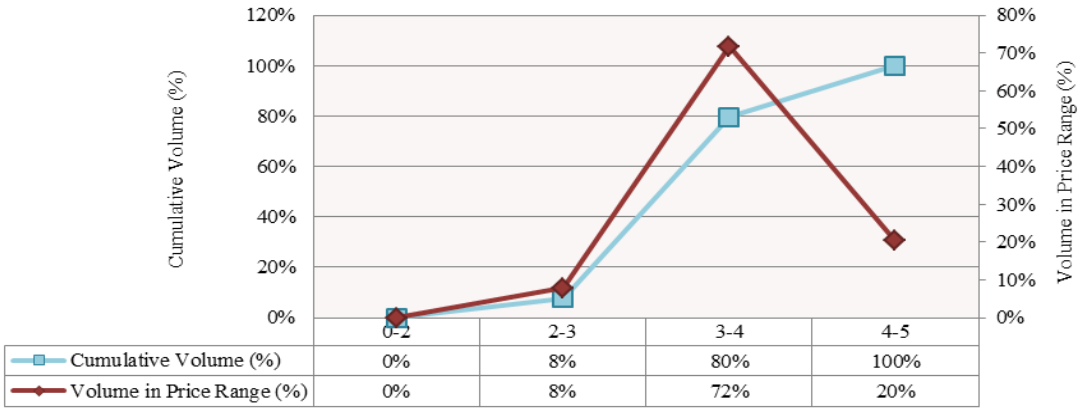
Volume of PXIL transactions at different price slabs in DAM and RTM segments during 2020-21 are depicted in Figure-21 (a) and 21 (b) respectively. The figure shows that 90% of the volume of electricity in DAM was transacted at less than ₹4/kWh and 100% of the volume was transacted at less than ₹6/kWh. Similarly, under RTM segment, 80% of the volume of electricity was transacted at less than ₹4/kWh and 100% of the volume was transacted at less than ₹5/kWh.

Figure-21 (a): Volume of PXIL Transactions in Day Ahead Market at different Price Slabs, 2020-21



	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8
Cumulative Volume (%)	0%	2%	68%	90%	98%	100%	100%	100%
Volume in Price Range (%)	0%	2%	66%	23%	7%	2%	0%	0%

Figure-21 (b): Volume of PXIL Transactions in Real Time Market at different Price Slabs, 2020-21



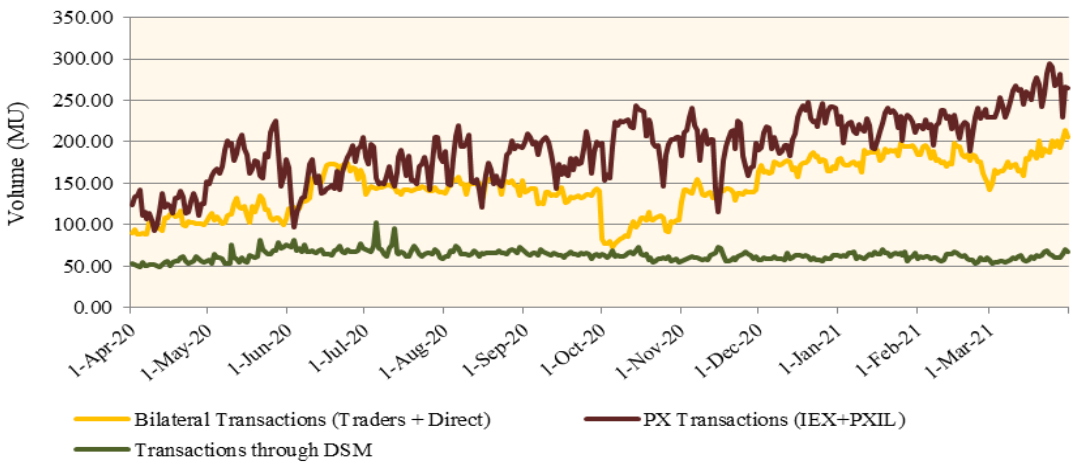
	0-2	2-3	3-4	4-5
Cumulative Volume (%)	0%	8%	80%	100%
Volume in Price Range (%)	0%	8%	72%	20%

4. Daily Trends in Short-term Transactions of Electricity (1st April 2020 to 31st March 2021)

4.1 Volume of Short-term Transactions of Electricity

Trends in daily volume of short-term transactions are shown in Figure-22. It can be observed from the figure that there was a cyclical trend in the volume of electricity transacted through power exchanges during 2020-21. It can also be observed that there was an irregular trend in the volume of electricity transacted through bilateral transactions and DSM during the year.

Figure-22: Volume of Short-term Transactions of Electricity, 2020-21



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 historic volatility formula (see Annexure-III for formula).

4.2.1 Price and its volatility in Power Exchanges

The weighted average price of electricity transacted through IEX in DAM and RTM with their respective volatility levels are shown in Figure-23 (a) and (b) respectively. Volatility in the price of electricity transacted through IEX has been computed using daily data for 2020-21 and it works out to be 9.49% in case of DAM and 15.68% in RTM.

Figure-23 (a): Price and its Volatility in DAM on IEX during 2020-21

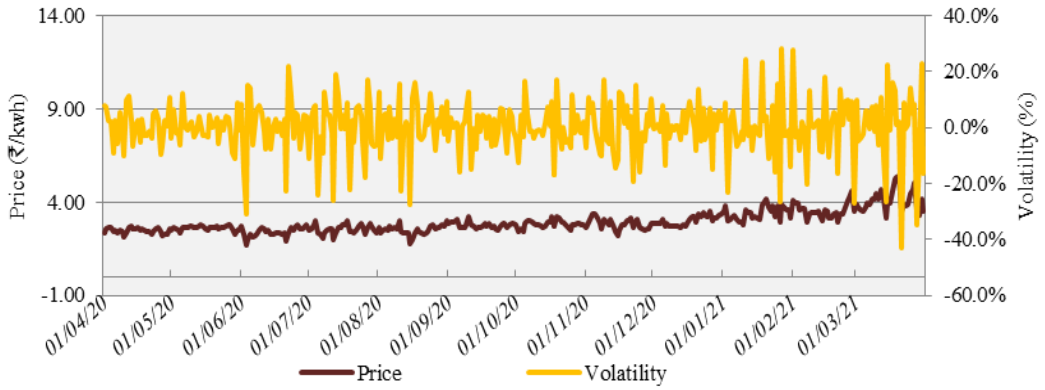
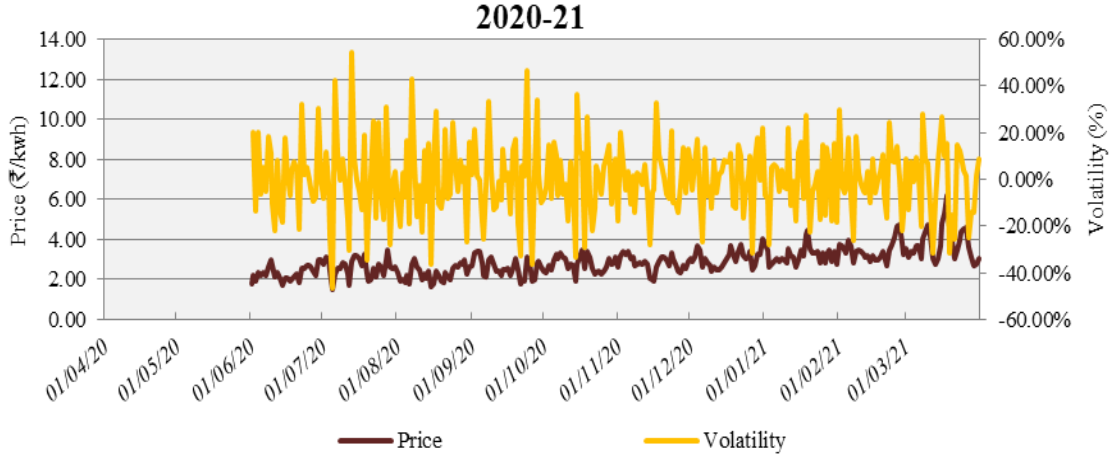


Figure-23 (b): Price and its Volatility in RTM on IEX during 2020-21



Note: RTM was introduced from 1st June 2020

The weighted average price of electricity transacted through PXIL in DAM and RTM with their respective volatility levels are shown in Figure-24 (a) and (b) respectively. Volatility in the price of electricity transacted through PXIL has been computed using daily data for 2020-21 and it works out to be 10.40% in case of DAM and 16.49% in RTM.

Figure-24 (a): Price and its Volatility in DAM on PXIL during 2020-21

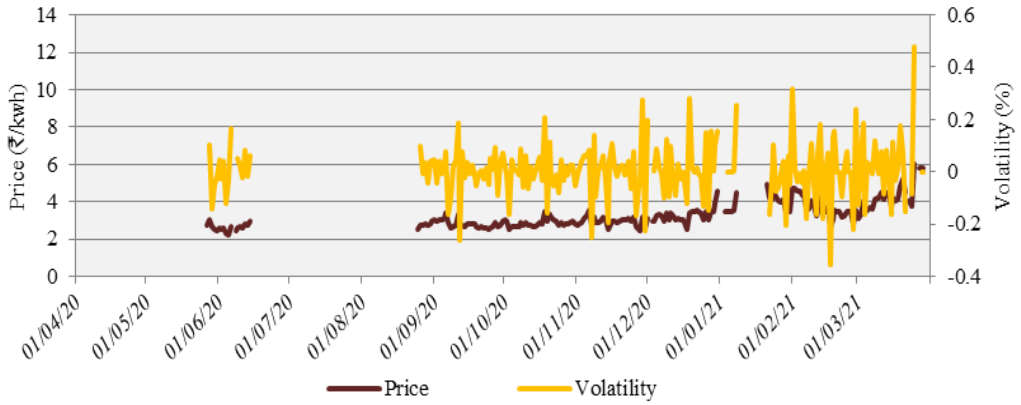
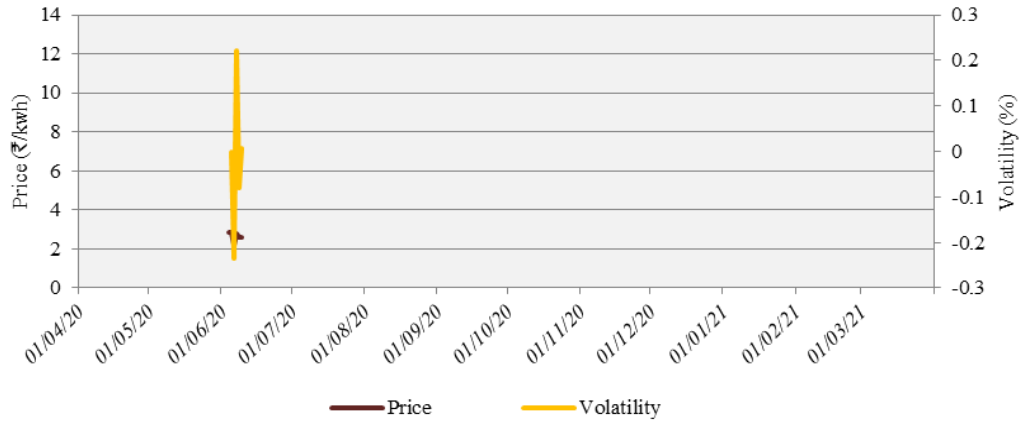


Figure-24 (b): Price and its Volatility in RTM on PXIL during 2020-21



Note: RTM was introduced from 1st June 2020

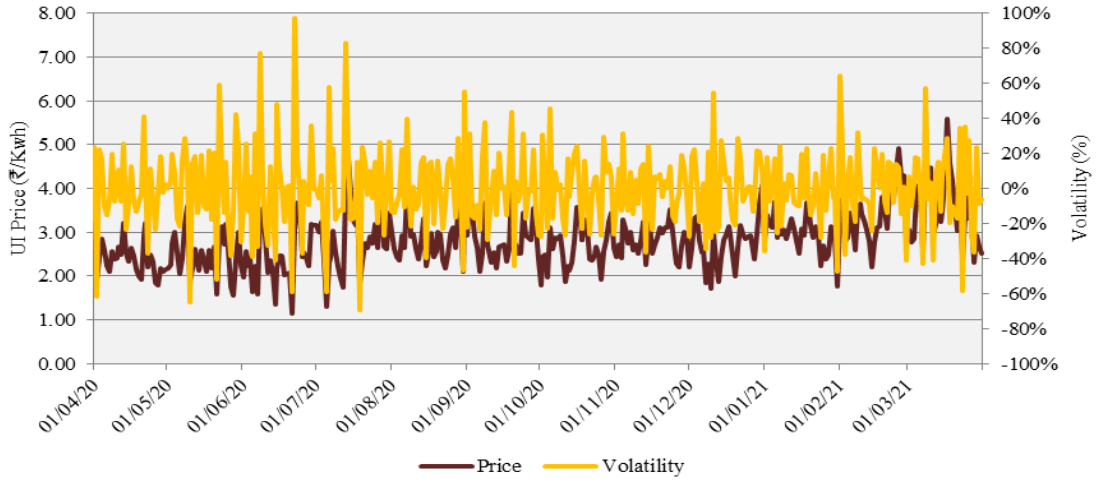
As may be seen from the above figures, the volatility in the price of electricity transacted through PXIL was relatively high as compared to the volatility in the price of electricity transacted through IEX in both the segments and this could be attributed to the low volume of electricity transacted through PXIL. Moreover, in RTM segment,

volume of transactions through PXIL was negligible during 2020-21, mainly seen during the month of June 2020, i.e., during the initial period of introduction of RTM.

