Report on Short-term Power Market in India: 2015-16

Economics Division
Central Electricity Regulatory Commission

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Preface

The Electricity Act, 2003 consolidated 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 moves of the Central Electricity Regulatory Commission (CERC) through its various regulations and orders required to enable a framework for a robust and healthy power market in the country. The CERC set this process in a motion through Trading License and Open Access Regulations, 2004 and Power Market Regulations, 2010.

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 per cent of the total electricity generation in India in 2015-16.

Dissemination of information is one of the key elements to ensure efficiency and competition in the sector and to maintain faith in stakeholders and consumers in the system. CERC brings out monthly and annual short-term power market reports to keep market participants as well as stakeholders aware and updated on the state of the power market. The annual report provides a snapshot on the short-term transactions of electricity through different instruments used by various market participants.

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 various types of participants and effect of congestion on volume of electricity traded on power exchanges. It also covers tariff of long-term sources of power and analysis of transactions of Renewable Energy Certificates.

This report would be useful to all individuals and organizations interested in the power sector. 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, 2015-16 useful.

Abbreviations

Abbreviation	Expanded Version
AC	Alternating Current
APL	Adani Power Limited
APM	Administered Price Mechanism
APPCC	Andhra Pradesh Power Coordination Committee
APSPDCL	Andhra Pradesh Southern Power Distribution Company Limited
AT&C	Aggregate Technical and Commercial
BEST	Bombay Electric Supply & Transport Undertaking
Block	15 Minutes Time Block
BRPL	BSES Rajdhani Power Ltd
BSEB	Bihar State Electricity Board
BSPHCL	Bihar State Power Holding Company Limited
BU	Billion Units (Billion kWh)
CAGR	Compound Annual Growth Rate
CCGT	Combined Cycle Gas Turbine
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CESC	Calcutta Electric Supply Corporation
Ckm	Circuit km
CPP	Captive Power Producer/Plant
CTU	Central Transmission Utility
DAM	Day Ahead Market
DISCOMs	Distribution Companies
DSM	Deviation Settlement Mechanism
ER	Eastern Region
FGUTPP	Firoz Gandhi Unchahar Thermal Power Project
GOHP/GoHP	Government of Himachal Pradesh
GPS	Gas Power Station
GRIDCO	Grid Corporation of Orissa Limited
HEP	Hydro Electric Project
HHI	Herfindahl-Hirschman Index
HSD	High Speed Diesel
HVDC	High-Voltage Direct Current

Abbreviation	Expanded Version
IEX	Indian Energy Exchange
IFFCO	Indian Farmers Fertiliser Cooperative Limited
IPDS	Integrated Power Development Scheme
IPP	Indipendent Power Producers
IT	Information Technology
JIPTL	Jindal India Thermal Power Limited
JVVNL	Jaipur Vidyut Vitaran Nigam Limited
KSEB	Kerala State Electricity Board
KV	Kilovolt
kWh	Kilo Watt Hour
LNG	Liquefied Natural Gas
LOI	Letter of Intent
Ltd	Limited
MPPTCL	Madhya Pradesh Power Trading Company Limited
MSEDCL	Maharashtra State Electricity Distribution Company Limited
MU	Million Units
MVA	Mega Volt Ampere
MW	Mega Watts
MWh	Mega Watt Hour
NCTP	National Capital Thermal Power Plant
NDMC	New Delhi Municipal Corporation
NEEPCO	North Eastern Electric Power Corporation Limited
NER	North Eastern Region
NEW Grid	Northern, Eastern, Western and North-Eastern Region Grid
NHDC	National Hydro Development Corporation Limited
NHPC	National Hydro-Electric Power Corporation Limited
NLC	Neyveli Lignite Corporation Limited
NLDC	National Load Dispatch Centre
NPCL	Noida Power Company Limited
NR	Northern Region
NTPC	National Thermal Power Corporation Limited
OA	Open Access
OAC	Open Access Consumer
OTP	Other than RTC and Peak period

Abbreviation	Expanded Version
PFC	Power Finance Corporation
PGCIL	Power Grid Corporation of India Limited
PX	Power Exchange
PXIL	Power Exchange India Limited
REC	Renewable Energy Certificate
RES	Renewable Energy Sources
RLDC	Regional Load Despatch Centre
ROR	Run of River
RTC	Round The Clock
S1	Southern Region 1
S2	Southern Region 2
SEB	State Electricity Board
SJVNL	Satluj Jal Vidyut Nigam Limited
SR Grid	Southern Region Grid
St	Stage
STPS	Super Thermal Power Station
TAM	Term Ahead Market
THDC	Tehri Hydro Development Corporation Limited
TPCIL	Thermal Powertech Corporation India Limited
TPCL	Tata Power Company Limited
TPS	Thermal Power Station
UDAY	Ujwal DISCOM Assurance Yojana
UPCL	Uttarakhand Power Corporation Limited
UPPCL	Uttar Pradesh Power Corporation Limited
UT	Union Territory
W1	Western Region 1
W2	Western Region 2
W3	Western Region 3
WBSEDCL	West Bengal State Electricity Distribution Company Ltd
WR	Western Region

Executive Summary

The report comprises of overview of the power sector, short-term power market in India, tariff of long-term sources of power and transactions of renewable energy certificates. 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. Coal is an important source of electricity generation in India, contributing about 61.3% of the total capacity of generation in 2015-16, followed by Hydro (14.2%), Renewable Energy Source (14.2%), Gas (8.1%), Nuclear (1.9%) and Diesel (0.3%).

2. The Compound Annual Growth Rate (CAGR) of total installed generation capacity was 10% during the period from 2006-07 to 2015-16.

3. During the period from 2006-07 to 2015-16, share of state sector in the total installed generation capacity declined from 56% to 34% and share of central sector has declined from 32% to 25%, while share of private sector increased from 13% to 41%. However, the public sector continues to be the largest owner, holding 59% share in 2015-16.

4. 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 2.1% in 2015-16. During the period, the peak shortage decreased from 12.7% to 3.2%.

5. Gross electricity generation in India increased from 768.4 BU in 2009-10 to 1107.8 BU in 2015-16.

6. During 2012-16, the annual growth in the bulk transmission was between 6% and 9%, while the annual growth in the transmission capacity of substations was between 11% and 15%.

7. All India average cost of supply and average revenue (without subsidy) increased from ₹3.40/kWh and ₹2.63/kwh, respectively, in 2008-09 to ₹5.15/kWh and ₹4.00/kWh, respectively, in 2013-14. During the period, average revenue gap registered an

increasing trend upto 2012-13, however, it declined from ₹1.28/kWh in 2012-13 to ₹1.15/kWh in 2013-14.

'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 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. The report also covers analysis on tariff of long-term sources of power, and transactions of renewable energy certificates (RECs) through power exchanges. Salient features of the short-term power market are as under:

1. Of the total electricity procured in India in 2015-16, the short-term power market comprised 10%. The balance 90% of generation was procured mainly by distribution companies through long-term contracts and short-term intra-state transactions.

2. In terms of volume, the size of the short-term market in India was 115.23BU (Billion Units) in the year 2015-16. As compared to the volume of electricity transacted through short-term market in the year 2014-15 (98.99BU), this was about 16% higher. The growth in volume of 16.24BU was accounted mainly by the positive growth in transactions through power exchanges (5.60 BU) and by direct bilateral transactions between the DISCOMs (8.47 BU).

3. Excluding DSM and direct bilateral sale between the DISCOMs, the volume of electricity transacted was 70.43BU in 2015-16. This was about 10% higher than in 2014-15. Volume of electricity transacted through power exchanges witnessed an increase of about 19%, whereas the volume of electricity transacted through inter-state

trading licensees witnessed an increase of 3% over 2014-15. In monetary terms, the size of this segment of the short-term market was ₹24,096 crore in the year 2015-16[1], which was 4% less than in the year 2014-15. The decline in size of the market can be attributed to lower electricity prices in 2015-16.

4. The volume of DSM in 2015-16 increased by 7% over 2014-15. 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 39% in 2009-10 to 18% in 2015-16.

5. In terms of volume, the direct bilateral transactions between DISCOMs witnessed an increase of about 54% in 2015-16 as compared to 2014-15. The share of direct bilateral transactions between DISCOMs as a percentage of total short term transaction volume increased from 9% in 2009-10 to 21% in 2015-16.

6. The weighted average price of electricity transacted through power exchanges was ₹2.72/kWh and through trading licensees it was ₹4.11/kWh in 2015-16. The corresponding values for the year 2014-15 were ₹3.50/kWh and ₹4.28/kWh, respectively. In the year 2015-16, the weighted average price of electricity transacted through Day Ahead Market sub-segment of the power exchanges was ₹2.72/kWh and that through Term Ahead Market sub-segment was ₹2.96/kWh.

7. During 2015-16, about 93% of the volume of electricity transacted through traders was at a price less than ₹6/kWh. About 61% of the volume was transacted at a price less than ₹4/kWh.

8. During 2015-16, IEX transacted 99% of the volume of electricity at a price less than ₹6/kWh while about 92% of the volume was transacted at a price less than ₹4/kWh. During the year, PXIL transacted 99% of the volume of electricity at a price less than ₹6/kWh while about 76% of the volume was transacted at less than ₹4/kWh.

9. During 2015-16, of the total electricity bought under bilateral transactions from traders, 80.68% was on round the clock (RTC) basis, followed by 17.70% in periods other than

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

RTC and peak (OTP) and 1.62% was during peak hours. The per unit price of electricity procured during RTC was high (₹4.24/kWh) when compared with the price during Peak period (₹3.46/kWh) and OTP (₹3.53/kWh).

10. It is observed from the block-wise and region-wise prices of electricity transacted through power exchanges in 2015-16 that the price of electricity in Southern Region (S1 and S2 regions) was high when compared to the price in other regions in both the power exchanges.

11. Competition among the trading licensees was shown for the period from 2004-05 to 2015-16. During the period, number of traders who were undertaking trading increased from 4 to 27 and concentration of market power (HHI based on volume of trade undertaken by the licensees) declined from high concentration (HHI of 0.5512) to non-concentration (HHI of 0.1432). The competition among the trading licensees resulted an increase in volume and decrease in prices in the short-term bilateral market.

12. The weighted average trading margin charged by the trading licensees in 2015-16 was ₹0.03/kWh, which is in line with the CERC Trading Margin Regulations, 2010.

13. The procurement of power by the industrial consumers through power exchanges began in the year 2009. In both power exchanges, Open Access industrial consumers bought 20.36BU of electricity, which formed 60% of the total day ahead volume transacted in the power exchanges during 2015-16.

14. The weighted average price of electricity bought by open access consumers at IEX was lower (₹2.56/kWh) compared to the weighted average price of total electricity transacted through IEX (₹2.72/kWh). The weighted average price of electricity bought by open access consumers at PXIL was lower (₹2.61/kWh) compared to the weighted average price of total electricity transacted through PXIL (₹2.66/kWh).

15. The year also witnessed constraints on the volume of electricity transacted through power exchanges, mainly due to transmission congestion. During 2015-16, the actual transacted volume was about 6% less than the unconstrained volume. Because of

congestion and the splitting of day ahead market at both the power exchanges, the congestion amount collected during the year was ₹214.22 crore.

16. In 2015-16, the number of Solar RECs transacted on IEX and PXIL were 4,65,456 and 1,82,745 respectively and the market clearing price of these RECs was ₹3500/MWh on both IEX and PXIL. During the year, market clearing volume of Non-Solar RECs transacted on IEX and PXIL were 26,73,434 and 16,33,518 respectively and the market clearing price of these RECs was ₹1500/MWh on both IEX and PXIL.

Chapter-I

Overview of Power Sector

India's power sector is well diversified with market dynamics. Sources of power generation range from conventional sources such as coal, lignite, natural gas, oil, hydro and nuclear power to viable non-conventional sources such as wind, solar, and agricultural and domestic waste. Electricity demand in the country has increased rapidly and is expected to rise further in the years to come. In order to meet the increasing demand for electricity in the country, the electricity supply chain consisting of generation, transmission and distribution has undergone a phase of transformation to competitiveness.

1. Electricity Generation

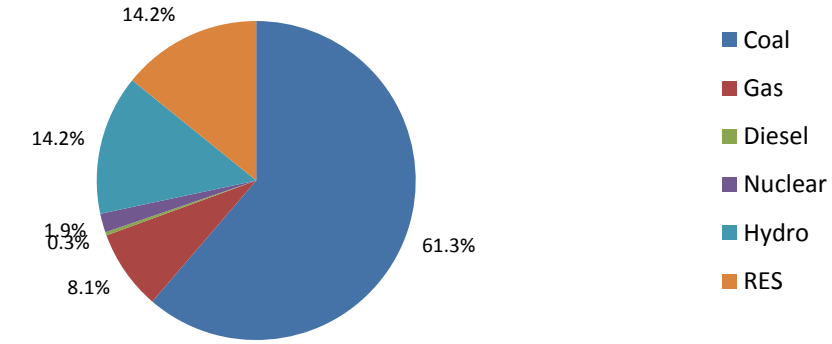
Sources of electricity generation are of two types i.e. conventional and non-conventional. The conventional sources of power generation are coal, lignite, natural gas, oil, hydro and nuclear power, and non-conventional sources of power generation are wind, solar, agricultural and domestic waste etc. Table-1 and Figure-1 shows the installed electricity generation capacity in India by source.

Table-1: Installed Electricity Generation Capacity in India by Source (MW), 2006-07 to 2015-16

Year	Thermal				Nuclear	Hydro	RES	Grand Total
	Coal	Gas	Diesel	Total				
2006-07	71121	13692	1202	86015	3900	34654	7760	132329
2011-12	112022	18381	1200	131603	4780	38990	24504	199876
2012-13	130221	20110	1200	151531	4780	39491	27542	223343
2013-14	145273	21782	1200	168255	4780	40532	31692	245259
2014-15	164636	23062	1200	188898	5780	41267	35777	271722
2015-16	185173	24509	994	210675	5780	42783	42849	302088
Percentage of Installed Generation Capacity								
2006-07	53.7%	10.3%	0.9%	65.0%	2.9%	26.2%	5.9%	100%
2011-12	56.0%	9.2%	0.6%	65.8%	2.4%	19.5%	12.3%	100%
2012-13	58.3%	9.0%	0.5%	67.8%	2.1%	17.7%	12.3%	100%
2013-14	59.2%	8.9%	0.5%	68.6%	1.9%	16.5%	12.9%	100%
2014-15	60.6%	8.5%	0.4%	69.5%	2.1%	15.2%	13.2%	100%
2015-16	61.3%	8.1%	0.3%	69.7%	1.9%	14.2%	14.2%	100%

Source: CEA

Figure-1: Installed Electricity Generation Capacity in India, 2015-16



As can be seen in Figure-1, coal is the most important source of electricity generation in India, contributing about 61.3% of the total capacity of generation in 2015-16, followed by Hydro (14.2%), Renewable Energy Source (14.2%), Gas (8.1%), Nuclear (1.9%) and Diesel (0.3%). The percentage of coal based generation capacity increased from 53.7% in 2006-07 to 61.3% in 2015-16. During the period, hydro based generation capacity decreased from 26.2% to 14.2% whereas renewables based generation capacity increased from 5.9% to 14.2%.

The Electricity Act of 2003 liberalised the generation sector through a license-free regime. As a result, the entry of private players into the generation segment significantly increased their share in the total electricity generation.

The players in the generation segment can be divided into three types based on ownership and operations. These are (i) Central public sector undertakings includes National Thermal Power Corporation, National Hydroelectric Power Corporation, and similar organizations. (ii) State public sector undertakings/State Electricity Boards; and (iii) Private sector enterprises includes Tata Power Company Ltd, Reliance Power Ltd, Adani Power Ltd., and similar entities.

Sector-wise growth of installed generation capacity has been shown in Table-2 and Figure-2. It is observed from the table that CAGR of total installed generation capacity was 10% during the period from 2006-07 to 2015-16. During the period, the share of state

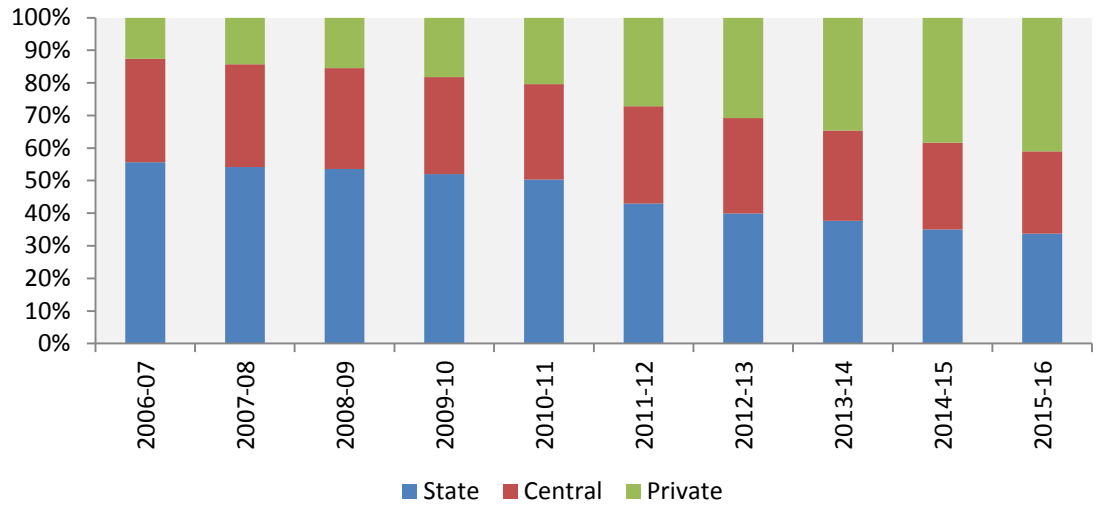
sector in the total installed generation capacity has declined from 56% to 34% and the share of central sector has declined from 32% to 25%. The share of private sector has increased from 13% to 41%. However, the public sector continues to be the largest owner, holding 59% share in 2015-16.

Table-2: Sector-wise Growth of Installed Generation Capacity, 2006-07 to 2015-16

Year	Installed Generation Capacity (MW)				% of Installed Generation Capacity		
	State	Central	Private	Total	State	Central	Private
2006-07	73579	42037	16713	132329	56%	32%	13%
2007-08	77523	45027	20511	143061	54%	31%	14%
2008-09	79309	45777	22879	147965	54%	31%	15%
2009-10	82905	47479	29014	159398	52%	30%	18%
2010-11	87417	50759	35450	173626	50%	29%	20%
2011-12	85919	59682	54276	199877	43%	30%	27%
2012-13	89125	65360	68859	223344	40%	29%	31%
2013-14	92265	68126	84868	245259	38%	28%	35%
2014-15	95079	72521	104122	271722	35%	27%	38%
2015-16	101790	76297	124001	302088	34%	25%	41%
CAGR				10%			

Source: CEA

Figure-2: Sector-wise Growth of Installed Generation Capacity, 2006-07 to 2015-16 (%)



As shown in the above table, the total installed electricity generation capacity of India increased from 1,32,329MW in 2006-07 to 3,02,088 MW in 2015-16. Increase in installed electricity generation capacity made an impact on the power supply position shown in Table-3. 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 2.1% in 2015-16. During the period, the peak shortage decreased from 12.7% to 3.2%.

Table-3: Power Supply Position in India, 2009-10 to 2015-16

Year	Energy (MU)			Peak (MW)		
	Require-ment	Availability	Deficit (%)	Peak Demand	Peak Met	Deficit (%)
2009-10	830594	746644	-10.1%	119166	104009	-12.7%
2010-11	861591	788355	-8.5%	122287	110256	-9.8%
2011-12	937199	857886	-8.5%	130006	116191	-10.6%
2012-13	995557	908652	-8.7%	135453	123294	-9.0%
2013-14	1002257	959829	-4.2%	135918	129815	-4.5%
2014-15	1068923	1030785	-3.6%	148166	141160	-4.7%
2015-16	1114408	1090850	-2.1%	153366	148463	-3.2%

Source: Ministry of Power

Electricity generation is shown in Table-4. It is observed from the table that total gross electricity generation in India has increased from 768.4 BU in 2009-10 to 1107.8 BU in 2015-16. During the period, the CAGR of gross electricity generation was 6%.

Table-4: Gross Electricity Generation in India (Mode-wise) (BU), 2009-10 to 2015-16

Year	Thermal	Hydro	Nuclear	Bhutan Import	Total
2009-10	640.5	103.9	18.6	5.4	768.4
2010-11	665.0	114.3	26.3	5.6	811.1
2011-12	708.8	130.5	32.3	5.3	876.9
2012-13	760.7	113.7	32.9	4.8	912.1
2013-14	792.5	134.8	34.2	5.6	967.2
2014-15	878.3	129.2	36.1	5.0	1048.7
2015-16	943.8	121.4	37.4	5.2	1107.8

Source: CEA

2. Transmission

The transmission sector was opened for private investments in 1998. The CTU is the nodal agency for providing the medium-term (3 months to 3 years) and long-term (12 years to 25 years) access typically required by a generating station or a trader acting on the station's behalf. The PGCIL is responsible for interstate transmission and development of the national grid, and it acts as the CTU. The RLDCs are the nodal agencies for grants 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.

Table-5 shows the growth of transmission lines and transmission capacity in India during the period from 2011-12 to 2015-16.

Table-5: Growth of Transmission Sector in India, 2011-12 to 2015-16

Transmission System Type	Voltage (KV) level	Unit	As on 31.3.2012	As on 31.3.2013	As on 31.3.2014	As on 31.3.2015	As on 31.3.2016
AC Transmission lines	765	ckm	5250	6459	11096	18644	24245
	400	ckm	106819	118180	125957	135949	147130
	220	ckm	135980	140517	144851	149412	157238
	Total	**ckm**	**248049**	**265156**	**281904**	**304005**	**328613**
HVDC		ckm	9432	9432	9432	9432	12938
Total (AC+ HVDC)		**ckm**	**257481**	**274588**	**291336**	**313437**	**341551**
Annual Growth		**(%)**	**-**	**7%**	**6%**	**8%**	**9%**
AC Substations	765	MVA	25000	49000	83000	121500	141000
	400	MVA	151027	167822	177452	192422	209467

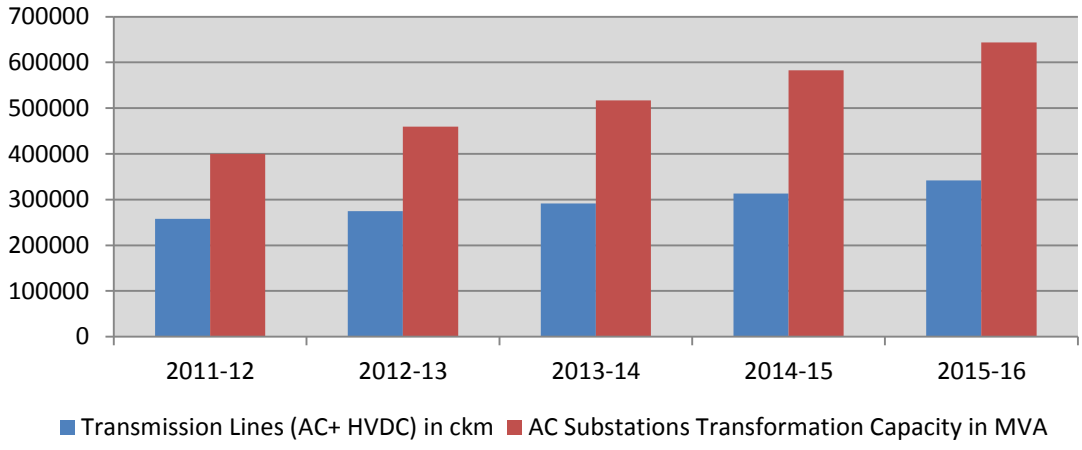
[2] *Captive Power refers to generation from a unit set up by industry for its own consumption*
[3] *Bulk consumers are consumers with power requirement of 1MW or above*

Transformation Capacity	220	MVA	223774	242894	256594	268678	293482
	Total AC	**MVA**	**399801**	**459716**	**517046**	**582600**	**643949**
Annual Growth		**(%)**	**-**	**15%**	**12%**	**13%**	**11%**

Source: CEA

It is observed from the table that bulk transmission (transmission lines upto 220kv) has increased from 2,57,481 ckm as on 31.3.2012 to 3,41,551 ckm as on 31.3.2016. During the period, annual growth in the bulk transmission was varying from 6% to 9%. The transmission capacity of substations has also increased from 3,99,801 MVA as on 31.3.2012 to 6,43,949 MVA as on 31.3.2016. During the period, annual growth in the transmission capacity of substations was varying from 11% to 15%. There is a significant growth in the transmission capacity during the last five years. The year-wise bulk transmission and the transmission capacity of substations has been shown in Figure-3.