4.2.2 *Price and its volatility in DSM*

The average price of electricity transacted through DSM and its volatility is shown in Figure-25. Volatility in the price of electricity transacted through DSM has been computed using daily data for 2020-21 and it works out to be 23.00%.

Figure-25: Price and its Volatility in DSM during 2020-21



Since the nature of transactions through DSM are different from transactions through power exchanges, the volatility in the price of electricity transacted through DSM is higher (23.00%) than the volatility in the price of electricity transacted through power exchanges in DAM (9.49% in IEX and 10.40% in PXIL).

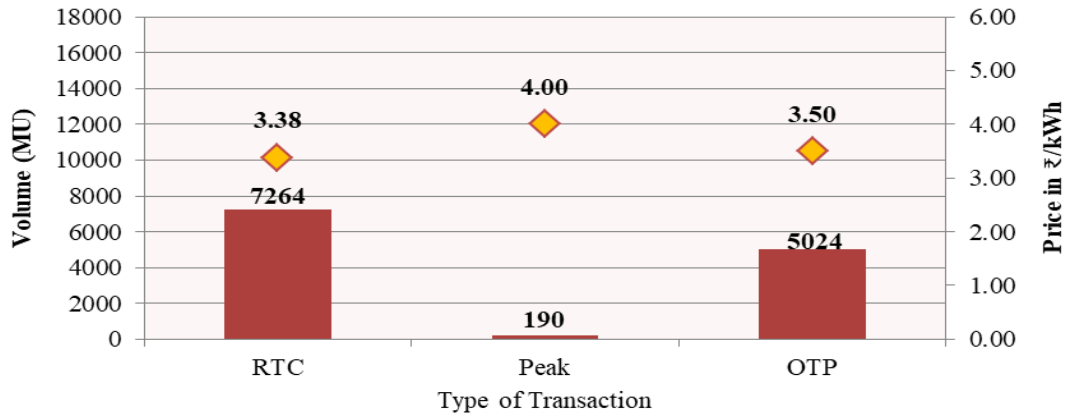
5. Time of the Day Variation in Volume and Price of Electricity Transacted through Traders and Power Exchanges

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

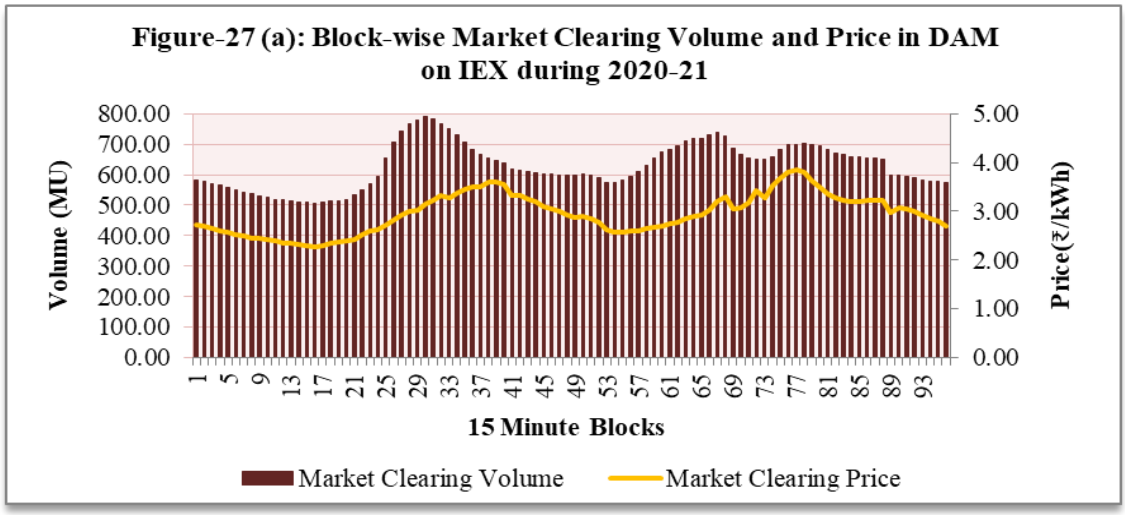
Time of the day variation in volume and price of electricity transacted through bilateral traders' transactions during 2020-21 is shown in Figure-26. The volume of electricity transacted through traders represent inter-state transactions, i.e., excluding banking transactions. Time of the day variation in volume is shown during RTC (Round the Clock), Peak period and OTP (other than RTC & Peak period). Of the total volume, 58.2% was transacted during RTC followed by 40.3% during OTP and 1.5% during peak period. It can be observed from the figure that the share of volume transacted during peak period is low, at 1.5% of the total transactions. It can also be observed that the weighted average price during Peak period was higher (₹4.00/kWh), as compared to prices during RTC (₹3.38/kWh) and OTP (₹3.50/kWh).

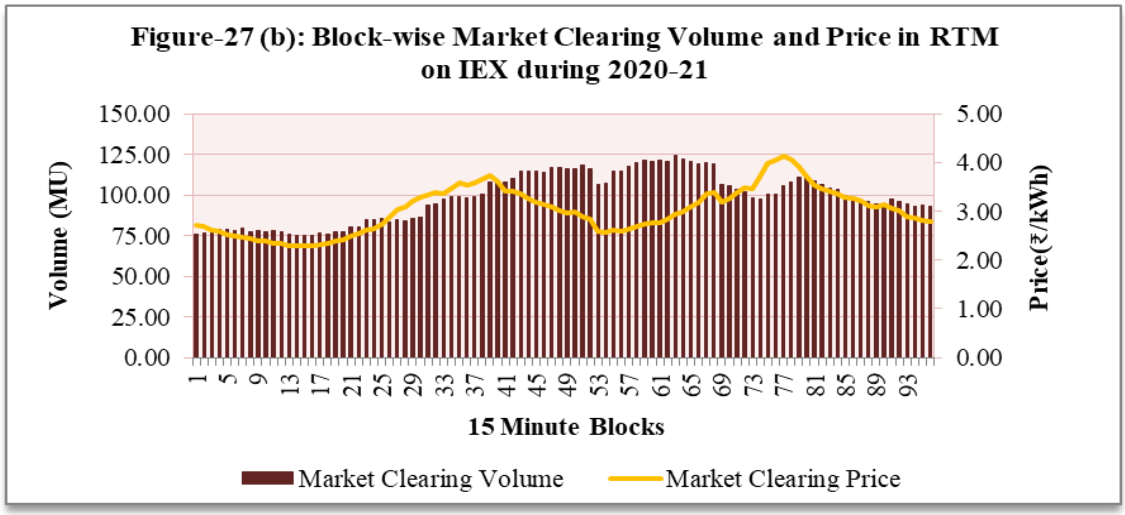
Figure-26: Volume and Price of Electricity Transacted through Traders during RTC, Peak and OTP, 2020-21



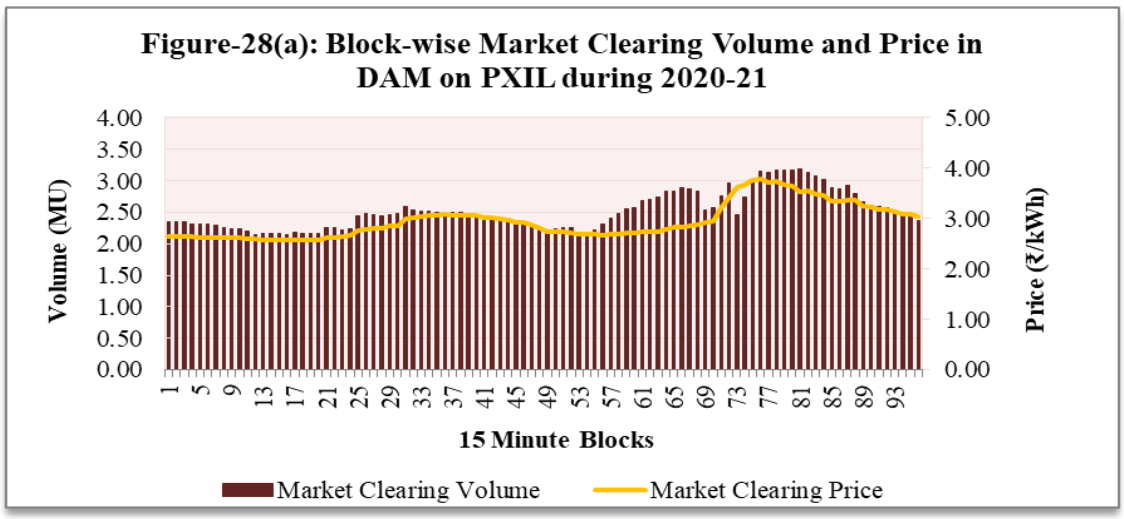
5.2 Time of the Day Variation in Volume and Price of Electricity Transacted through Power Exchanges

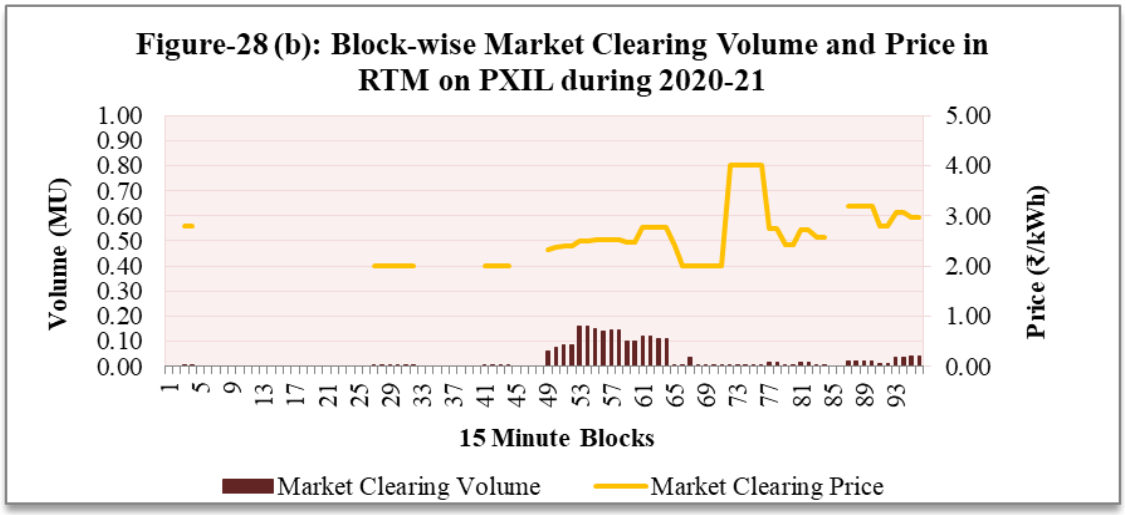
Time of the day variation in volume and price of electricity transacted under DAM and RTM at IEX during 2020-21 are shown block-wise in Figure-27(a) and Figure-27 (b) respectively. It can be observed from the figure that the weighted average price witnessed a similar trend in both DAM and RTM segment with price fluctuating during peak and non-peak hours.





Time of the day variation in volume and price of electricity transacted through DAM and RTM in PXIL during 2020-21 are shown block-wise in Figure-28(a) and Figure-28 (b) respectively.





Region-wise and hour-wise prices of electricity transacted through IEX and PXIL are shown in Figure-29(a) & (b) and Figure-30(a) & (b) respectively. It can be observed from the Figures 29(a) and 29(b) that during 2020-21, the price of electricity in southern region was marginally high during peak period when compared with the price in other regions in IEX. This is mainly due to high demand for electricity in the southern region. The prices were high due to congestion between southern region and rest of the regions, accompanied by market splitting on the power exchanges. The price of electricity in northern region was relatively low when compared with the price in other regions in PXIL {Figure 30(a)}.