Figure-3: Growth of Transmission Sector in India, 2011-12 to 2015-16



The sector is having natural monopoly as there are high sunk costs in investing in the infrastructure needed to transmit electricity, such as transmission lines. Because of these characteristics, non-public entities also face entry barriers, and private investments are allowed in projects only after 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 41 Inter-state transmission licensees as on 31.3.2016 granted by CERC (Annexure-I).

3. Distribution

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 with a reliable and good-quality power supply and universal access to electricity.

The DISCOMs have been facing huge losses because they sell electricity below cost or provide power free/subsidized rates for the agriculture and rural sectors. Average cost of supply, average revenue and revenue gap (i.e. Rupees per unit) of all the state power utilities has been shown for the period from 2008-09 to 2013-14 in Table-6.

Table-6: Average Cost of Supply, Average Revenue and Revenue Gap of State Power Utilities, 2008-09 to 2013-14

Year	Average Cost of Supply (₹/kWh)	Average Revenue (without subsidy) (₹/kWh)	Revenue Gap (₹/kWh) (-)
2008 - 09	3.40	2.63	0.77
2009 - 10	3.55	2.68	0.87
2010 - 11	3.98	3.03	0.95
2011 - 12	4.55	3.30	1.25
2012 - 13	5.04	3.76	1.28
2013 - 14	5.15	4.00	1.15
Source: PFC, "The Performance of State Power Utilities for the years, 2008-09 to 2010-11 and 2011-12 to 2013-14.			

All India average cost of supply and average revenue (without subsidy) increased from ₹3.40/kWh and ₹2.63/kwh, respectively, in 2008-09 to ₹5.15/kWh and ₹4.00/kWh, respectively, in 2013-14. During the period, average revenue gap registered an increasing trend upto 2012-13, however, it declined from ₹1.28/kWh in 2012-13 to ₹1.15/kWh in 2013-14.

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 last few years like Ujwal DISCOM Assurance Yojana (UDAY), Integrated Power Development Scheme (IPDS), National Smart Grid Mission, 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; (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.

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. Bulk purchase and sale is a regular phenomenon between DISCOMs and licensees that was construed as part of the activity of supply of electricity. It is with the enactment of the Electricity Act, that the transaction 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, trading margin regulations, power market regulations etc., of the Central Commission have facilitated power trading in an organized manner.

Bulk electric power supply in India is mainly tied in long-term contracts. The DISCOMs who have the obligation to provide electricity to their consumers mainly rely on supplies from these long-term contracts. Nevertheless, to meet the short-term requirements of the market participants, short term trading plays an important role in the power market.

A brief analysis of the short-term transactions of electricity in India has been done in this Report[4] for the year 2015-16. Here, "short-term transactions of electricity" refers to the contracts less than one year for the following trades:

[4]*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 also considered a part of short-term*

(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)), and

(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;

2. Yearly Trends in Short-term Transactions of Electricity (2008-09 to 2015-16)

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 both Day Ahead and Term Ahead Markets,
- DSM segment, and
- Direct transactions of electricity between DISCOMs.

market. In the year 2015-16, the volume of DSM was about 20.75BU and that between distribution companies was about 24.04BU.

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, IEX and PXIL started their operations in June 2008 and October 2008 respectively. As of March 2016, there were 40 inter-state trading licensees (list is enclosed at Annexure-II) and two power exchanges.

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

Total volume of short-term transactions of electricity increased from 65.90BU in 2009-10 to 115.23BU in 2015-16. Except in 2014-15, there was a positive growth in the volume of short-term transactions of electricity during the period. During the period there was 75% growth in volume despite negative growth of 5% witnessed in 2014-15. The volume of short-term transactions of electricity as percentage of total electricity generation varied from 9% to 11% during the period from 2009-10 to 2015-16 (Table-7).

Table-7: Volume of Short-term Transactions of Electricity with respect to Total Electricity Generation

Year	Volume of Short-term Transactions of Electricity (BU)	Total Electricity Generation (BU)	Volume of Short-term Transactions of Electricity as % of Total Electricity Generation
2009-10	65.90	768.43	9%
2010-11	81.56	811.14	10%
2011-12	94.51	876.89	11%
2012-13	98.94	912.06	11%
2013-14	104.64	967.15	11%
2014-15	98.99	1048.67	9%
2015-16	115.23	1107.82	10%

Source: NLDC & CEA

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

2.1.1 Electricity Transacted through Traders and Power Exchanges

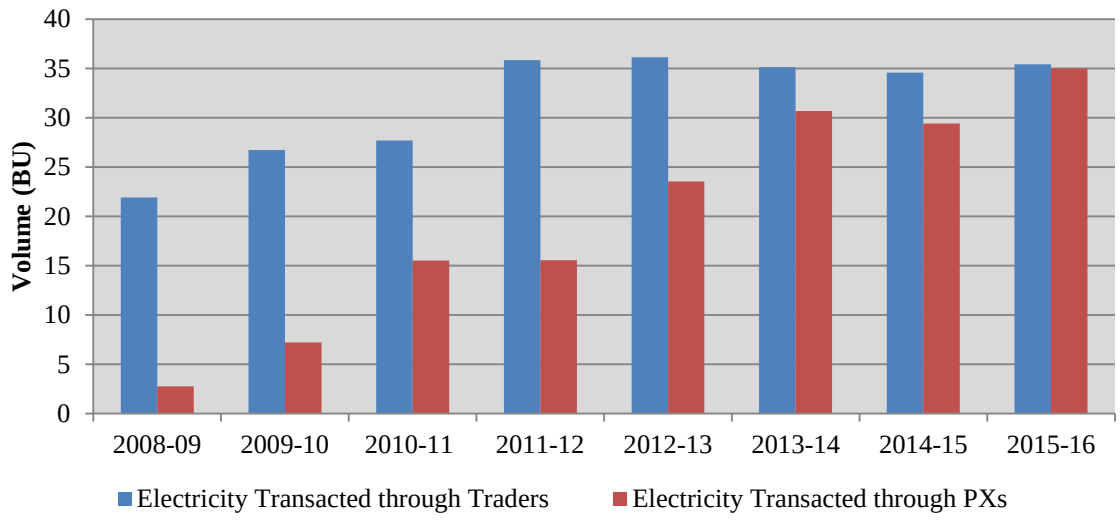
Table-8, Table-9, Figure-4 & Figure-5 show details of volume of electricity transacted through traders under bilateral transactions and through power exchanges for the period from 2008-09 to 2015-16. The volume of electricity transacted through traders and power exchanges increased from 24.69BU in 2008-09 to 70.43BU in 2015-16. The share of electricity transacted through traders and power exchanges as a percentage of total short-term transactions of electricity has increased from 51.45% in 2009-10 to 64.62% in 2014-15 and further decreased to 61.12% in 2015-16. However, the growth in volume for this segment during the year 2015-16 was positive as compared to 2014-15 and it was 10%.

Table-8: Volume of Electricity Transacted through Traders and Power Exchanges

Year	Electricity Transacted through Traders (BUs)	Electricity Transacted through IEX (BUs)		Electricity Transacted through PXIL (BUs)		Electricity Transacted through IEX and PXIL (BUs)	Total (BUs)
		Day Ahead Market	Term Ahead Market	Day Ahead Market	Term Ahead Market		
2008-09	21.92	2.62		0.15		2.77	24.69
2009-10	26.72	6.17	0.095	0.92	0.003	7.19	33.91
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

Note1: The volume of electricity transacted through traders in 2008-09 (April to July 2008) includes cross border trading and intra-state trading volume.

Figure-4: Volume of Electricity Transacted through Traders and Power Exchanges

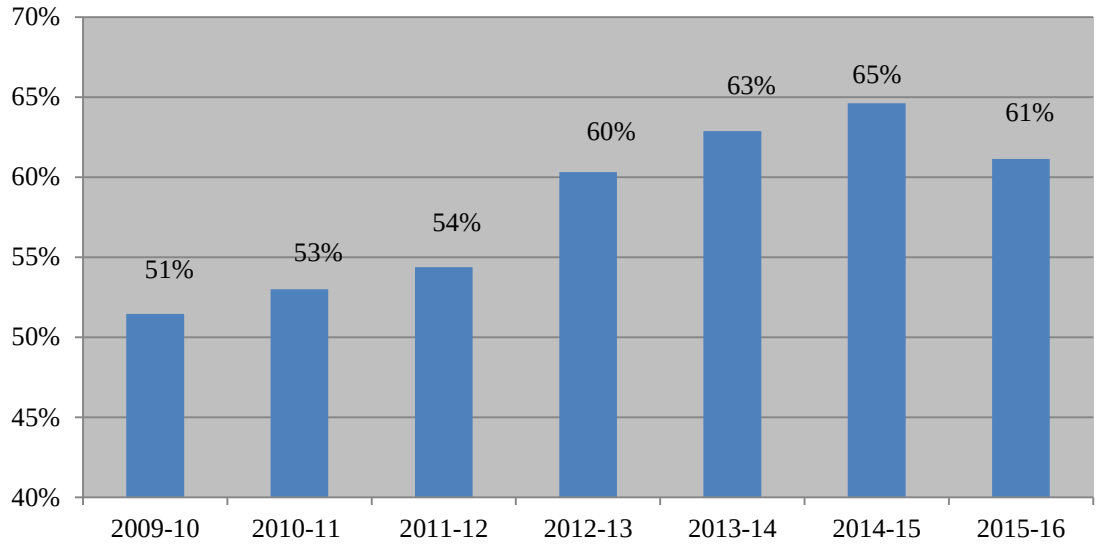


A comparison between the volume of electricity transacted through traders and power exchanges has been shown in Figure-4. It is observed from the figure that there was no significant variation in the volume of electricity transacted through traders during the period from 2011-12 to 2015-16. However, there was an increasing trend in the volume of electricity transacted through power exchanges. This shows that there was more demand for DAM of power exchanges than the bilateral transactions of traders.

Table-9: Electricity Transacted through Traders and Power Exchanges as % of Total Short-term Transactions

Year	Volume of Electricity Transacted through Traders & Power Exchanges (BUs)	Total Short-term Transactions of Electricity (BUs)	Electricity Transacted through traders & PXs as % to Total Volume of Short-term
2009-10	33.91	65.90	51.45%
2010-11	43.22	81.56	53.00%
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%

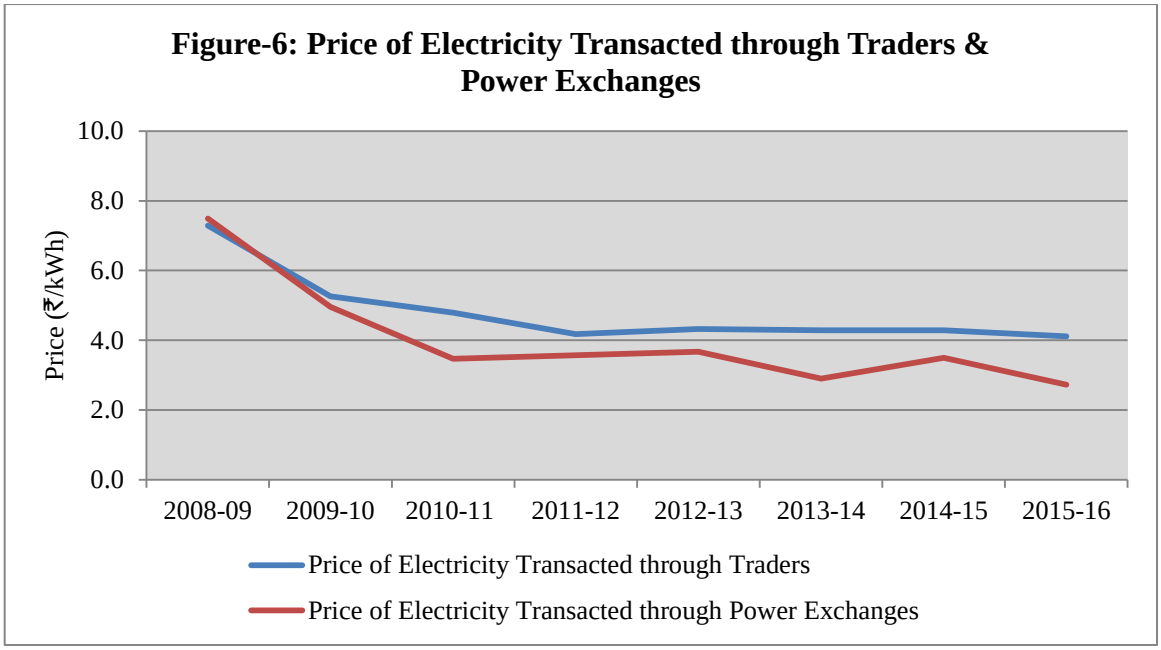
Figure-5: Electricity Transacted through Traders & Power Exchanges as % of Total Short-term Transactions



The prices of electricity transacted through traders and Power Exchanges are shown in Table-10 and Figure-6. The weighted average price of electricity transacted through traders and power exchanges declined from₹7.29/kWh and ₹7.49/kWh respectively in 2008-09 to ₹4.11/kWh and ₹2.72/kWh respectively in 2015-16.

Table-10: Price of Electricity Transacted through Traders & Power Exchanges

Year	Price of Electricity transacted through Traders (₹/kWh)	Price of Electricity transacted through Power Exchanges (DAM+TAM) (₹/kWh)
2008-09	7.29	7.49
2009-10	5.26	4.96
2010-11	4.79	3.47
2011-12	4.18	3.57
2012-13	4.33	3.67
2013-14	4.29	2.90
2014-15	4.28	3.50
2015-16	4.11	2.72



Variation in volume and price affected the size of bilateral and power exchange market and the size of the market increased by 37% during 2009-10 to 2015-16 (Table-11). Volume of electricity transacted registered a positive growth in the year 2015-16 compared to 2014-15, while price of electricity declined both in bilateral and power exchange during the period. This lead to overall decline in the size of the market by about 4% in 2015-16 compared to 2014-15.

Table-11: Size of Short-term Power Market (Bilateral and Power Exchange)

Year	Electricity Transacted through trading Licensees (BU)	Price of Electricity Transacted through Trading licensees (₹/kWh)	Size of bilateral trader Market in ₹ Crore	Electricity Transacted through Power Exchanges (BU)	Price of Electricity Transacted through Power Exchanges (₹/kWh)	Size of Power Exchange Market in ₹ Crore	Total Size of the bilateral trader + Power Exchange (₹ Crore)
2009-10	26.72	5.26	14055	7.19	4.96	3563	17617
2010-11	27.7	4.79	13268	15.52	3.47	5389	18657
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

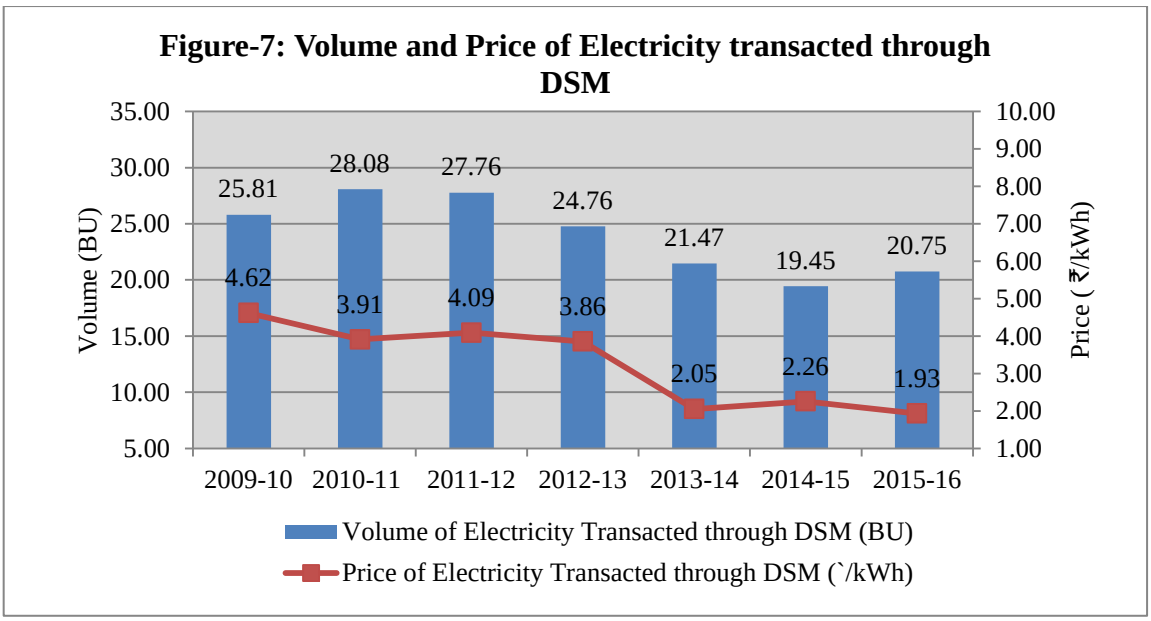
2.1.2 Electricity Transacted through DSM

The volume and price of electricity transacted through DSM is shown in Table-12 and Figure-7. It can be observed from the table that the volume of electricity transacted through DSM declined from 25.81 BU in 2009-10 to 20.75 BU in 2015-16, and the volume of DSM as percentage of total short-term volume declined to 18% in 2015-16 from 39% in 2009-10. It can also be observed from the table that the average price of DSM declined from ₹4.62/kWh in 2009-10 to ₹1.93/kWh in 2015-16. This was mainly due to changes in in DSM regulations.

Table-12: Volume and Price of Electricity transacted through DSM

Year	Volume of Electricity Transacted through DSM (BU)	Total Volume of Short term (BU)	Volume of DSM as % of total volume of Short term	Price of Electricity Transacted through DSM (₹/kWh)
2009-10	25.81	65.90	39%	4.62
2010-11	28.08	81.56	34%	3.91
2011-12	27.76	94.51	29%	4.09
2012-13	24.76	98.94	25%	3.86
2013-14	21.47	104.64	21%	2.05
2014-15	19.45	98.99	20%	2.26
2015-16	20.75	115.23	18%	1.93

Figure-7: Volume and Price of Electricity transacted through DSM



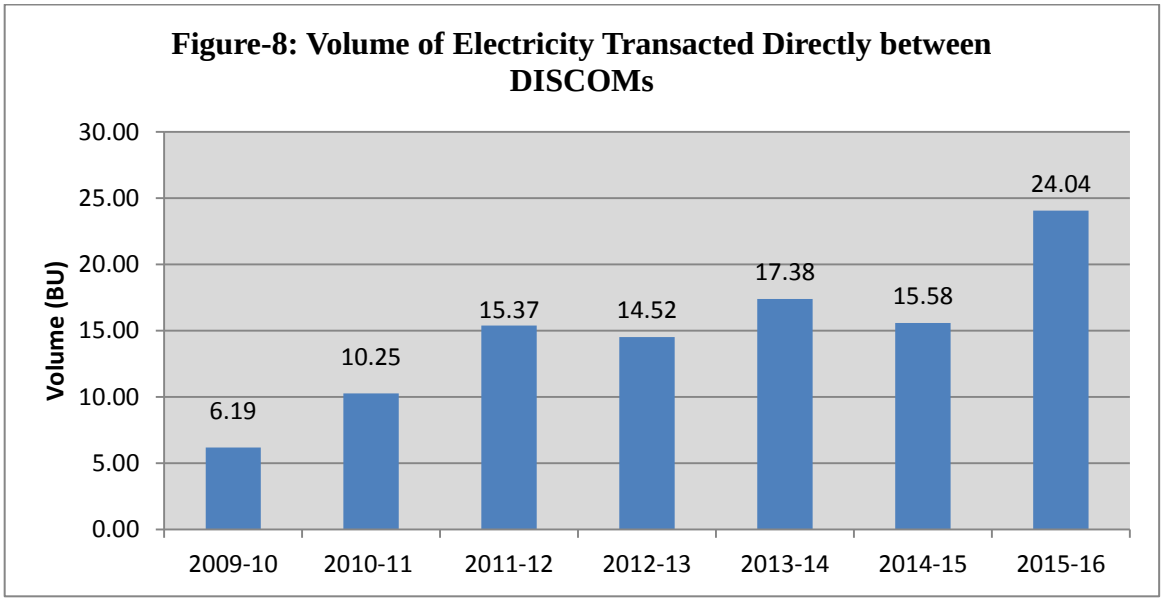
2.1.3 Electricity Transacted Directly Between DISCOMs

The volume of electricity transacted directly between DISCOMs is shown in Table-13 and Figure-8. It can be observed from the table that the volume of electricity transacted directly between DISCOMs increased from 6.19 BU in 2009-10 to 24.04 BU in 2015-16. It can also be observed that the share of electricity transacted directly between DISCOMs as percentage to total volume of short-term transaction of electricity also increased from 9% to 21% in the same period. In 2015-16, there is a significant growth in the volume of electricity transacted directly between DISCOMs as well as its share in total volume of short-term transaction of electricity.