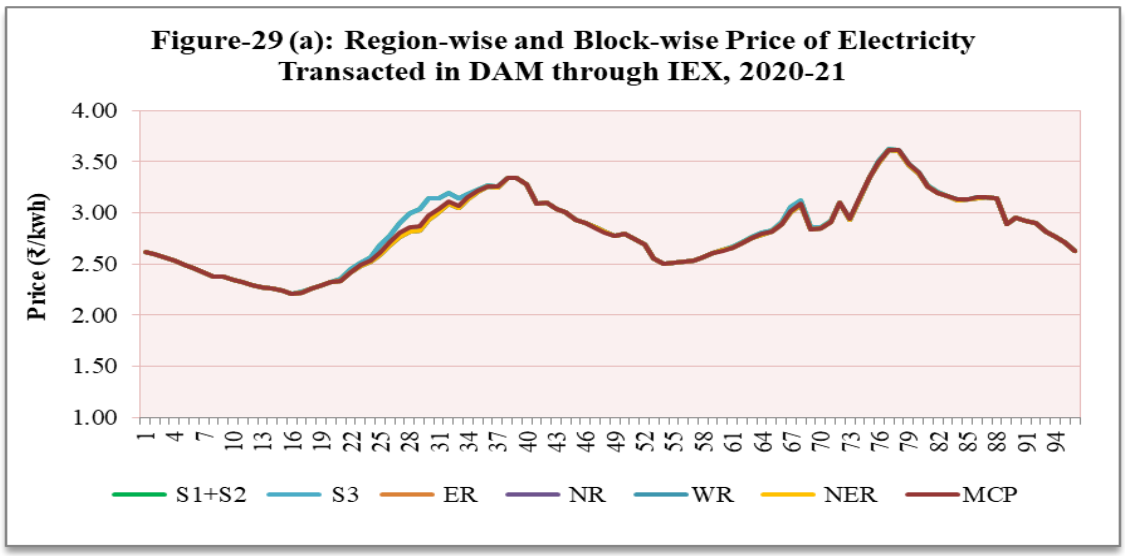


Figure-29 (b): Region-wise and Block-wise Price of Electricity Transacted in RTM through IEX, 2020-21

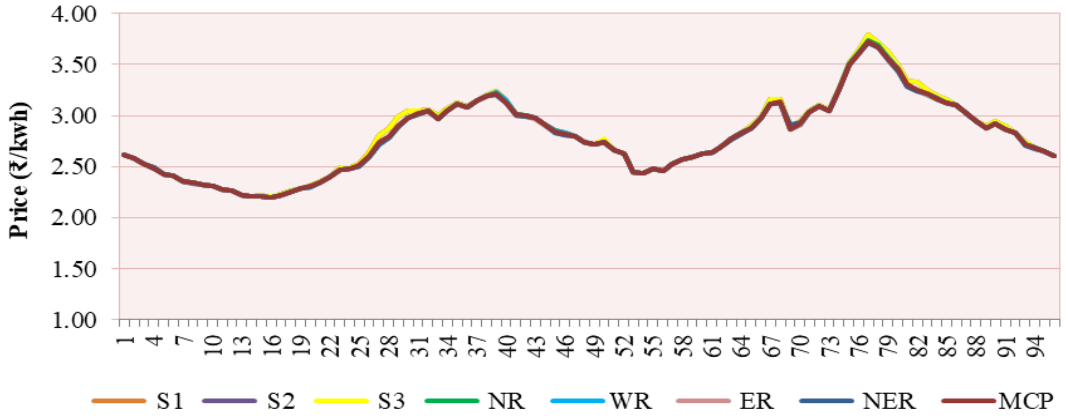


Figure-30 (a): Region-wise and Block-wise Price of Electricity Transacted in DAM through PXIL, 2020-21

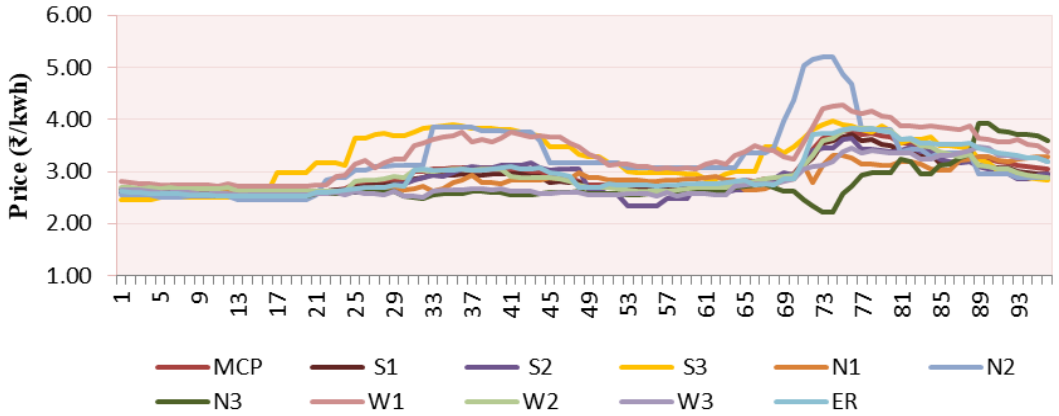
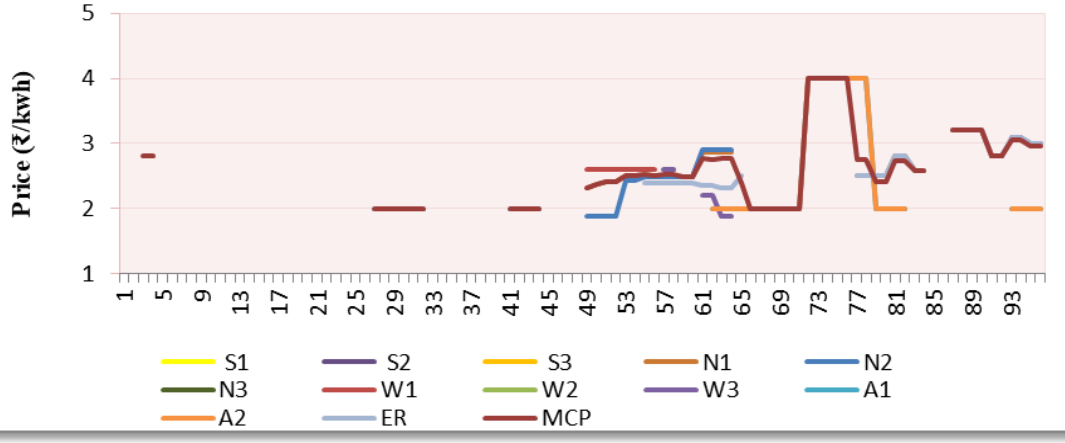


Figure-30 (b): Region-wise and Block-wise Price of Electricity Transacted in RTM through PXIL, 2020-21



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 has necessitated to fix 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-31).

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.

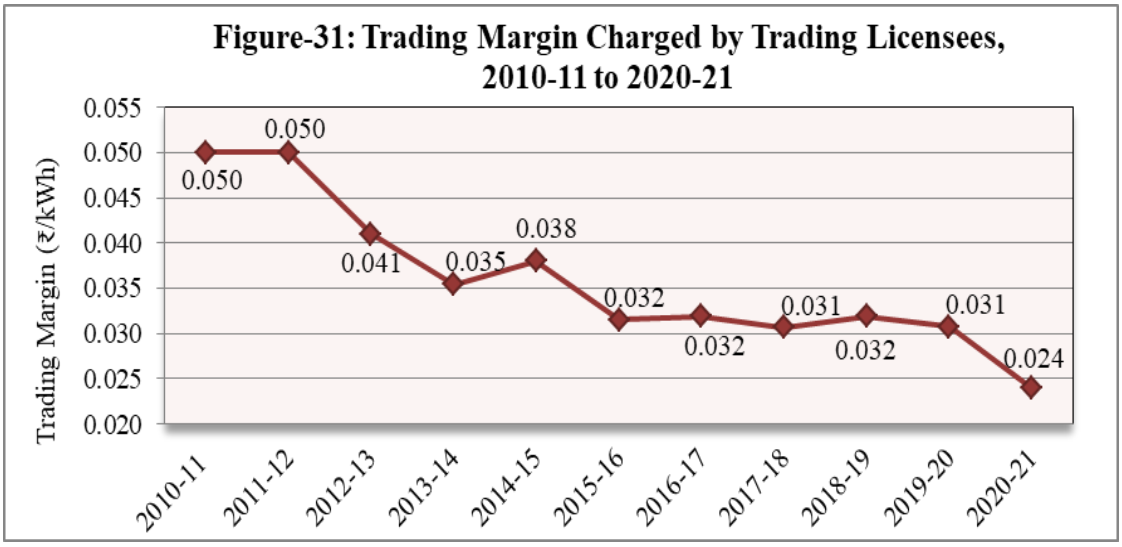
For increasing the volume of trading, some of the trading licensees misunderstood the intention of the trading margin regulations and charged negative trading margin for some of the transactions. Keeping this in view and to avoid negative trading margin, the Commission, in the CERC (Procedure, Terms 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) paise/kWh. The weighted average trading margin charged by the trading licensees for bilateral transactions during 2010-11 to 2020-21 is provided in Table-20 and Figure-31.

Table -20: Trading Margin Charged by Trading Licensees, 2010-11 to 2020-21

Period	Trading Margin (₹/kWh)
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

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



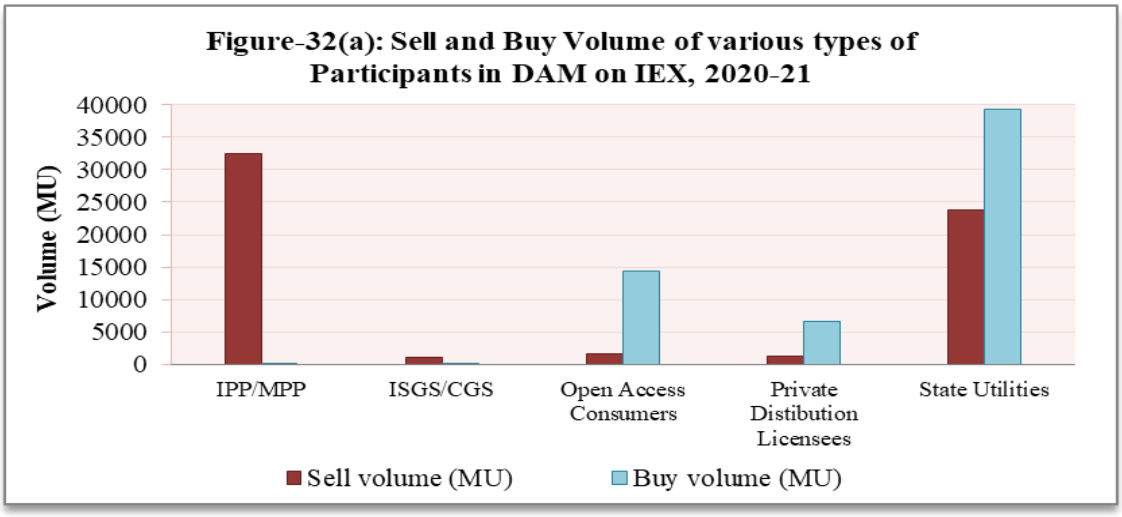
It can be observed from the above figure that the trading margin charged by the trading licensees remained stable at around 3.0 paise/kWh during the period from 2015-16 to 2019-20, before falling to 2.4 paise/kWh in 2020-21. This may be attributed to the increasing competition among the trading licensees.

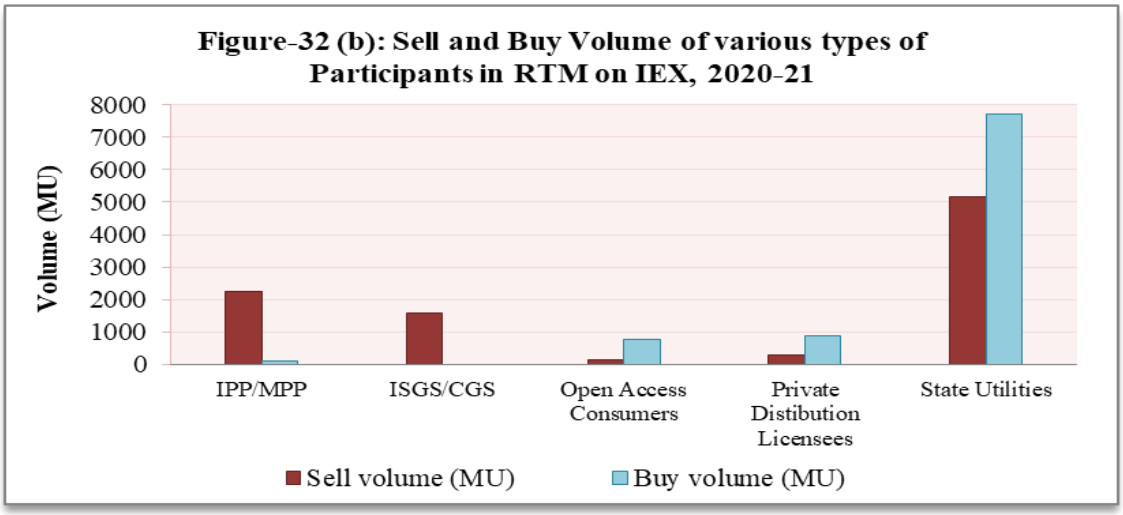
7. Open Access Consumers on Power Exchanges

This section discusses the various types of participants in power exchanges and provides analysis of open access consumers in DAM and RTM segments of power exchanges.