Table-13: Volume of Electricity Transacted Directly between DISCOMs

Year	Volume of Electricity Transacted Directly between DISCOMs (BU)	Total Volume of Short term (BU)	Volume of Bilateral Direct as % of total volume of Short term
2009-10	6.19	65.9	9%
2010-11	10.25	81.56	13%
2011-12	15.37	94.51	16%
2012-13	14.52	98.94	15%
2013-14	17.38	104.64	15%
2014-15	15.58	98.99	16%
2015-16	24.04	115.23	21%

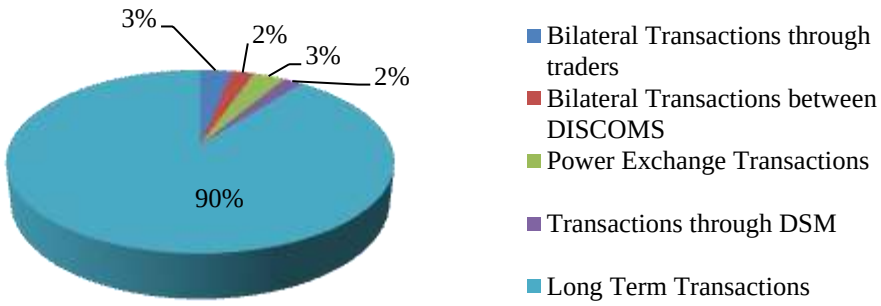
Figure-8: Volume of Electricity Transacted Directly between DISCOMs



3. Monthly Trends in Short-term Transactions of Electricity (April 2015-March 2016)

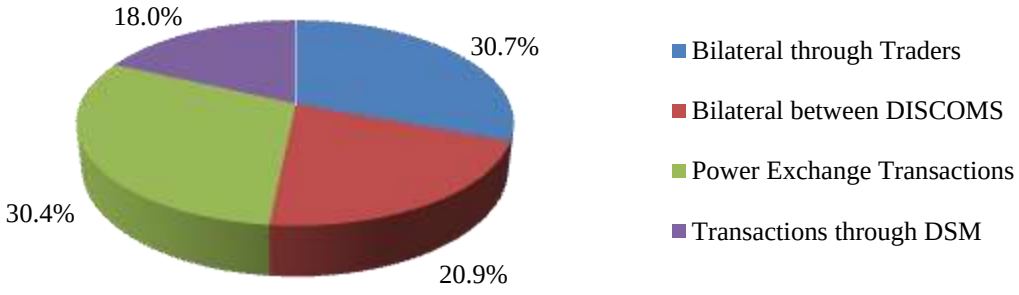
During 2015-16, the share of the total short-term transactions in volume terms, including DSM, as a percentage of total electricity generation in the country was about 10% (Figure-9 and Table-14).

Figure-9: Share of Different Market Segments in Total Electricity Generation in 2015-16



The share of different segments within the total short-term transaction for the year 2015-16 has been shown in the Figure-10 below.

Figure-10: Share of Different Market Segments in Short Term Transactions in 2015-16



3.1 Volume of Short-term Transactions of Electricity

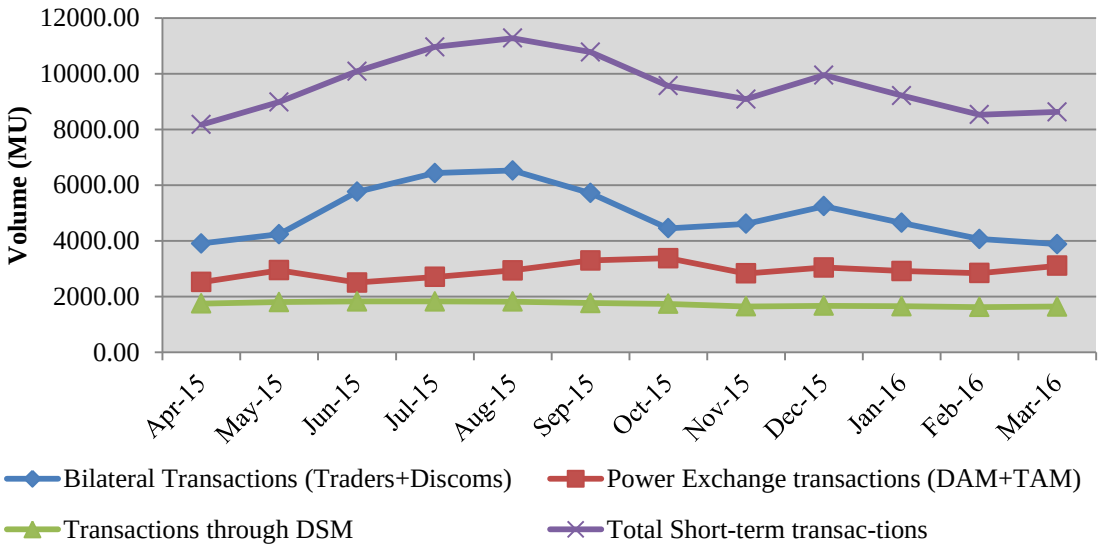
The volume of short-term transactions of electricity during different months of 2015-16 with break-up for different segments is shown in Table-14 and Figure-11.

Table-14: Volume of Short-term Transactions of Electricity (MU), 2015-16

Period	Bilateral through Traders	Bilateral between DISCOMS	Total Bilateral transac-tions	Power Exchange transac-tions (DAM+TAM)	Transactions through DSM	Total Short-term transac-tions	Total Electricity Generation
Apr-15	2293.40	1612.47	3905.87	2517.15	1751.49	8174.51	86160.54
May-15	2740.04	1495.85	4235.89	2943.27	1802.45	8981.61	94942.22
Jun-15	3391.85	2370.40	5762.25	2500.66	1825.65	10088.56	88858.89
Jul-15	4086.32	2344.03	6430.35	2704.69	1825.34	10960.38	92917.85
Aug-15	4064.51	2459.22	6523.73	2937.19	1815.97	11276.89	95559.13
Sep-15	3279.63	2433.72	5713.35	3296.49	1768.00	10777.84	95163.70
Oct-15	1895.65	2555.16	4450.81	3372.48	1739.07	9562.36	98462.42
Nov-15	2414.90	2194.79	4609.69	2828.06	1646.95	9084.70	85327.13
Dec-15	2954.70	2290.28	5244.98	3041.02	1666.05	9952.05	89308.75
Jan-16	3313.51	1333.87	4647.38	2916.19	1651.67	9215.24	91671.33
Feb-16	2858.91	1207.16	4066.07	2840.79	1623.10	8529.96	88402.90
Mar-16	2134.56	1746.27	3880.83	3107.06	1638.69	8626.58	96075.12
Total	**35427.98**	**24043.22**	**59471.20**	**35005.05**	**20754.43**	**115230.68**	**1102849.98**
% share in total generation	**3%**	**2%**	**5%**	**3%**	**2%**	**10%**	**100%**
% share in Short-term Volume	**30.7%**	**20.9%**	**51.6%**	**30.4%**	**18.0%**	**100%**	

It is observed from Figure-11 that there is a cyclical trend in the monthly volume of short-term transactions of electricity. A similar trend is also observed in the volume of bilateral transations. It is also observed from the figure that the volume of all other segments of the short-term transactions of electricity reflect irregular trend.

Figure-11: Volume of Short-term Transactions of Electricity, 2015-16



The volume of short-term transactions of electricity as percentage of total electricity generation varied from 8.98% to 11.80% during the months from April 2015 to March 2016 (Table-15).

Table-15: Volume of Short-term transactions of electricity as % of total Generation, 2015-16

Period	Short-term transactions of electricity as % of total generation
Apr-15	9.49%
May-15	9.46%
Jun-15	11.35%
Jul-15	11.80%
Aug-15	11.80%
Sep-15	11.33%
Oct-15	9.71%
Nov-15	10.65%
Dec-15	11.14%
Jan-16	10.05%
Feb-16	9.65%
Mar-16	8.98%

There were 40 inter-state trading licensees as on 31.3.2016. Of the total, 27 trading licensees actively undertook trading during the year 2015-16 (Table-16).

The volume of electricity transacted through traders (traders inter-state bilateral transactions + traders transactions through Power Exchanges) has been analysed using the Herfindahl-Hirschman Index (HHI) for measuring competition among the traders (Table-16). Increase in the HHI generally indicates a decrease in competition and an increase of market power, whereas decrease indicates the opposite. HHI value below 0.15 indicates unconcentration 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 2015-16 was 0.1432, which indicates non-concentration of market power among the traders.

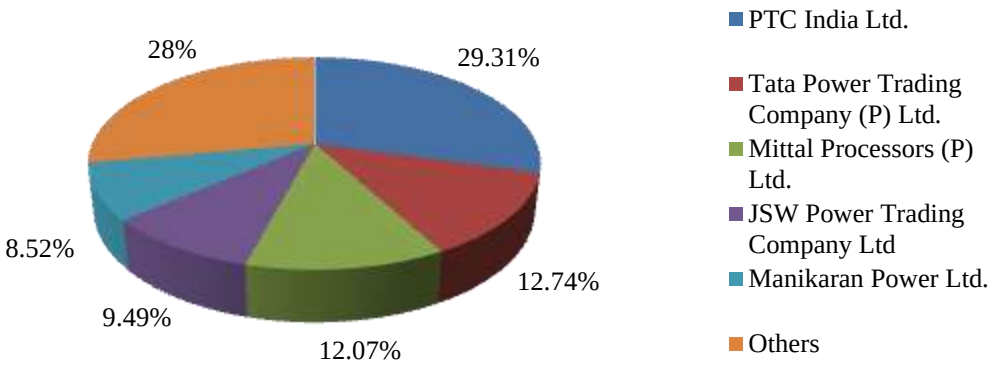
Table-16: Share of Electricity Transacted by Traders and HHI, 2015-16

Sr No	Name of the Trader	Share of Electricity transacted by Traders, 2015-16	Herfindahl Herschman Index (HHI)
1	PTC India Ltd.	29.31%	0.086
2	Tata Power Trading Company (P) Ltd.	12.74%	0.016
3	Mittal Processors (P) Ltd.	12.07%	0.015
4	JSW Power Trading Company Ltd	9.49%	0.009
5	Manikaran Power Ltd.	8.52%	0.007
6	Adani Enterprises Ltd.	5.73%	0.003
7	GMR Energy Trading Ltd.	5.64%	0.003
8	NTPC Vidyut Vyapar Nigam Ltd.	4.08%	0.002
9	Knowledge Infrastructure Systems (P) Ltd	2.59%	0.001
10	Arunachal Pradesh Power Corporation (P) Ltd	2.16%	0.000
11	Shree Cement Ltd.	2.09%	0.000
12	Jaiprakash Associates Ltd.	1.37%	0.000
13	Instinct Infra & Power Ltd.	1.30%	0.000
14	RPG Power Trading Company Ltd.	0.91%	0.000
15	National Energy Trading & Services Ltd.	0.63%	0.000
16	SN Power Markets Pvt. Ltd.	0.52%	0.000
17	My Home Power Private Ltd.	0.23%	0.000
18	Essar Electric Power Development Corp. Ltd.	0.19%	0.000
19	Customized Energy Solutions India (P) Ltd.	0.14%	0.000
20	Greenko Energies Private Ltd.	0.14%	0.000

21	Ambitious Power Trading Company Ltd.	0.09%	0.000
22	Reliance Energy Trading (P) Ltd	0.06%	0.000
23	Gita Power & Infrastructure Pvt. Ltd.	0.05%	0.000
24	Indrajit Power Technology (P) Ltd.	0.04%	0.000
25	Phillip Commodities India (P) Ltd.	0.01%	0.000
26	Adhunik Alloys Pvt. Ltd.	0.00%	0.000
27	Vedprakash Power Pvt. Ltd.	0.00%	0.000
Total Volume		**100.00%**	**0.1432**
Share of the Top 5 Traders		**72.14%**	
Note: Percentage share in total volume transacted by Traders in 2015-16 computed based on the volume which includes the volume traded by inter-state traders through bilateral and power exchanges.			
Source: Information submitted by Traders.			

The percentage share of electricity transacted by major traders in the total volume of electricity transacted by all the traders is shown in Figure-12.

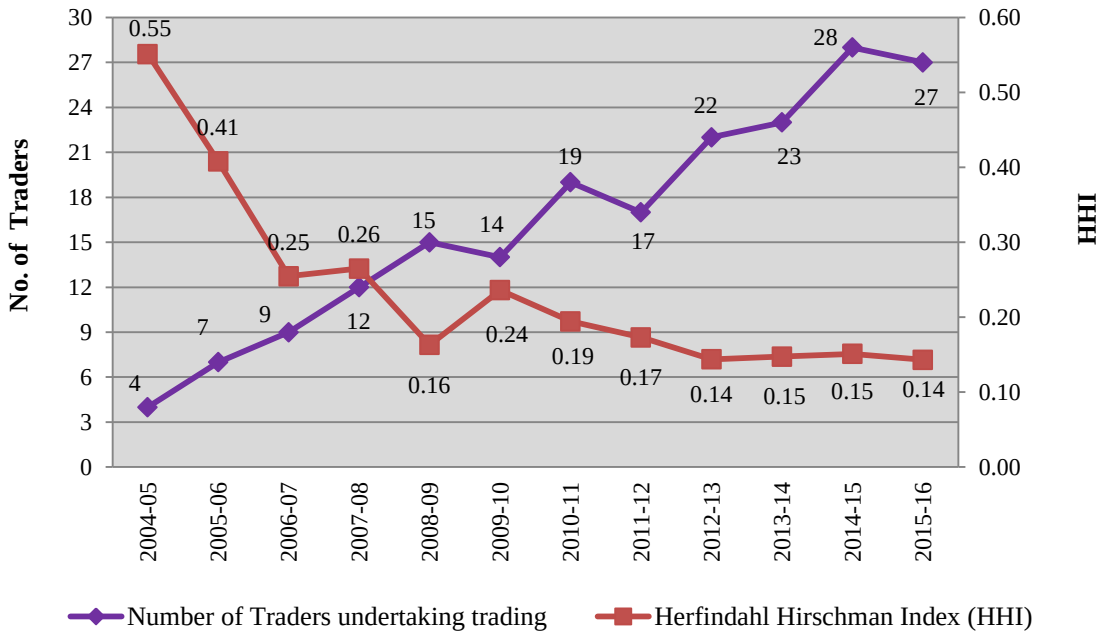
Figure-12: Share of Electricity Transacted by Traders, 2015-16



Level of competition among the traders (HHI based on volume of trade undertaken by the traders) is shown in Figure-13 for the period 2004-05 to 2015-16. Number of traders, who were undertaking trading bilaterally or through power exchanges or through both, increased from 4 in 2004-05 to 27 in 2015-16. It can be observed from the figure that there is an inverse relationship between number of traders and the HHI. The concentration of market power declined from high concentration (HHI of 0.55) in 2004-05 to non-

concentration (HHI of 0.1432) in 2015-16. The competition among the traders resulted in increase in volume and decrease in prices in the short-term bilateral market (Table-10).

Figure-13: Concentration of Market Power: Number of traders and HHI, 2004-05 to 2015-16



3.2 Price of Short-term Transactions of Electricity

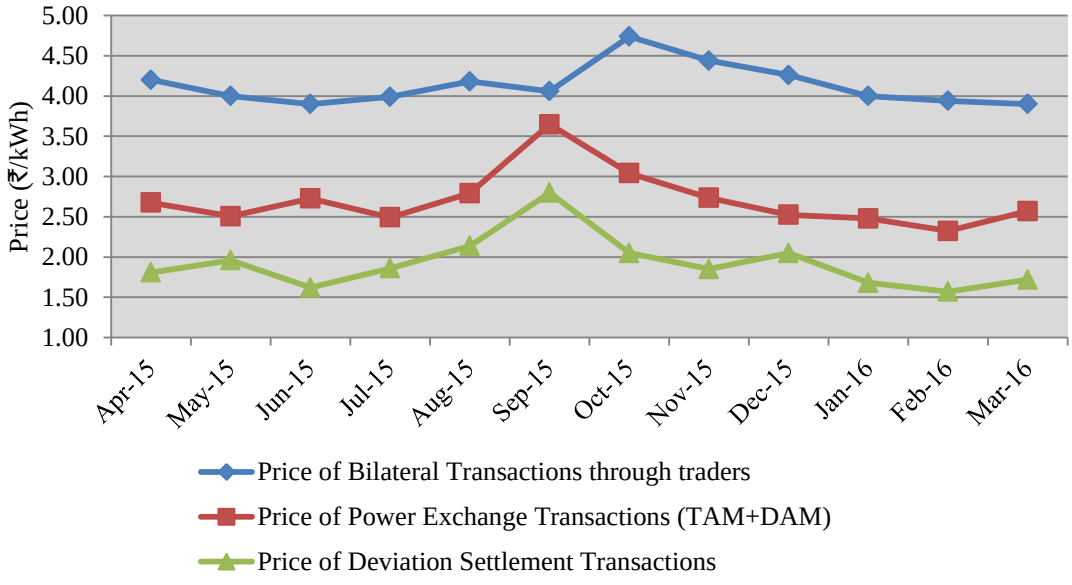
The monthly trends in price of short-term transactions of electricity are shown in Table-17 and Figure-14&15. The price analysis is mainly based on the average price of DSM and the weighted average price of other short-term transactions of electricity. The price of bilateral trader transactions represents the price of electricity transacted through traders. The trends in price of electricity transacted through traders(bilateral trader transactions) were studied separately for total transactions as well as for the transactions undertaken during Round the Clock (RTC), Peak and Off-peak periods.

Table-17: Price of Short-term Transactions of Electricity (₹/KWh), 2015-16

Period	Bilateral through Traders				Power Exchange		DSM
	RTC	Peak	Off-peak	Total	IEX	PXIL	All India Grid
Apr-15	4.29	3.05	3.64	4.20	2.67	2.53	1.81
May-15	4.07	4.13	3.55	4.00	2.50	2.35	1.96

Jun-15	3.98	3.91	3.54	3.90	2.72	2.77	1.62
Jul-15	4.07	3.6	3.57	3.99	2.47	2.70	1.86
Aug-15	4.25	3.52	3.52	4.18	2.80	2.59	2.14
Sep-15	4.35	3.61	3.3	4.06	3.65	3.56	2.80
Oct-15	4.92	3.68	3.81	4.74	3.04	3.03	2.05
Nov-15	5.37	3.89	3.55	4.44	2.73	2.82	1.85
Dec-15	5.42	-	2.92	4.26	2.52	2.67	2.05
Jan-16	4.10	-	3.55	4.00	2.48	2.66	1.68
Feb-16	4.06	4.41	3.64	3.94	2.32	2.30	1.57
Mar-16	3.97	2.48	4.14	3.90	2.56	2.46	1.72

Figure-14: Comparison of prices of Bilateral, Power Exchange and DSM Transactions in 2015-16

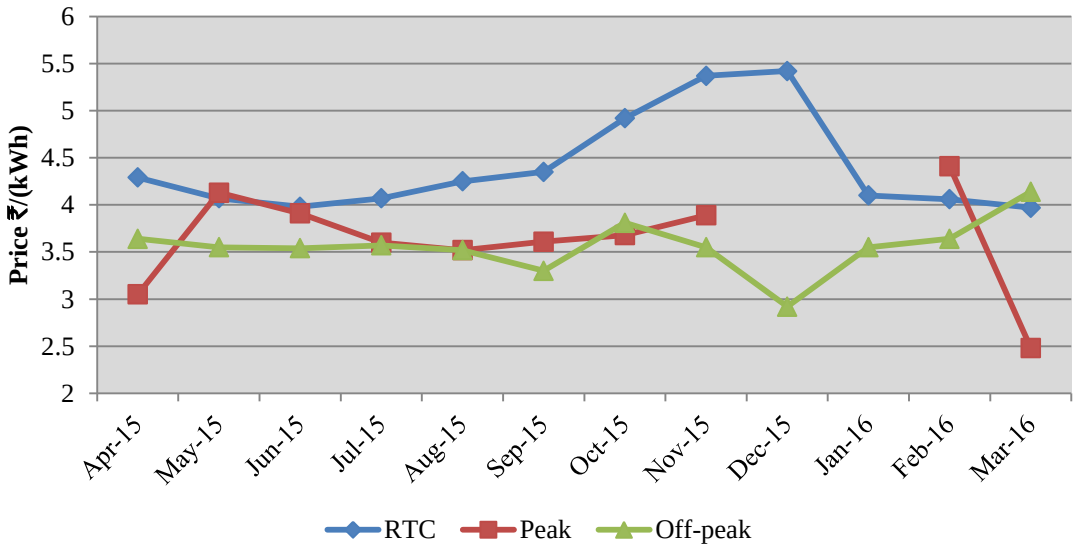


It can be observed from the above figure that the price of electricity transacted through traders was relatively high when compared with the price of electricity transacted through power exchanges and DSM during all the months in 2015-16.[5] The price of electricity transacted through power exchanges was relatively high when compared with the price of electricity transacted through DSM.

[5] 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 trends in price of electricity transacted by traders during RTC, Peak and Off-peak periods are shown in Table-17 & Figure-15. It can be observed from the figure that the price of electricity during peak period was higher in May 2015 and February 2016 when compared with the price during RTC and off peak periods. The price of electricity during RTC was relatively high in all the months except in May 2015, February and March 2016 when compared with the price during peak and off peak periods.

Figure-15: Price of Electricity Transacted through Traders during Round the Clock, Peak and Off Peak periods

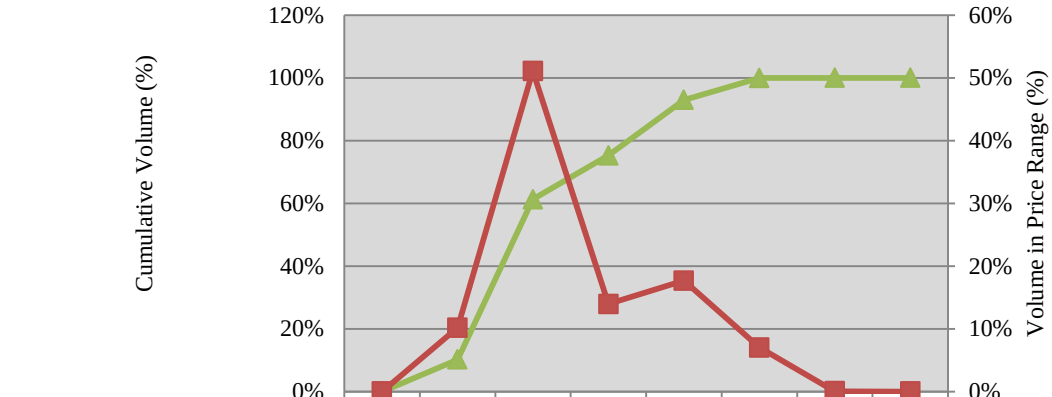


3.3 Volume of Electricity Transacted in Various Price Slabs

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, it is the Day Ahead Market sub-segment that has been considered.

Volume of bilateral transactions at different price slabs in 2015-16 is depicted in Figure -16. The figure shows that 61% of the volume of electricity was transacted through traders at less than ₹4/kWh and 93% of the volume was transacted through traders at less than ₹6/kWh.