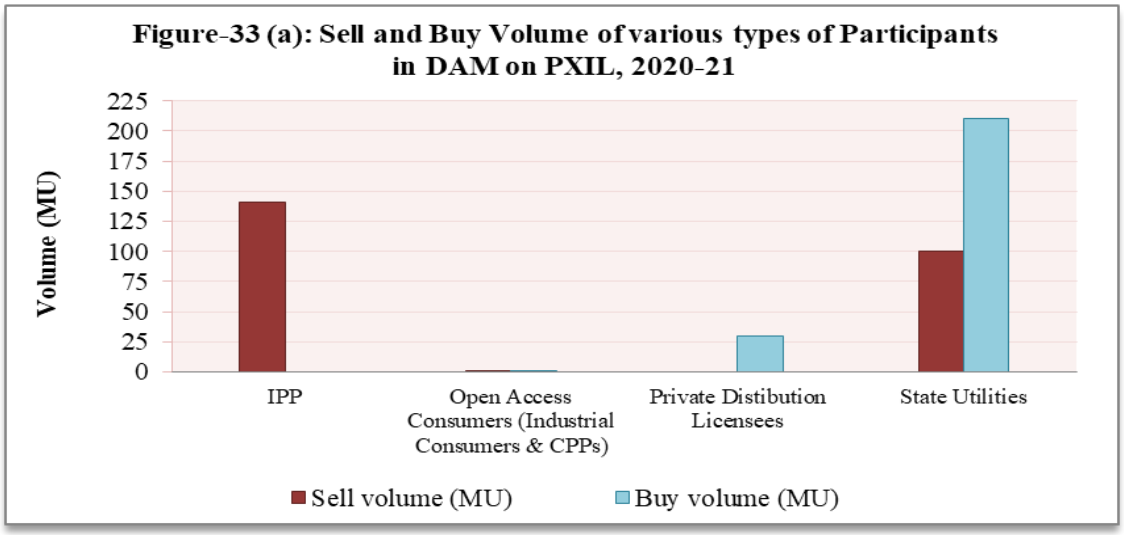
7.1 Types of Participants in Power Exchanges

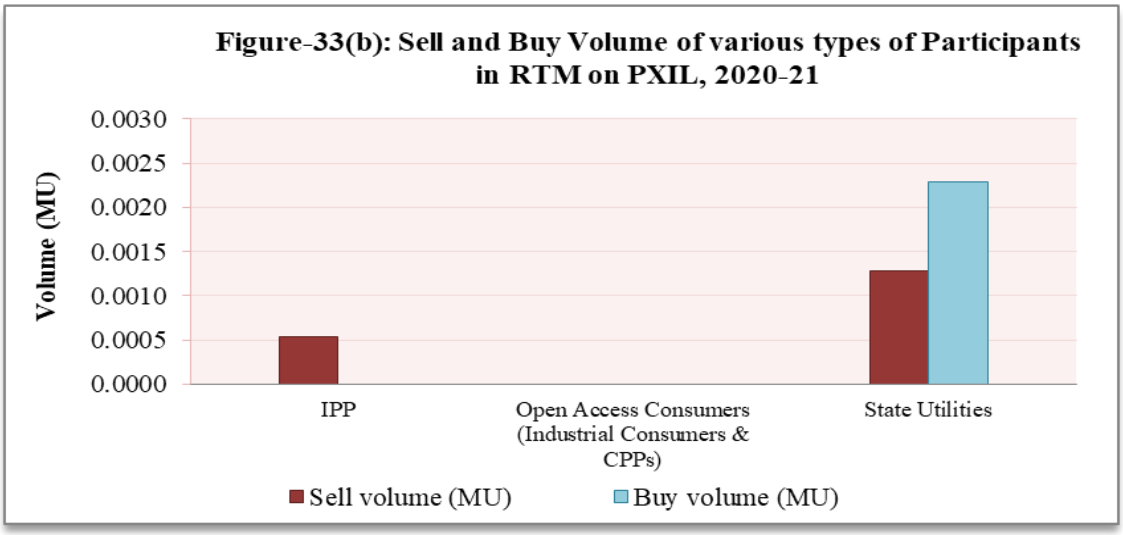
As shown in Figure-32 (a) and (b), there were five types of participants at IEX under DAM and RTM segments. In case of DAM, the major sellers of electricity at IEX were independent power producers and state utilities, while the major buyers of electricity were state utilities followed by open access consumers and private distribution licensees {Figure 32 (a)}. In case of RTM, state utilities were the major buyers as well as major sellers of electricity during 2020-21. The second largest seller in RTM were independent power producers, followed by inter-state generating station (ISGS).





There were 4 types of participants at PXIL in DAM during 2020-21, as shown in Figure-33 (a). It can be observed from the figure that major sellers of electricity at PXIL in DAM were independent power producers and state utilities, while major buyers of electricity at PXIL were state utilities and private distribution licencees. In case of RTM, there were 3 types of participants at PXIL as shown in Figure-33(b). The state utilities were the major sellers as well as buyers of electricity in RTM at PXIL, followed by independent power producers as major seller.





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 in both IEX and PXIL increased from 825 and 170 respectively in 2010-11 to 4768 and 632 respectively in 2020-21 (Table-21). During the period, the percentage of open access consumers in total portfolios varied between 90% to 96% in IEX whereas the percentage varied between 16% to 90% in PXIL. The number of OA consumers in IEX increased at a CAGR of 19%, and at 14% in case of PXIL. Though there is an increasing trend in the number of OA consumers in PXIL, the percentage of open access consumers in total portfolio of PXIL declined significantly from the high of about 90% in 2010-11 to 17% in 2020-21.

Table-21: Number of Open Access Consumers in Power Exchanges, 2010-11 to 2020-21

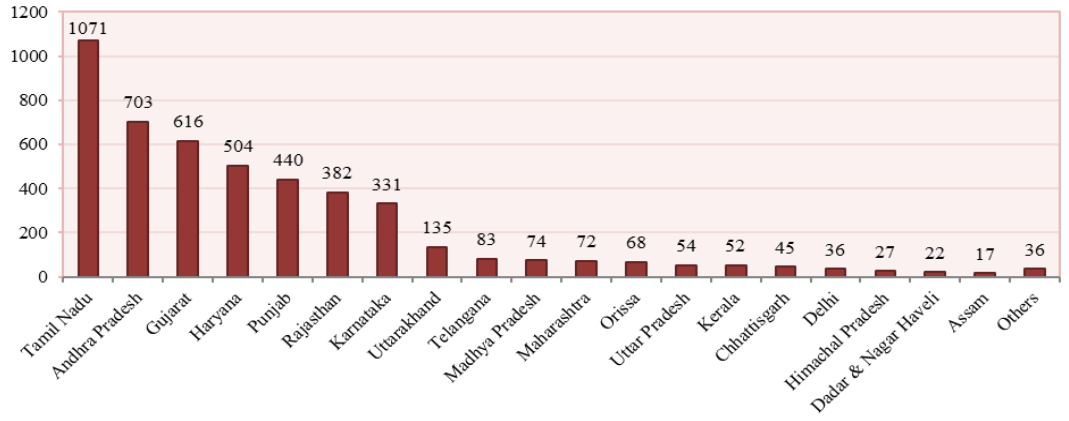
Year	IEX			PXIL		
	No. of Open Access Consu-mers	Total No. of Portfolios	% of Open Access Consu-mers	No. of Open Access Consu-mers	Total No. of Portfolios	% of Open Access Consu-mers
2010-11	825	863	95.6%	170	190	89.5%
2011-12	968	1073	90.2%	231	465	49.7%
2012-13	2110	2227	94.7%	336	379	88.7%

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%

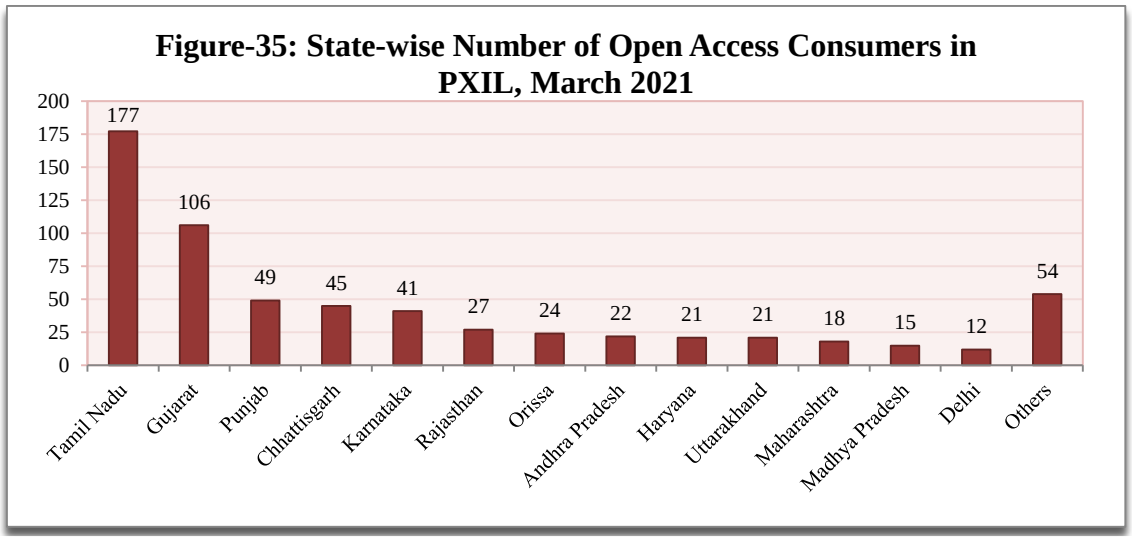
Note: Status as on 31st March of respective year.

In 2020-21, about 4768 OA consumers procured 14383 MU of electricity (a part of their power requirements) through IEX. These OA consumers were mostly located in Tamil Nadu, Andhra Pradesh, Gujarat, Haryana, Punjab, Rajasthan, Karnataka, and Uttarakhand (Figure-34). The weighted average price of electricity bought by OA consumers at IEX was lower (₹2.64/kWh) when compared to the weighted average price of total electricity transacted through IEX (₹3.00/kWh).

Figure-34: State-wise Number of Open Access Consumers in IEX in March 2021



About 632 OA consumers procured 0.24 MU of electricity (a part of their power requirements) through PXIL in 2020-21. These consumers were mostly located in Tamil Nadu, Gujarat, Punjab, Chhattisgarh, and Karnataka (Figure-35). The weighted average price of electricity bought by open access consumers at PXIL was lower (₹2.78/kWh) when compared to the weighted average price of total electricity transacted through PXIL (₹2.98/kWh).



Annual comparison between purchase volume of OA consumers and total volume in DAM of IEX and PXIL during 2010-11 to 2020-21 is shown in Table-22 (a). As may be seen in the Table below, the volume of electricity procured by OA consumers as a percentage of total volume transacted in IEX during 2010-11 to 2020-21 varied between 22% and 61%, while the volume of electricity procured by OA consumers as a percentage of total volume transacted in PXIL varied between 0.1% and 58% during the same period.

Table-22 (a): Volume of Purchase by Open Access Consumers in Day Ahead Market of Power Exchanges, 2010-11 to 2020-21

Year	IEX			PXIL		
	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Participation	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Participation
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%

The month-wise trend in purchase volume by OA consumers vis-à-vis total volume in RTM, which became operational in power exchanges from June 2020, is given in Table 22 (b). As may be seen in the Table, the volume of electricity procured by OA consumers as a percentage of total volume transacted in IEX varied between 6% to 13%, while no electricity was procured by OA consumers through PXIL in RTM segment.

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

Year	IEX			PXIL		
	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Partici-pation	OAC Purchase Volume (MU)	Total Volume (MU)	% OAC Purchase Partici-pation
Jun-20	35.51	515.46	6.89%	0.00	1.86	0.00%
Jul-20	44.08	784.94	5.62%	0.00	0.43	0.00%
Aug-20	65.33	860.57	7.59%	0.00	0.00	-
Sep-20	80.11	704.04	11.38%	0.00	0.00	-
Oct-20	103.39	814.48	12.69%	0.00	0.00	-
Nov-20	88.48	893.62	9.90%	0.00	0.00	-
Dec-20	81.50	1129.09	7.22%	0.00	0.00	-
Jan-21	80.67	1233.31	6.54%	0.00	0.00	-
Feb-21	74.20	1118.45	6.63%	0.00	0.00	-
Mar-21	123.46	1413.96	8.73%	0.00	0.00	-
Total	**776.73**	**9467.94**	**8.20%**	**0.00**	**2.29**	**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

Top 10 sellers and buyers of electricity through traders (bilateral trader segment transactions) 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 is also provided in the tables.

Details of Top 10 sellers in DAM and RTM segment of IEX are given in Table-25 (a) & (b) respectively and details of top 10 buyers of electricity in DAM and RTM segment of IEX are given in Table-26 (a) & (b). Similarly, details of Top 10 sellers and

buyers of electricity in DAM and RTM segment of PXIL are given in Table-27 (a) &(b) and Table-28 (a) & (b) respectively.

As can be seen that 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.