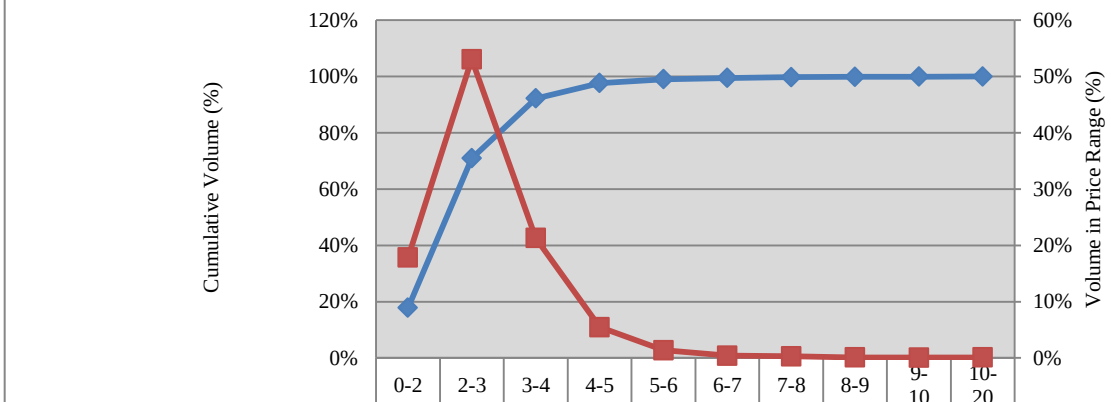
Figure-16: Volume of Bilateral Transactions at different Price Slabs, 2015-16



	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9
Cumulative Volume (%)	0%	10%	61%	75%	93%	100%	100%	100%
Volume in Price Range (%)	0%	10%	51%	14%	18%	7%	0%	0%

Volume of IEX transactions at different price slabs in 2015-16 is depicted in Figure -17. The figure shows that 92% of the volume of electricity was transacted through IEX at less than ₹4/kWh and 99% of the volume was transacted through IEX at less than ₹6/kWh.

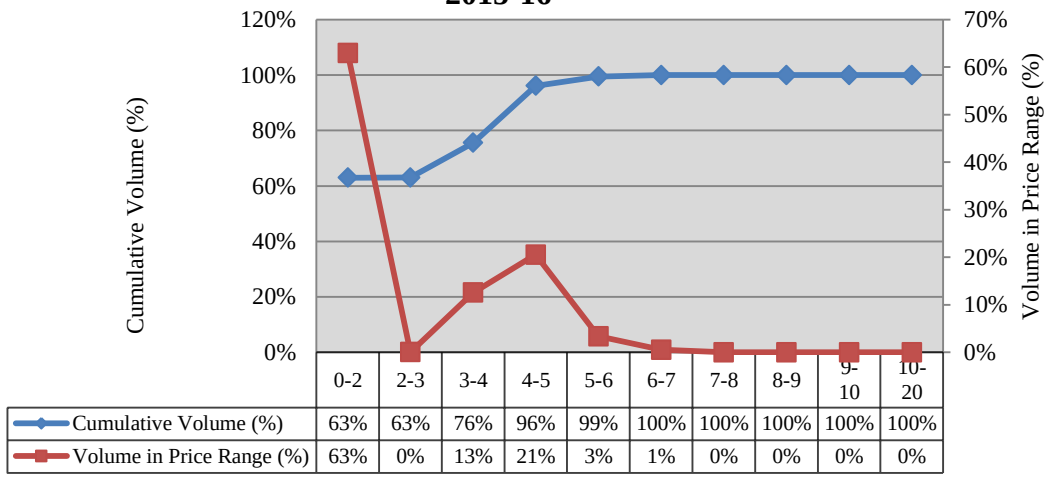
Figure-17: Volume of IEX Transactions at different Price Slabs, 2015-16



	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-20
Cumulative Volume (%)	18%	71%	92%	98%	99%	99%	100%	100%	100%	100%
Volume in Price Range (%)	18%	53%	21%	5%	1%	0%	0%	0%	0%	0%

Volume of PXIL transactions at different price slabs in 2015-16 is depicted in Figure -18. The figure shows that 76% of the volume of electricity was transacted through PXIL at less than ₹4/kWh and 99% of the volume was transacted through PXIL at less than ₹6/kWh.

Figure-18: Volume of PXIL Transactions at different Price Slabs, 2015-16



	0-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-20
Cumulative Volume (%)	63%	63%	76%	96%	99%	100%	100%	100%	100%	100%
Volume in Price Range (%)	63%	0%	13%	21%	3%	1%	0%	0%	0%	0%

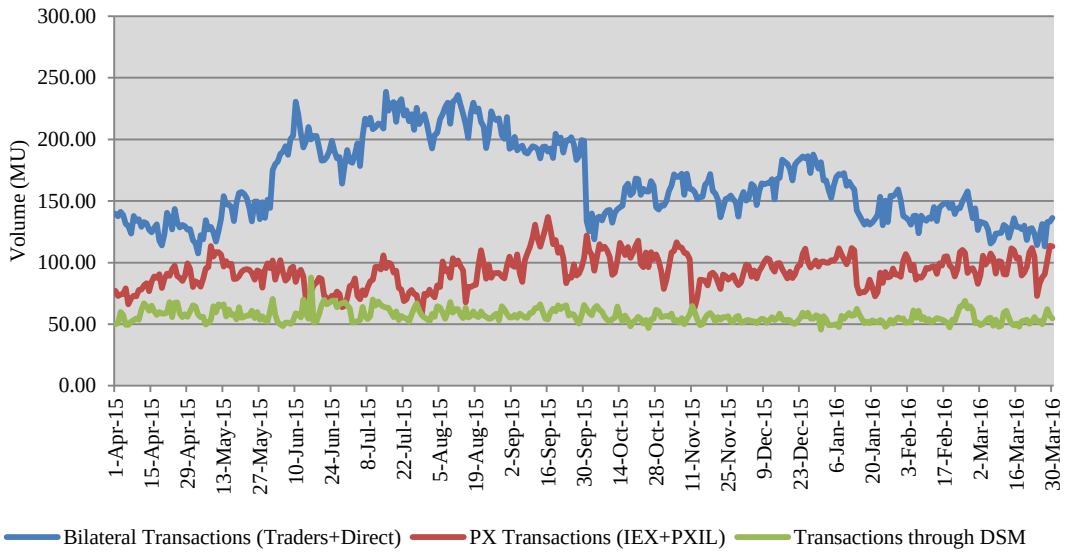
The Volume of electicity transacted at ₹4/kWh or less was more in IEX (92%) when compared to PXIL (76%). This was mainly due to different set of participants in different exchanges.

4. Daily Trends in Short-term Transactions of Electricity (1st April 2015 to 31st March 2016)

4.1 Volume of Short-term Transactions of Electricity

Trends in daily volume of short-term transactions are shown in Figure-19. It can be observed from the figure that there was a cyclical trend in the volume of electricity transacted through bilateral transactions during 2015-16. It can also be observed that there was irregular trend in the volume of electricity transacted through power exchanges and through DSM during the year.

Figure-19: Volume of Short-term Transactions of Electricity, 2015-16

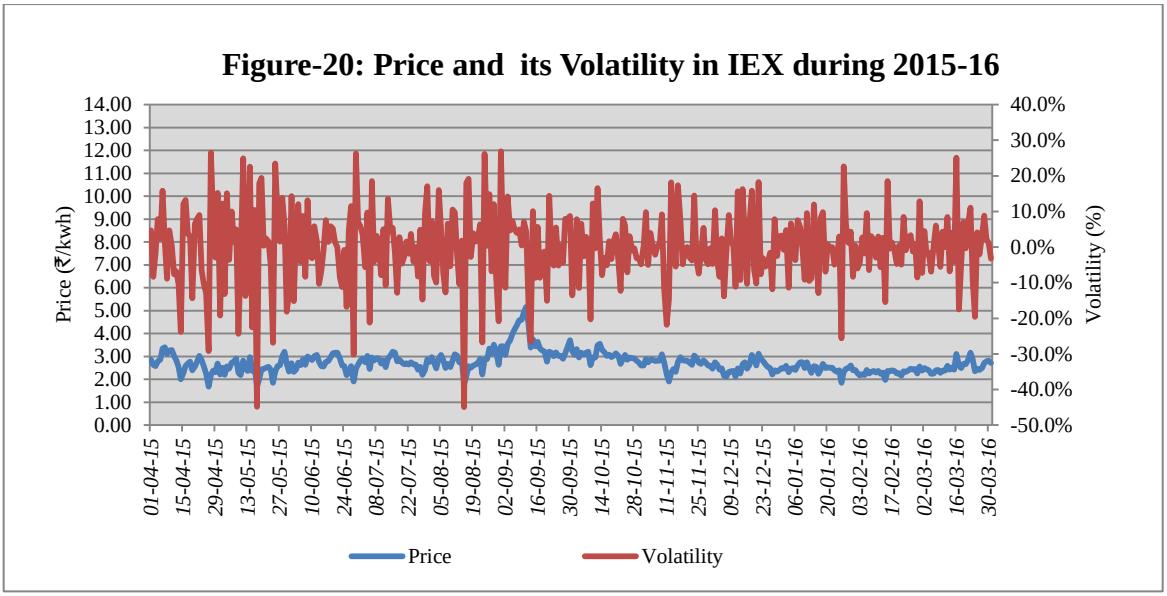


4.2 Price of Short-term Transactions of Electricity

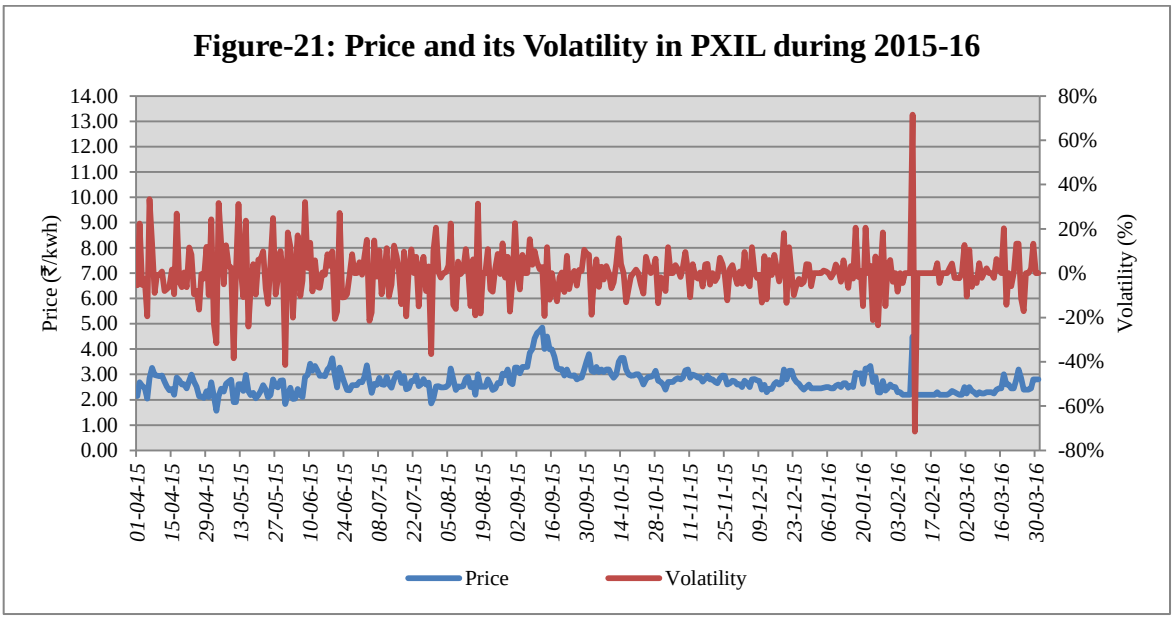
Trends in daily price of short-term transactions have been illustrated in this section for power exchanges and DSM.

4.2.1 Trends in Price of Electricity Transacted through Power Exchanges

The weighted average price of electricity transacted through IEX and its volatility is shown in Figure-20. Volatility in the Price of electricity transacted through IEX has been computed using daily data for 2015-16 and it works out to 10.52%. (See Annexure-II for historic volatility formula).