Table 23: Major Sellers of Electricity through Traders, 2020-21

S.No.	Seller	State	Volume (MU)	Approx. % of total volume transacted through Traders	Weighted Average Price (₹/kWh)
1	Raipur Energen Ltd.	Chhattisgarh	2242.55	17.97%	3.20
2	Essar Power MP Limited	Madhya Pradesh	1675.15	13.43%	2.88
3	Adani Power Ltd	Gujarat	1512.79	12.12%	3.60
4	HPSEB	Himachal Pradesh	1457.41	11.68%	4.33
5	Jaypee Nigrie STPP	Madhya Pradesh	871.37	6.98%	3.26
6	Jindal Power Ltd.	Chhattisgarh	789.27	6.33%	3.07
7	Raigarh Energy Generation Ltd.	Chhattisgarh	681.10	5.46%	3.06
8	DB Power Ltd	Chhattisgarh	666.61	5.34%	3.27
9	Sembcorp Energy India Limited	Andhra Pradesh	604.75	4.85%	3.07
10	Power Company of Karnataka Ltd.	Karnataka	484.13	3.88%	4.89

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, 2020-21

S.No.	Buyer	State	Volume (MU)	Approx. % of total volume transacted through traders	Weighted Average Price (₹/kWh)
1	PSPCL	Punjab	2533.77	20.31%	3.02
2	UPPCL	Uttar Pradesh	1628.45	13.05%	3.49
3	TANGEDCO	Tamil Nadu	1503.29	12.05%	3.49

4	JVVNL	Rajasthan	851.37	6.82%	3.05
5	HPSEB	Himachal Pradesh	818.34	6.56%	3.01
6	Adani Electricity Mumbai Ltd	Maharashtra	655.13	5.25%	3.55
7	TPDDL	Delhi	636.56	5.10%	4.86
8	GUVNL	Gujarat	550.02	4.41%	2.77
9	BSES Rajdhani Power Limited	Delhi	483.97	3.88%	3.91
10	NDMC	Delhi	311.10	2.49%	4.26

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

As can be seen from Table 24, the weighted average purchase prices of electricity of major buyers such as UPPCL, TANGEDCO, Adani Electricity Mumbai Ltd, TPDDL, BSES Rajdhani Power Limited and NDMC from traders (bilateral transactions) were higher than the weighted average price for the entire bilateral trader segment (₹3.47/kWh).

Table-25 (a): Major Sellers of Electricity in Day Ahead Market of IEX, 2020-21

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	Teesta Urja Ltd	Sikkim	4674.48	7.74%	2.81
2	GRIDCO	Odisha	4620.73	7.65%	2.90
3	UPPCL	Uttar Pradesh	4089.12	6.77%	3.17
4	Jaypee Nigrie STPP	Madhya Pradesh	2694.99	4.46%	2.97
5	Sembcorp Energy India Ltd	Andhra Pradesh	2369.65	3.92%	3.13
6	WBSEDCL	West Bengal	1967.94	3.26%	3.42
7	Jindal Power Ltd Stage I	Chhattisgarh	1834.47	3.04%	2.98
8	Raipur Energen Ltd	Chhattisgarh	1832.92	3.04%	2.87
9	GOHP	Himachal Pradesh	1595.33	2.64%	2.61
10	JKPCL	J&K	1537.69	2.55%	2.41

Note: Total Volume transacted through Day Ahead Market in IEX was about 60376.03 MU.

Table-25 (b): Major Sellers of Electricity in Real Time Market of IEX, 2020-21

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	740.99	7.83%	3.64
2	GRIDCO	Odisha	738.32	7.80%	3.21
3	WBSEDCL	West Bengal	600.00	6.34%	3.96
4	UPPCL	Uttar Pradesh	599.87	6.34%	2.83
5	JKPCL	J&K	524.43	5.54%	2.36
6	Power Company of Karnataka Ltd.	Karnataka	465.21	4.91%	2.38
7	RUVNL	Rajasthan	319.46	3.37%	2.89
8	Sembcorp Energy India Ltd	Andhra Pradesh	299.33	3.16%	2.98
9	NLC Thermal Power Station- II Stage- I	Tamil Nadu	262.42	2.77%	2.60
10	TSSPDCL	Telangana	214.11	2.26%	2.95

Note: Total Volume transacted through Real Time Market in IEX was about 9467.94 MU.

Table-26 (a): Major Buyers of Electricity in Day Ahead Market of IEX, 2020-21

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	APSPDCL	Andhra Pradesh	7227.71	11.97%	3.15
2	GUVNL	Gujarat	5918.05	9.80%	3.47
3	TSSPDCL	Telangana	5506.04	9.12%	3.19
4	MSEDCL	Maharashtra	3768.25	6.24%	2.59
5	Adani Electricity Mumbai Limited	Maharashtra	3352.94	5.55%	2.79
6	PSPCL	Punjab	3323.97	5.51%	2.61
7	RUVNL	Rajasthan	2273.81	3.77%	3.39
8	UPCL	Uttarakhand	1729.85	2.87%	2.80
9	JKPCL	J&K	1539.81	2.55%	3.14
10	TANGEDCO	Tamil Nadu	1421.34	2.35%	3.57

Note: Total Volume transacted through Day Ahead Market in IEX was about 60376.03 MU.

Table-26(b): Major Buyer of Electricity in Real Time Market of IEX, 2020-21

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	JKPCL	J&K	740.99	7.83%	3.64
2	TSSPDCL	Telangana	738.32	7.80%	3.21
3	RUVNL	Rajasthan	600.00	6.34%	3.96
4	APSPDCL	Andhra Pradesh	599.87	6.34%	2.83
5	WBSEDCL	West Bengal	524.43	5.54%	2.36
6	HPPC	Haryana	465.21	4.91%	2.38
7	MSEDCL	Maharashtra	319.46	3.37%	2.89
8	GUVNL	Gujarat	299.33	3.16%	2.98
9	PSPCL	Punjab	262.42	2.77%	2.60
10	TPCL	Maharashtra	214.11	2.26%	2.95
Note: Total Volume transacted through Real Time Market in IEX was about 9467.94 MU.					

From Table-26 (a), it can be seen that the weighted average prices of electricity for major buyers such as APSPDCL, GUVNL, TSSPDCL, RUVNL, JKPCL and TANGEDCO 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 (₹2.99/kWh). Moreover, the weighted average prices of electricity for major buyers such as JKPCL, RUVNL and TSSPDCL in the RTM segment of IEX was higher than the weighted average price of the electricity transacted through the entire real time market of IEX (₹3.06/kWh) as may be seen in Table 26 (b).

Table-27(a): Major Sellers of Electricity in Day Ahead Market of PXIL, 2020-21

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	Sembcorp Energy India Ltd	Andhra Pradesh	46.66	19.34%	2.80
2	Adani Power Limited Stage 2	Gujarat	38.62	16.01%	2.96
3	GRIDCO Ltd	Odisha	33.49	13.89%	2.98
4	JBVNL	Jharkhand	22.22	9.21%	2.54
5	KSEB	Kerala	17.59	7.29%	3.56
6	MPPMCL	Madhya Pradesh	15.60	6.47%	4.04
7	Raipur Energen Limited	Chhattisgarh	11.69	4.85%	2.87
8	Essar Power MP Limited	Madhya Pradesh	10.04	4.16%	2.91
9	DB Power Ltd	Chhattisgarh	9.22	3.82%	2.87
10	Adani Power Limited Stage 3	Gujarat	8.38	3.47%	2.90
Note: Total Volume transacted in the Day Ahead Market of PXIL was about 241.19 MU.					

Table-27(b): Major Sellers of Electricity in Real Time Market of PXIL, 2020-21

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	UPPCL	Uttar Pradesh	0.90	39.34%	2.68
2	Essar Power MP Limited	Madhya Pradesh	0.43	18.91%	2.62
3	GRIDCO	Orissa	0.26	11.36%	2.86
4	Singrauli STPS	Uttar Pradesh	0.14	5.91%	2.06
5	Rihand STPS-II	Uttar Pradesh	0.10	4.37%	2.19
6	Rihand STPS-I	Uttar Pradesh	0.07	3.02%	2.32
7	HPSEB	Himachal Pradesh	0.06	2.73%	2.57
8	NCTPS Dadri II	Uttar Pradesh	0.06	2.70%	2.37
9	Kahalgaon Super Thermal Power Station Stage-II	Bihar	0.05	2.39%	3.02
10	Raipur Energen Limited	Chhattisgarh	0.05	2.19%	2.60
Note: Total Volume transacted through Real Time Market in PXIL was about 2.29 MU.					

Table-28(a): Major Buyers of Electricity in Day Ahead Market of PXIL, 2020-21

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	APSPDCL	Andhra Pradesh	110.87	45.97%	2.91
2	Adani Electricity Mumbai Limited	Maharashtra	29.99	12.43%	2.98
3	BSPHCL	Bihar	22.12	9.17%	3.10
4	PSPCL	Punjab	17.88	7.42%	2.65
5	TSSPDCL	Telangana	14.09	5.84%	3.27
6	GUVNL	Gujarat	12.99	5.39%	2.80
7	JBVNL	Jharkhand	10.01	4.15%	4.06
8	TANGEDCO	Tamil Nadu	8.98	3.73%	3.01
9	HPSEB	Himachal Pradesh	7.23	3.00%	2.91
10	RUVNL	Rajasthan	2.44	1.01%	3.60
Note: Total Volume transacted in the Day Ahead Market of PXIL was about 241.19 MU.					

Table-28(b): Major Buyer of Electricity in Real Time Market of PXIL, 2020-21

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	HPPC	Haryana	1.75	76.37%	2.56
2	TANGEDCO	Tamil Nadu	0.14	6.33%	3.05
3	WBSEDCL	West Bengal	0.14	6.07%	2.45
4	MSEDCL	Maharashtra	0.09	3.72%	2.60
5	DVC	DVC	0.08	3.50%	3.20
6	MSPDCL	Manipur	0.05	2.29%	2.67
7	TSSPDCL	Telangana	0.04	1.72%	2.14
Note: Total Volume transacted through Real Time Market in PXIL was about 2.29 MU.					

From Table-28 (a), it can be seen that the weighted average prices of electricity for major buyers such as BSPHCL, TSSPDCL, JBVNL, TANGEDCO and RUVNL in the DAM of PXIL were much higher than the weighted average price of the electricity transacted through the entire day ahead market of PXIL (₹2.98/kWh). Moreover, the weighted average prices of electricity for major buyers such as TANGEDCO, DVC and

MSPDCL in the RTM segment of PXIL was higher than the weighted average price of the electricity transacted through the entire real time market of PXIL (₹2.61/kWh) as maybe seen in Table 28 (b).

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. The details of congestion in both the power exchanges are shown in Table-29 and Table-30.

The effect of congestion on volume of electricity transacted through power exchanges during 2010-11 to 2020-21 is shown in Table-29. It can be observed from the table that there is an increasing trend in the unconstrained cleared volume and actual volume transacted. Unconstrained cleared volume and actual volume transacted increased from 14.26 BU and 13.54 BU respectively in 2010-11 to 70.13 BU and 70.09 BU respectively in 2020-21. The volume of electricity that could not be cleared, i.e., the difference of unconstrained cleared volume and actual volume transacted, as % to unconstrained cleared volume witnessed an increasing trend during 2010-11 to 2012-13 and thereafter showed a declining trend from 2012-13 to 2020-21, with the lowest rate of 0.06% reported in 2020-21. Congestion for the volume of electricity transacted through power exchanges reduced significantly 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 percentage to unconstrained cleared volume in both the power exchanges from 2013-14 onwards. During the last 4 years, i.e., 2017-18 to 2020-21, the volume of electricity that could not be cleared as % to unconstrained cleared volume was less than 1%, which shows that the congestion remained insignificant.

Table-29: Effect of Congestion on the Volume of Electricity Transacted through Power Exchanges, 2010-11 to 2020-21

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
2010-11	14.26	13.54	0.72	5%
2011-12	17.08	14.83	2.26	13%
2012-13	27.67	23.02	4.65	17%
2013-14	35.62	30.03	5.59	16%
2014-15	31.61	28.46	3.14	10%
2015-16	36.36	34.20	2.16	6%
2016-17	41.60	40.08	1.52	4%
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%
** This power would have been scheduled had there been no congestion.*				

Source: IEX & PXIL

During 2020-21, in IEX, the unconstrained cleared volume and the actual volume transacted was 60.41 BU and 60.38 respectively in DAM segment (Table-30), whereas in RTM in IEX, the unconstrained cleared volume and the actual volume transacted was 9.48 BU and 9.47 BU respectively. Therefore, the actual transacted volume was 0.05% lesser than unconstrained volume in DAM and 0.12% in RTM segment of IEX. During the same period, in PXIL the unconstrained cleared volume and the actual volume transacted was 0.24 BU and 0.24 BU respectively in DAM segment (Table-30), whereas in RTM in PXIL, the unconstrained cleared volume and the actual volume transacted was 0.002 BU and 0.002 BU respectively. Therefore, the actual transacted volume was 0.02% lesser than unconstrained volume in DAM and 0.00% in RTM segment of PXIL.

Table-30: Details of Congestion in Power Exchanges, 2020-21

	Items	IEX		PXIL		Total
		DAM	RTM	DAM	RTM	
A	Unconstrained Cleared Volume* (BU)	60.41	9.48	0.24	0.002	70.13

B	Actual Cleared Volume and hence scheduled (BU)	60.38	9.47	0.24	0.002	70.09
C	Volume of electricity that could not be cleared and hence not scheduled because of congestion (BU) (A-B)	0.03	0.01	0.00	0.00	0.04
D	Volume of electricity that could not be cleared as % to Unconstrained Cleared Volume	0.05%	0.12%	0.02%	0.00%	0.06%
** This power would have been scheduled had there been no congestion.*						

Source: IEX, PXIL & 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 both power exchanges for the period from 2010-11 to 2020-21 are provided in Table-31.

Table-31: Congestion Charges of Power Exchanges, 2010-11 to 2020-21

Year	Congestion Charges of IEX (₹ Crore)	Congestion Charges of PXIL (₹ Crore)	Total (₹ Crore)
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*	70.96	0.0043	70.96

Source: NLDC

**Congestion revenue is summation of DAM (IEX: ₹ 65.06 Cr and PXIL: ₹ 0.0043 Cr) and RTM (IEX: ₹ 5.90 Cr and PXIL: ₹ 0 Cr)*

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 time frames 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; (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, increasing private sector participation and competition introduced in 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. 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.

Regulation Up Service shall utilize "un-requisitioned surplus" of inter-State generating stations, whose tariff is determined or adopted by the Commission for their full capacity. Un-requisitioned surplus means the reserve capacity in a generating station that has not been requisitioned and is available for dispatch, and is computed as the difference between the declared capacity of the generating station and its total schedule under long-terms, medium-term and short-term transactions, as per the relevant regulations of the Commission. On the other hand, Regulation Down service may be provided by any eligible generator. Incentives for both the generators and their beneficiaries have been built into the framework.

As per the regulation, all the generators, that are regional entities, and whose tariff for the full capacity is determined or adopted by the CERC have been mandated to

provide Ancillary Services as RRAS Providers. NLDC, through the RLDCs, has been designated as the Nodal Agency for Ancillary Services Operations. The Nodal Agency prepares the Merit Order Stack based on the variable cost of generation. Separate stacks are prepared for Up and Down.

Ancillary Services may be triggered because of extreme weather forecast, generating unit or transmission line outages, trend of load met, trend of frequency, any abnormal event such as outage of hydro generating units due to silt, coal supply blockade, etc., excessive loop flows leading to congestion, trend of computed Area Control Error (ACE) at regional level, recall by the original beneficiary, grid voltage profile at important nodes, 'N-1' criteria not being satisfied in a transmission corridor, loading of transmission lines beyond limits specified in CEA Manual on Transmission Planning Criteria.

A virtual regional entity called "Virtual Ancillary Entity (VAE)" has been created in the respective Regional Pool for scheduling and accounting. The quantum of RRAS instruction is incorporated in the schedule of RRAS providers. RRAS instruction may be scheduled to the VAE in any one or more regional grids. The deviation in schedule of the RRAS providers, beyond the revised schedule, is being settled as per the CERC Deviation Settlement Mechanism (DSM) Regulations. The energy dispatched under RRAS is deemed delivered ex-bus.

Nodal agency directs the RRAS provider to withdraw RRAS, on being satisfied, that the circumstances leading to triggering of RRAS services have ceased to exist. The RRAS energy accounting is being done by the respective Regional Power Committee (RPC) on weekly basis along with DSM account, based on interface meters data and schedule. A separate RRAS statement is being issued by RPC along with Regional DSM account. Any post-facto revision in rates/charges by RRAS providers is not permitted. In case of Regulation Up, fixed charges and variable charges along with pre-specified mark-up are payable to the RRAS providers from the pool. CERC, vide order dated 29th February 2016, specified the mark-up for participation in Regulation 'Up' as 50 paisa/kWh. In case of Regulation Down, 75 percent of the variable charges are

payable by RRAS providers to the pool. No commitment charges are payable to the RRAS provider.

10.3 RRAS Instructions issued by Nodal Agency

Table-32 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 2020-21 in a time block, maximum power despatched was 3300 MW in May 2020 while the maximum power regulated was 5000 MW in March 2021.

Table 32: Maximum Ancillary despatched in a Time Block (MW), 2020-21

Month	Max Regulation "UP"	Max Regulation "DOWN"
Apr-20	3126	2137
May-20	3300	2701
Jun-20	2134	2380
Jul-20	1612	2793
Aug-20	2040	2808
Sep-20	2052	1989
Oct-20	1500	2000
Nov-20	1500	3500
Dec-20	1500	2500
Jan-21	1500	2500
Feb-21	1000	2500
Mar-21	1300	5000

Source: POSOCO 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 2020-21 are given in Table-33.

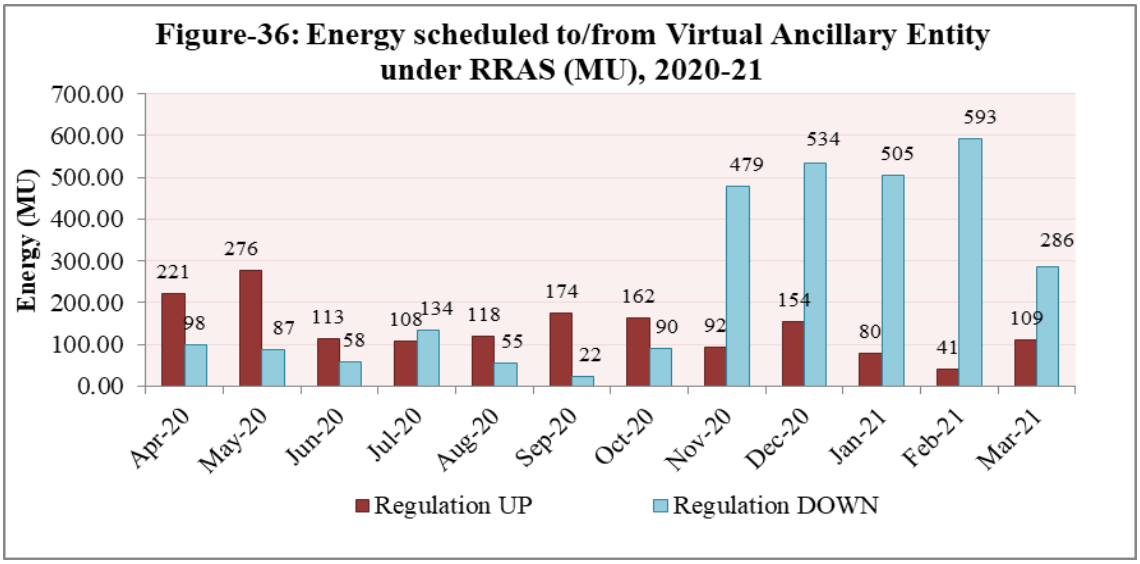
Table 33: Energy Scheduled and Payments made for Ancillary Services, 2016-17 to 2020-21

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

Source: POSOCO Website

The energy scheduled under Regulation UP of RRAS was decreased from 2212.28 MU in 2016-17 to 1649.50 MU in 2020-21, whereas the energy scheduled under Regulation DOWN of RRAS was increased from 286.00 MU in 2016-17 to 2940.01 MU in 2020-21.

Month-wise energy scheduled to/from VAE under RRAS during 2020-21 can be seen in Figure-36. It can be observed from the figure that ancillary despatch under Regulation UP was relatively high when compared with the ancillary despatch under Regulation DOWN during the initial months of 2020-21. However, from November 2020 onwards, the ancillary despatch under Regulation DOWN was much higher as compared to ancillary despatch under Regulation UP.



Presently, the Ancillary Services implementation is load-following and for congestion management. The RRAS is primarily a framework for tertiary reserves, therefore, there is a need for enhancing the adequacy of reserves with shorter time of response.

Secondary control is the control area (Region considered as area) wise automatic control which delivers reserve power in order to bring back the frequency and the area interchange programs to their target values. In doing so, the delivered primary control reserves are restored on those machines which have contributed to primary response. The AGC implemented projects have the ability to follow signals given directly by the system operator (POSOCO), to regulate variation in ACE by increasing/decreasing generation. The response time is quick and automated, in the range of few minutes.

For stable frequency operation and security of the grid, the Automatic Generation Control (AGC) is used as one of the steps for Secondary Control. The Commission in its order dated 06.12.2017 approved the Commissioning of the AGC Pilot Project between NLDC and NTPC Dadri Stage-II. The Commission also directed that similar pilot projects may be replicated by NLDC, in at least one other regional grid of the country. The Commission after gaining valuable experience through pilot projects, envisages large scale implementation of AGC as a step forward. Vide its order dated 28.08.2019, the Commission has directed all thermal

Inter State Generating Stations that are regional entities with installed capacity of 200 MW and above and all hydro stations with capacity exceeding 25 MW (excluding the Run-of-River Hydro Projects) and whose tariff is determined or adopted by the Commission, to install the required software for implementation of AGC at the unit control rooms for transferring the required set of data for AGC. Further the Central Transmission Utility and the NLDC are also directed to commission the required communication system in parallel. Valuable experience has been gained in terms of implementation aspects, communication protocols, generator regulation and load following capabilities, cyber security etc. which is useful for implementation of secondary reserves on a large scale. The Commission observes that the feedback on implementation of AGC submitted by POSOCO highlights the need for enhancing adequacy of reserves in the country.

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Chapter-III

Cross Border Trade of Electricity

1. Background

The Cross Border Trade of Electricity (import or export of electricity between India and its neighbouring countries) between India and Nepal and between India and Bhutan has been taking place for many years. The Cross Border Trade of Electricity was expanded significantly since the year 2013. India has started exporting electricity to Bangladesh from the year 2013 and to Myanmar from the year 2017.

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

The Ministry of Power (MOP) issued the Guidelines on Cross Border Trade of Electricity on 05.12.2016, which was subsequently substituted by the 'Guidelines for Import/Export (Cross Border) of Electricity-2018' issued on 18.12.2018, to promote cross border trade of electricity with neighbouring countries. Following the guidelines, the Central Electricity Regulatory Commission has issued the CERC (Cross Border Trade of Electricity) Regulations, 2019 on 8th March 2019. The Central Electricity Authority (CEA) issued "Draft Conduct of Business Rules of the Designated Authority" on 25th April 2019 for facilitating the Cross Border Trade of Electricity. In continuation

to the draft business rules, on 21 Feb 2021, CEA notified the "Procedure for Approval and Facilitating Import/Export (Cross Border) of Electricity by the Designated Authority".

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

2. Cross Border Trade of Electricity

Presently, India exports electricity to Nepal, Bangladesh, and Myanmar, while India imports electricity from Bhutan. However, sometimes India also exports power to Bhutan during lean hydro season. Table-34 provides the details on Cross Border Trade of Electricity between Indian and its neighbouring countries during the period from 2013-14 to 2020-21.

Table-34: Cross Border Trade of Electricity between India and its Neighbouring Countries, 2013-14 to 2020-21 (BU)

Year	Bhutan (+)	Nepal (-)	Bangladesh (-)	Myanmar (-)	Net Export/Import by India
2013-14	5.56	0.84	1.45	0.00	3.27
2014-15	5.11	1.00	3.27	0.00	0.84
2015-16	5.56	1.47	3.65	0.00	0.43
2016-17	5.86	2.02	4.42	0.00	-0.58
2017-18	5.61	2.39	4.81	0.01	-1.59
2018-19	4.66	2.80	5.69	0.01	-3.84
2019-20	6.31	2.37	6.99	0.01	-3.06
2020-21	9.32	1.87	7.55	0.01	-0.11

(+) Import; (-) Export
Source: POSOCO

It can be observed from the above table that India was net importer of electricity during the period from 2013-14 to 2015-16 and net exporter of electricity during the period from 2016-17 to 2020-21.

India has gradually strengthened its position as an electricity exporting nation and has been exporting power to Bangladesh, Nepal, and Myanmar. Cross-border trade of electricity will get further boost with the opening of trading on power exchanges, in addition to the trade through existing trading arrangements.

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Chapter-IV

Tariff of Long-term Sources of Power

1. Background

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

Section 63 of the Act states that "Notwithstanding anything contained in section 62, the Appropriate Commission shall adopt the tariff if such tariff has been determined through transparent process of bidding in accordance with the guidelines issued by the Central Government" in line with the Ministry of Power's Competitive Bidding guidelines notified in 2005. The guidelines are being issued for procurement of electricity by distribution licensees for (a) long-term procurement of electricity for a period of 7 years and above and (b) medium-term procurement for a period of upto 7 years but exceeding 1 year. The guidelines shall apply for procurement of base-load, peak load and seasonal power requirements through competitive bidding, through the mechanisms: (i) where location, technology, or fuel is not specified by the procurer (Case-1); and (ii) for hydro-power projects, load center projects or other location specific projects with specific fuel allocation such as captive mines available, which the procurer intends to set up under tariff-based bidding process (Case-2).

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

2. Tariff of Central Public Sector power generating companies

In 2020-21, the central public sector power generating companies (NTPC, NHPC, NLC, NEEPCO, etc.)/ central government owned generating companies accounted for about 35% (provisional) of the total power generation in the country which was mainly procured by the various distribution companies through long-term Power Purchase Agreements.

The price paid by distribution companies to procure power from central government owned generating companies in 2020-21 is shown in Table-35 and 36. It can be seen that, on an average, the distribution companies paid between ₹1.05 and ₹5.75 per kWh for procuring power from coal-based stations, between ₹3.34 and ₹6.37 per kWh from gas-based power stations, (Table-35), and between ₹1.09 per kWh and ₹10.69 per kWh from hydro stations (Table-36).

Table-35: Tariff of Central Thermal Power Stations, 2020-21

Sl. No.	Name of the Generating Station	Installed Capacity (MW) as on March, 2021	Fixed charges (₹/kWh)	Energy Charges (₹/kWh)	Total Tariff (₹/ kWh)
I: Coal Based thermal generating Stations of NTPC					
A.	**Pit head Generating Stations**				
1	Rihand STPS (St-I)	1000	0.84	1.36	2.21
2	Rihand STPS (St-II)	1000	0.70	1.36	2.06
3	Rihand STPS (St-III)	1000	1.44	1.34	2.78
4	Singrauli STPS	2000	0.65	1.36	2.01
5	Farrakka STPS (St-I&II)	1600	0.82	2.54	3.36
6	Farrakka STPS (St-III)	500	1.49	2.50	3.99
7	Kahalgaon STPS (St-I)	840	1.05	2.19	3.24
8	Kahalgaon STPS (St-II)	1500	1.09	2.08	3.17

9	Vindhyachal STPS (St-I)	1260	0.85	1.78	2.63
10	Vindhyachal STPS (St-II)	1000	0.70	1.70	2.40
11	Vindhyachal STPS (St-III)	1000	1.04	1.70	2.74
12	Vindhyachal STPS (St-IV)	1000	1.56	1.68	3.24
13	Vindhyachal STPS (St-V)	500	1.67	1.71	3.38
14	Korba STPS (St-I & II)	2100	0.68	1.36	2.04
15	Korba STPS (St-III)	500	1.38	1.33	2.71
16	Ramagundam STPS (St-I&II)	2100	0.73	2.60	3.33
17	Ramagundam STPS (St-III)	500	0.77	2.56	3.32
18	Talcher TPS	460	1.44	1.87	3.31
19	Talcher STPS (St-I)	1000	0.96	2.02	2.98
20	Talcher STPS (St-II)	2000	0.71	2.00	2.71
21	Sipat STPS (St-I)	1980	1.30	1.43	2.73
22	Sipat STPS (St-II)	1000	1.23	1.47	2.70
23	Lara STPS (St-I)	800	1.96	2.46	4.42
24	Darlipalli STPS (St-I)	800	2.11	1.19	3.30
	Sub-Total (A)	**27440**			
B.	**Non-Pit head Generating Stations**				
25	FGUTPS (St-I)	420	1.08	3.53	4.60
26	FGUTPS (St-II)	420	1.01	3.57	4.58
27	FGUTPS (St-III)	210	1.34	3.54	4.88
28	FGUTPS (St-IV)	500	1.55	3.39	4.95
29	NCTP Dadri (St-I)	840	0.97	4.13	5.10
30	NCTP Dadri (St-II)	980	1.43	3.75	5.18
31	Tanda TPS (St-I)	440	1.26	3.17	4.43
32	Tanda TPS (St-II)	660	1.60	2.66	4.26
33	Simhadri STPS (St-I)	1000	0.94	3.28	4.22
34	Simhadri STPS (St-II)	1000	1.52	3.22	4.74
35	Mauda STPS (St-I)	1000	1.87	3.27	5.15
36	Mauda STPS (St-II)	1320	1.48	3.22	4.70
37	Barh STPS (St-II)	1320	1.84	2.46	4.30
38	Bongaigaon TPS	750	2.40	3.35	5.75
39	Solapur STPS	1320	1.72	3.06	4.78
40	Kudgi STPS	2400	1.66	3.71	5.37
41	Barauni TPS (St-I)	220	1.15	3.21	4.37
42	Barauni TPS (St-II)	250	2.38	2.27	4.65
43	Gadarwara STPS (St-I)	800	1.98	3.32	5.31
44	Khargone STPS (St-I)	660	2.06	2.93	4.99

	Sub-Total (B)	**16510**			
	Total Coal (A+B)	**43950**			
II: Gas based Power Generating Stations of NTPC					
1	Anta CCGT	419	0.71	5.66	6.37
2	Auraiya GPS	663	0.63	4.07	4.70
3	Dadri CCGT	830	0.58	4.42	5.00
4	Faridabad GPS	432	0.74	3.17	3.91
5	Gandhar GPS	657	1.06	3.05	4.11
6	Kawas GPS	656	0.84	2.84	3.68
7	Kayamkulam RGPS	360	1.14	Not Scheduled	
	Total	**4017**			
III: Gas based Power Generating Stations of NEEPCO					
1	Agartala GPS	135	1.91	2.58	4.49
2	Assam GPS	291	1.99	1.99	3.98
3	Tripura GPS	101	2.58	1.65	4.23
	Total NEEPCO	**527**			
IV: Lignite Based thermal generating Stations of NLC					
1	TPS-II Stage-I	630	2.71	0.71	3.41
2	TPS-II Stage-II	840	2.71	0.73	3.45
3	TPS-I (Expansion)	420	2.50	0.96	3.47
4	TPS-II (Expansion)	500	2.53	2.30	4.84
5	Barsingsar TPS	250	1.11	2.30	3.41
6	Neyveli New TPS	500	2.30	1.73	4.03
	Total NLC	**3140**			
V: Thermal generating Stations of DVC					
1	Bokaro TPS- B	630	0.77	2.44	3.21
2	Bokaro TPS- A	500	2.19	2.20	4.40
3	Chandrapura TPS Unit 3	210	1.05	0.00	1.05
4	Chandrapura TPS (7-8)	500	1.58	2.37	3.94
5	Durgapur TPS	210	0.92	2.37	3.29
6	Mejia TPS (1-3)	630	0.85	3.27	4.12
7	Mejia TPS (4)	210	0.84	3.27	4.11
8	Mejia TPS (5-6)	500	1.41	3.03	4.43
9	Mejia TPS (7-8)	1000	1.45	2.85	4.30
10	Durgapur Steel TPS	1000	1.57	2.90	4.46
11	Koderma TPS	1000	1.67	2.66	4.33
12	Rangnathpur TPS	1200	1.65	2.96	4.61
	Total DVC	**7590**			
VI: Other Inter-state Coal based Power Generating Stations					
1	Indira Gandhi STPP,	1500	1.62	3.81	5.43

	Stage-I				
2	Vallur TPP	1500	1.79	3.84	5.62
3	NTPL TPS	1000	2.97	1.55	4.52
4	Maithon Right Bank TPP	1050	1.75	2.68	4.43
5	MUNPL Meja	660	2.28	3.27	5.55
6	BRBCL Nabinagar	750	2.49	2.34	4.83
7	NPGCL, Nabinagar	660	2.53	2.09	4.63
8	KBUNL Kanti I	220	1.10	3.26	4.36
9	KBUNL Kanti II	390	2.73	2.73	5.46
	Total	**7730**			
VII: Other Inter-state Gas based Power Generating Stations					
1	OTPC Ltd	671	1.67	1.673	3.34
2	Pragati Power Plant-III	1371	1.32	3.67	4.99
	Total	**2042**			

Table-36: Composite Tariff of Central Hydro Power Stations, 2020-21

Sr. No.	Name of the Generating Company/ Station	Type	Installed Capacity (MW)	Design Energy (MU)	Composite Tariff (including water tax for J&K) (₹/kWh)
NHPC					
1	Bairasiul	Pondage	180	779	2.04
2	Loktak	Storage	105	448	3.86
3	Salal	ROR	690	3082	2.35
4	Tanakpur	ROR	94.2	452	3.30
5	Chamera-I	Pondage	540	1665	2.28
6	Uri-I	ROR	480	2587	2.11
7	Rangit	Pondage	60	339	3.81
8	Chamera-II	Pondage	300	1500	2.01
9	Dhauliganga-I	Pondage	280	1135	2.43
10	Dulhasti	ROR	390	1907	6.00
11	Teesta-V	Pondage	510	2572	2.32
12	Sewa-II	Pondage	120	534	5.49
13	Chamera-III	Pondage	231	1108	3.94
14	Chutak	ROR	44	213	9.24
15	Uri-II	ROR	240	1124	5.16
16	Nimoo Bazgo	Pondage	45	239	10.69
17	Teesta-LDP-III	Pondage	132	594	5.03

18	Teesta-LDP-IV	Pondage	160	720	4.62
19	Parbati-III	ROR	520	1963	3.08
20	Kishanganga	ROR	330	1713	4.10
	Total		**5451**	**24674**	
NHDC					
1	Indira Sagar	Storage	1000	1443	3.74
2	Omkareshwar	Storage	520	677	5.31
	Total		**1520**	**2120**	
THDC					
1	Tehri HPP Stage-I	Storage	1000	2797	3.56
2	Koteshwar HEP	RoR with Pondage	400	1155	4.93
	Total		**1400**	**3952**	
SJVNL					
1	Naptha Jhakri	RoR	1500	6612	2.28
2	Rampur HP	RoR	412	1878	4.32
	Total		**1912**	**8490**	
NEEPCO					
1	Kopili HEP Stage-I	Storage	200	1186	1.09
2	Kopili HEP Stage-II	Storage	25	86	1.53
3	Khandong	Storage	50	228	1.57
4	Doyang	Storage	75	227	5.15
5	Ranganadi HEP	Pondage	405	1510	1.95
6	Tuirial	Storage	60	251	4.49
7	Pare	Pondage	110	506	5.00
8	Kameng	RoR	600	3353	Yet to be determined
	Total		**1525**	**7347**	
NTPC					
1	Koldam	Pondage	800	3055	4.85
	Total		**800**	**3055**	
DVC					
1	Maithon	Storage	63	137	2.55
2	Panchet	Storage	80	237	1.09
3	Taliya	Storage	4	-	7.88
	Total		**147**	**374**	

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Chapter-V

Trading of Renewable Energy Certificates

1. Renewable Energy Certificate Mechanism

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

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

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

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

2. Trading of Renewable Energy Certificates

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

One REC is equivalent to 1 MWh of electricity injected into the grid from renewable energy sources. The REC is exchanged only in the power exchanges approved by CERC within the band of a floor price and forbearance (ceiling) price as notified by CERC from time to time (Table-37).

Table-37: Floor and Forbearance Price applicable for REC Transactions

Applicable Period	Floor Price (₹/MWh)		Forbearance Price (₹/MWh)	
	Solar	Non-Solar	Solar	Non-Solar
w.e.f 1st June 2010	12000	1500	17000	3900
w.e.f 1st April 2012	9300	1500	13400	3300

w.e.f 1st March 2015	3500	1500	5800	3300
w.e.f 1st April 2017	1000	1000	2400	3000
w.e.f 1st July 2020 *	0	0	1000	1000

** The latest order of the CERC notifying the floor and forbearance price, effective from 1st July 2020, is sub-judice and no trading session of RECs has been held from July 2020 onwards.*

The first REC trading session was held on power exchanges in March 2011. The growth of RECs transacted on power exchanges in the last 10 years is given in Table-38. As may be seen in the table, the number of RECs transacted increased significantly from 10.15 lakh in 2011-12 to 162.00 lakh in 2017-18 and then declined to 89.28 lakh in 2019-20. A negative growth can be observed in number of RECs transacted in 2018-19 and 2019-20. This could be because state utilities may be buying more RE power directly from the RE power generators which may be relatively cheaper than buying RECs and non-RE power. During 2020-21, no trading session of RECs was held since July 2020 as the latest Order of CERC notifying the floor and forbearance price is sub-judice.

Table-38: Growth of Renewable Energy Certificates transacted on Power Exchanges, 2011-12 to 2020-21

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

Note: The buyers/sellers can transact through any of the Power Exchange.

** The latest order of the CERC notifying the floor and forbearance price, effective from 1st July 2020, is sub-judice and no trading session of RECs has been held from July 2020 onwards.*

Source: NLDC

Table-39 shows the demand and supply of RECs, i.e., the gap between the volume of buy and sell bids of RECs on power exchanges during 2012-13 to 2020-21. As may be observed from the table, the volume of buy bid as a percentage of volume of sell bid initially showed a declining trend from 2012-13 to 2016-17 followed by an increasing trend from 2017-18 to 2019-20 in both the power exchanges on account of change in demand for both Solar and Non-Solar RECs.

Table-39: Demand and Supply of RECs on Power Exchanges, 2012-13 to 2020-21

Year	IEX			PXIL		
	Volume of Buy Bid of RECs (Lakhs)	Volume of Sell Bid of RECs (Lakhs)	Volume of Buy Bid as % of volume of Sell Bid	Volume of Buy Bid of RECs (Lakhs)	Volume of Sell Bid of RECs (Lakhs)	Volume of Buy Bid as % of volume of Sell Bid
Solar						
2012-13	0.77	0.14	549%	0.12	0.05	265%
2013-14	0.54	5.86	9%	0.14	1.35	10%
2014-15	1.01	37.00	3%	0.63	33.46	2%
2015-16	4.65	227.67	2%	1.83	93.80	2%
2016-17	4.04	323.70	1%	1.53	147.66	1%
2017-18	0.89	34.99	3%	1.20	13.68	9%
2018-19	86.45	152.51	57%	44.46	99.85	45%
2019-20	71.49	19.45	367%	26.80	8.12	330%
2020-21*	1.46	2.44	60%	0.37	0.71	51%
Non-Solar						
2012-13	24.35	91.85	27%	6.55	24.90	26%
2013-14	12.71	251.65	5%	14.11	172.33	8%
2014-15	14.47	553.25	3%	14.51	550.88	3%
2015-16	26.73	889.92	3%	16.34	644.01	3%
2016-17	42.15	981.50	4%	17.16	596.37	3%
2017-18	94.17	635.09	15%	67.89	324.13	21%
2018-19	88.05	60.43	146%	37.82	16.53	229%
2019-20	91.87	94.72	97%	46.71	48.15	97%
2020-21*	5.78	41.70	14%	1.91	21.05	9%

** The latest order of the CERC notifying the floor and forbearance price, effective from 1st July 2020, is sub-judice and no trading session of RECs has been held from July 2020 onwards.*

The volume and price of RECs transacted on both power exchanges during 2012-13 to 2020-21 has been provided in Table-40. It can be observed from the table that there was an increasing trend in the volume of both solar and non-solar RECs transacted on both power exchanges and there is a declining trend in the weighted

average of market clearing price of the RECs. The increase in the volume of RECs transacted on power exchanges can be attributed to the increase in the RPO compliance. Decline in the price of RECs can be attributed to the demand and supply of RECs and the REC regulations issued by CERC from time to time, i.e., by reducing the floor and forbearance price.

The market clearing volume of Solar RECs transacted on both power exchanges increased from 0.14 lakhs in 2012-13 to 23.15 lakhs in 2019-20, whereas the weighted average of market clearing price of these RECs declined from ₹12740/MWh in 2012-13 to ₹2293/MWh in 2019-20. The market clearing volume of Non-Solar RECs transacted on both power exchanges increased from 25.76 lakhs in 2012-13 to 64.88 lakhs in 2019-20, whereas the weighted average of market clearing price of these RECs declined from ₹1692/MWh in 2012-13 to ₹1642/MWh in 2019-20. During 2020-21, no trading session of RECs was held from July 2020 onwards as the latest order of the CERC notifying the floor and forbearance price, effective from 1st July 2020, is sub-judice.

Table-40: Volume and Price of RECs transacted on Power Exchanges, 2012-13 to 2020-21

Month	IEX		PXIL		Total	
	Volume of RECs (MWh) in Lakhs	Weighted Average Price of RECs (₹/MWh)	Volume of RECs (MWh) in Lakhs	Weighted Average Price of RECs (₹/MWh)	Volume of RECs (MWh) in Lakhs	Weighted Average Price of RECs (₹/MWh)
Solar						
2012-13	0.10	12782	0.04	12615	0.14	12740
2013-14	0.53	9383	0.14	9668	0.67	9441
2014-15	1.01	3725	0.63	4756	1.64	4121
2015-16	4.65	3500	1.83	3500	6.48	3500
2016-17	4.04	3500	1.53	3500	5.57	3500
2017-18	0.89	1000	1.20	1000	2.08	1000
2018-19	46.59	1113	25.36	1067	71.95	1097
2019-20	17.11	2293	6.04	2292	23.15	2293
2020-21*	1.19	1491	0.33	1290	1.52	1447
Non-Solar						
2012-13	19.81	1731	5.95	1564	25.76	1692
2013-14	12.71	1500	14.11	1500	26.82	1500
2014-15	14.47	1500	14.51	1500	28.98	1500

2015-16	26.73	1500	16.34	1500	43.07	1500
2016-17	42.15	1500	17.16	1500	59.31	1500
2017-18	92.41	1480	67.35	1487	159.76	1483
2018-19	41.22	1298	10.77	1274	51.98	1293
2019-20	43.16	1634	21.71	1659	64.88	1642
2020-21*	5.78	1000	1.91	1000	7.69	1000

** The latest order of the CERC notifying the floor and forbearance price, effective from 1st July 2020, is sub-judice and no trading session of RECs has been held from July 2020 onwards.*

Consequent to the revised floor and forbearance price issued by CERC vide order dated 30.03.2017, the Supreme Court had put stay on trading of RECs. While trading of Non-Solar RECs was allowed conditionally from July 2017 onwards, trading of Solar RECs was suspended till March 2018. After the APTEL Judgement, vide order dated 12.04.2018, the trading of Solar RECs resumed after a gap of one year, i.e., in the month of April, 2018. As majority of the RECs expired/were likely to expire soon, the CERC extended the validity of the RECs up to 31.03.2018. Keeping in view the large inventory of RECs, the CERC further extended the validity of the RECs up to 31st December 2019 and up to 31st March 2020 through its order dated 30.04.2019 and 30.12.2019, respectively. In May 2018, Ministry of New and Renewable Energy (MNRE), vide order dated 22.05.2018, created the RPO Compliance Cell, with a function to coordinate with States, CERC and SERCs on matters relating to RPO compliance and taking up non-compliance issues with appropriate authorities.

MNRE has up-scaled the target of renewable energy capacity to 175 GW by 2022 which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-resources and 5 GW from small hydro-power. The generation target is also coupled with Renewable Purchase Obligation (RPO) to be met by distribution licensees and open access consumers.

In order to accelerate the growth of hydro power sector, the Ministry of Power (MoP) on 08.03.2019, declared Large hydro Power Plants (LHPs) having installed capacity of more than 25 MW as renewable energy source. The Ministry notified Hydro Purchase Obligation (HPO) as a separate category to Non-Solar RPO for procuring

power from LHPs. The Ministry also issued a revised trajectory of RPO for FY 21-22, including long-term trajectory for HPO on 29.01.2021 (Table 41).

Table-41: Long-term Growth Trajectory of RPOs

Year	Solar RPO	Non-Solar RPO			Total RPO
		HPO	Other Non-Solar RPO	Total Non-Solar RPO	
2019-20	7.25%	-	10.25%	10.25%	17.50%
2020-21	8.75%	-	10.25%	10.25%	19.00%
2021-22	10.50%	0.18%	10.50%	10.68%	21.18%
2022-23	To be specified later	0.35%	To be specified later	To be specified later	To be specified later
2023-24		0.66%			
2024-25		1.08%			
2025-26		1.48%			
2026-27		1.80%			
2027-28		2.15%			
2028-29		2.51%			
2029-30		2.82%			

Source: Ministry of Power

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Annexure-I

List of Transmission Licensees as on 31.03.2021

S.No.	Name of Licensee	Date of grant of licence
1	Powerlinks Transmission Ltd.	13.11.2003
2	Torrent Power Grid Ltd	16.05.2007
3	Jaypee Powergrid Ltd	01.10.2007
4	Essar Power Transmission Company Ltd.	10.04.2008
5	Parbati Koldam Transmission Company Ltd	15.09.2008
6	Western Region Transmission (Maharashtra) (P) Ltd	30.12.2008
7	Western Region Transmission (Gujrat) (P) Ltd	30.12.2008
8	Teestavalley Power Transmission Ltd	14.05.2009
9	North East Transmission Company Ltd	16.06.2009
10	East - North Inter - Connection Company Ltd.	28.10.2010
11	Talcher - II Transmission Company Ltd.	08.11.2010
12	Cross Border Power Transmission Company Ltd	01.12.2010
13	North Karanpura Transmission Company Ltd.	16.12.2010
14	Jindal Power Ltd	09.05.2011
15	Raichur Sholapur Transmission Company Ltd	24.08.2011
16	Jabalpur Transmission Company Ltd	12.10.2011
17	Bhopal Dhule Transmission Company Ltd	12.10.2011
18	Powergrid NM Transmission Ltd	20.06.2013
19	Torrent Energy Ltd	16.07.2013
20	Adani Transmission (India) Ltd	29.07.2013
21	Aravali Power Co. Ltd.	07.11.2013
22	Kudgi Transmission Ltd	07.01.2014
23	PowergridVizag Transmission Ltd	08.01.2014
24	Darbhanga - Motihari Transmission Company Ltd	30.05.2014
25	Purulia & Kharagpur Transmission Company Ltd	30.05.2014
26	Patran Transmission Company Ltd	14.07.2014
27	Powergrid Unchahar Transmission Ltd	21.07.2014
28	RAPP Transmission Company Ltd	31.07.2014
29	NRSS XXXI (B) Transmission Ltd	25.08.2014
30	Powergrid Kala Amb Transmission Ltd (NRSS XXXI (A) Transmission Ltd)	04.09.2014
31	NRSS XXIX Transmission Ltd (Sterlite)	14.11.2014
32	Powergrid Jabalpur Transmission Ltd	15.06.2015
33	DGEN Transmission Company Ltd	24.06.2015

34	Powergrid Parli Transmission Ltd (Gadarwara (B) Transmission Ltd)	10.07.2015
35	POWERGRID Warora Transmission Ltd	05.08.2015
36	Maheshwaram Transmission Ltd	23.11.2015
37	Raipur-Rajandgaon-Warora Transmission Ltd	29.02.2016
38	Chhattisgarh-WR Transmission Ltd	29.02.2016
39	Sipat Transmission Ltd	07.03.2016
40	POWERGRID Southern Interconnector Transmission System Ltd	14.03.2016
41	Alipurduar Transmission Ltd	21.03.2016
42	Odisha Generation Phase-II Transmission Ltd	30.06.2016
43	Gurgaon Palwal Transmission Ltd	29.09.2016
44	Warora-Kurnool Transmission Ltd	29.09.2016
45	North Karanpura Transco Ltd	29.09.2016
46	Khargone Transmission Ltd	17.11.2016
47	NRSS XXXVI Transmission Ltd	07.12.2016
48	NER-II Transmission Ltd	20.06.2017
49	Powergrid Medinipur Jeerat Transmission Ltd	20.06.2017
50	Kohima-Mariani Transmission Ltd	10.07.2017
51	Powergrid Mithilanchal Transmission Limited (ERSS XXI Transmission Ltd)	24.04.2018
52	Goa - Tamnar Transmission Project Ltd	13.07.2018
53	Fatehgarh-Bhadla Transmission Ltd	27.08.2018
54	Powergrid Varanasi Transmission Ltd (WR-NR Power Transmission Ltd)	27.08.2018
55	Powergrid Khetri Transmission System Limited	19.12.2019
56	Bikaner-Khetri Transmission Limited	27.12.2019
57	UdupiKasargode Transmission Limited (UKTL)	24.01.2020
58	WRSS XXI (A) Transco Limited	24.01.2020
59	Power Grid Bhuj Transmission Limited (PBTL)	03.03.2020
60	Lakadia Banaskantha Transco Limited	03.03.2020
61	Powergrid Ajmer Phagi Transmission Limited (PAPTL)	04.03.2020
62	Powergrid Fatehgarh Transmission Limited (PFTL)	04.03.2020
63	Lakadia Vadodara Transmission Project Limited (LVTPL)	04.03.2020
64	Jam Khambhaliya Transco Limited	24.03.2020

List of Trading Licensee as on 31.03.2021

Sr. No.	Name of Trading Licensee	Date of Issue of License	Category of License
1	Tata Power Trading Company Ltd	09.06.2004	I
2	Adani Enterprises Ltd	09.06.2004	I
3	PTC India Ltd	30.06.2004	I
4	NTPC Vidyut Vyapar Nigam Ltd	23.07.2004	I
5	National Energy Trading & Services Ltd.*	23.07.2004	II
6	Instinct Infra & Power Ltd*	07.09.2005	III
7	Essar Electric Power Development Corporation Ltd.*	14.12.2005	II
8	JSW Power Trading Company Ltd.	25.04.2006	IV
9	Greenko Energies (P) Ltd*	22.01.2008	III
10	Ambitious Power Trading Company Ltd	16.09.2008	IV
11	RPG Power Trading Company Ltd	23.09.2008	II
12	GMR Energy Trading Ltd	14.10.2008	I
13	Shyam Indus Power Solutions (P) Ltd.*	11.11.2008	III
14	Global Energy (P) Ltd.	28.11.2008	I
15	Knowledge Infrastructure Systems (P) Ltd	18.12.2008	IV
16	Kreate Energy (I) Pvt. Ltd.*	12.02.2009	II
17	Shree Cement Ltd	16.03.2010	IV
18	ABJA Power Pvt. Ltd.	26.04.2011	III
19	Customised Energy Solutions India (P) Ltd	08.06.2011	V
20	Statkraft Markets (P) Ltd	21.06.2012	I
21	Manikaran Power Ltd	29.06.2012	I
22	Arunachal Pradesh Power Corporation (P) Ltd	11.09.2012	II
23	Vedprakash Power (P) Ltd.*	19.08.2013	IV
24	Solar Energy Corporation of India	01.04.2014	I
25	Saranyu Power Trading Private Ltd.*	10.02.2015	III
26	Gita Power & Infrastructure (P) Ltd.	20.10.2015	V
27	Phillip Commodities India Pvt. Ltd.*	21.01.2016	IV
28	Renew Solar Services Pvt. Ltd.	27.01.2017	V
29	Atria Energy Services Private Ltd.*	20.06.2017	IV
30	NHPC Limited	23.04.2018	I
31	NLC India Ltd.	13.07.2018	I
32	Refex Energy Ltd.	30.08.2018	I
33	NTPC Limited	08.07.2019	I

* Provisional

Historical Volatility Formula:

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

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

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

Herfindahl-Hirschman Index (HHI)

Formula for computing the HHI is as under:

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

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

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

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

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

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