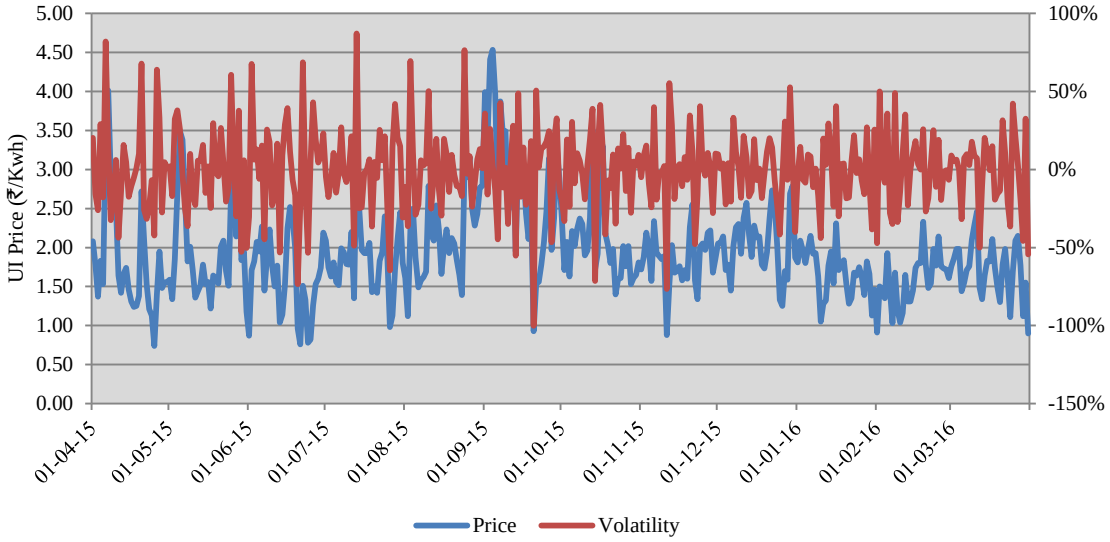
The weighted average price of electricity transacted through PXIL and its volatility is shown in Figure-21. Volatility in the price of electricity transacted through PXIL has been computed using daily data for 2015-16 and it works out to 11.72%.



4.2.2 *Trends in Price of Electricity Transacted through DSM*

The average price of electricity transacted through DSM and its volatility is shown in Figure-22.

Figure-22: Price and its Volatility in DSM during 2015-16



Volatility in the price of electricity transacted through DSM has been computed using daily data for 2015-16 and it works out 26.52%.

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

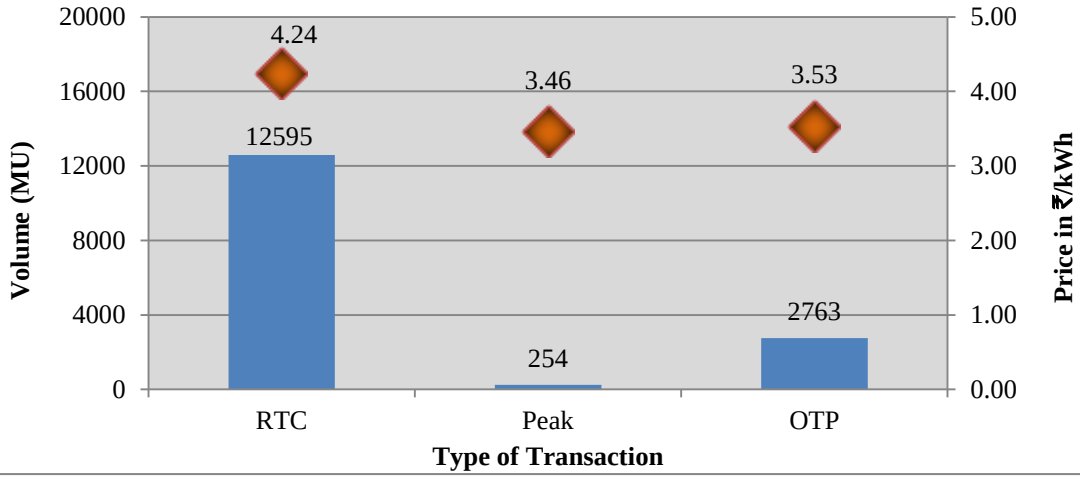
In this section, time of the day variation in volume and price of electricity transacted through traders has been illustrated for RTC (Round the Clock), Peak period and other than RTC & Peak period. Time of the day variation in volume and price of electricity transacted through power exchanges is shown block-wise. Price of electricity transacted through power exchanges is also shown 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 2015-16 is shown in Figure-23. 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, 80.68% was transacted during RTC followed by 17.70% during OTP, and 1.62% during

peak period. It can be observed from the figure that there is hardly any volume transacted during peak period. It can also be observed that the weighted average price during RTC is high (₹4.24/kWh), when compared with the price during Peak period (₹3.46/kWh) and OTP (₹3.53/kWh).

Figure-23: Volume and Price of Electricity Transacted through Traders during RTC, Peak and OTP, 2015-16



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 through IEX and PXIL (Day ahead market) during 2015-16 are shown block-wise in Figure-24 and Figure-25. It can be observed from the figure that the weighted average price in both the power exchanges was higher during peak period (between hours 18:00 to 23:00), when compared to the weighted average price in rest of the hours.

Figure-24: Block-wise Market Clearing Volume and Price in IEX during 2015-16

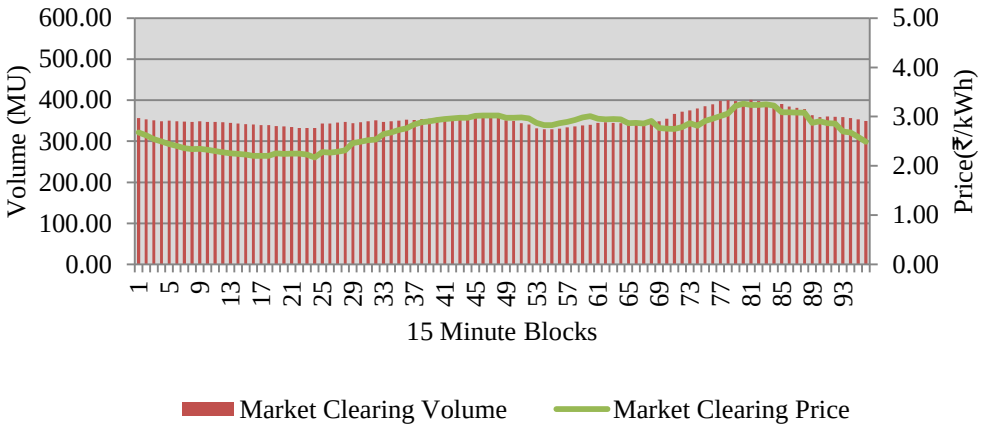
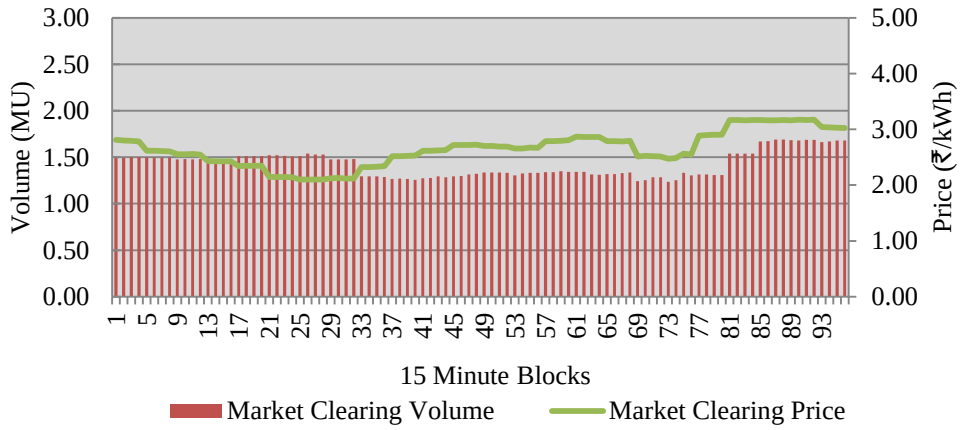


Figure-25: Block-wise Market Clearing Volume and Price in PXIL during 2015-16



Region-wise and hour-wise prices of electricity transacted through power exchanges are shown in Figure-26 and Figure-27. It can be observed from the figures that during the entire 2015-16, the price of electricity in Southern region (S1 and S2 regions) was high when compared with the price in other regions in both the power exchanges. It can also be observed that in the evening peak period, the price in the Southern region was even much higher in both the power exchanges when compared with other regions. 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.

Figure-26: Region-wise and Block-wise Price of Electricity Transacted through IEX, 2015-16

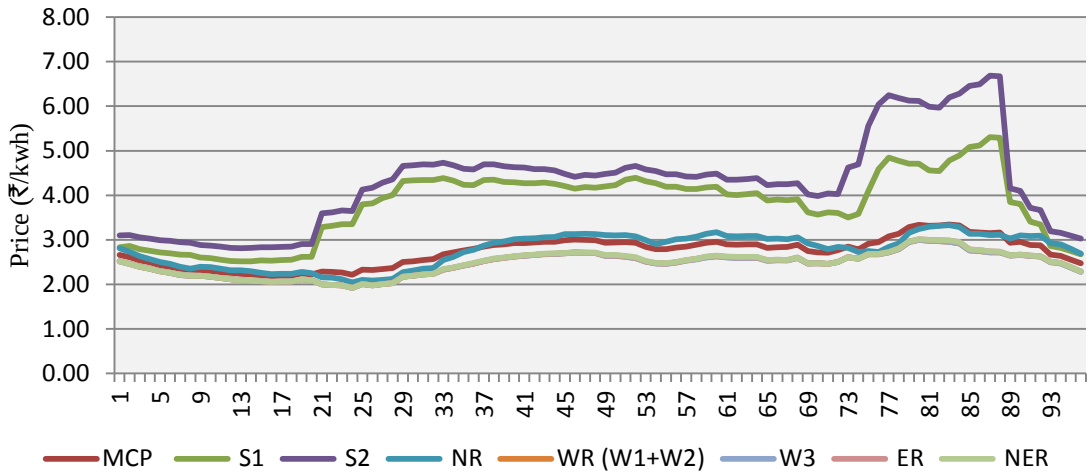
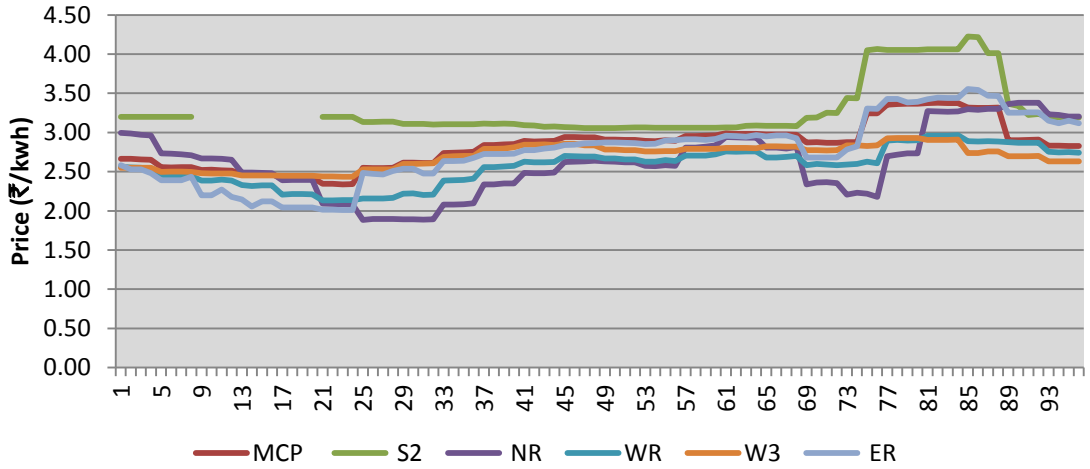


Figure-27: Region-wise and Block-wise Price of Electricity Transacted through PXIL, 2015-16



6. Trading Margin Charged by Trading Licensees for Bilateral Transactions

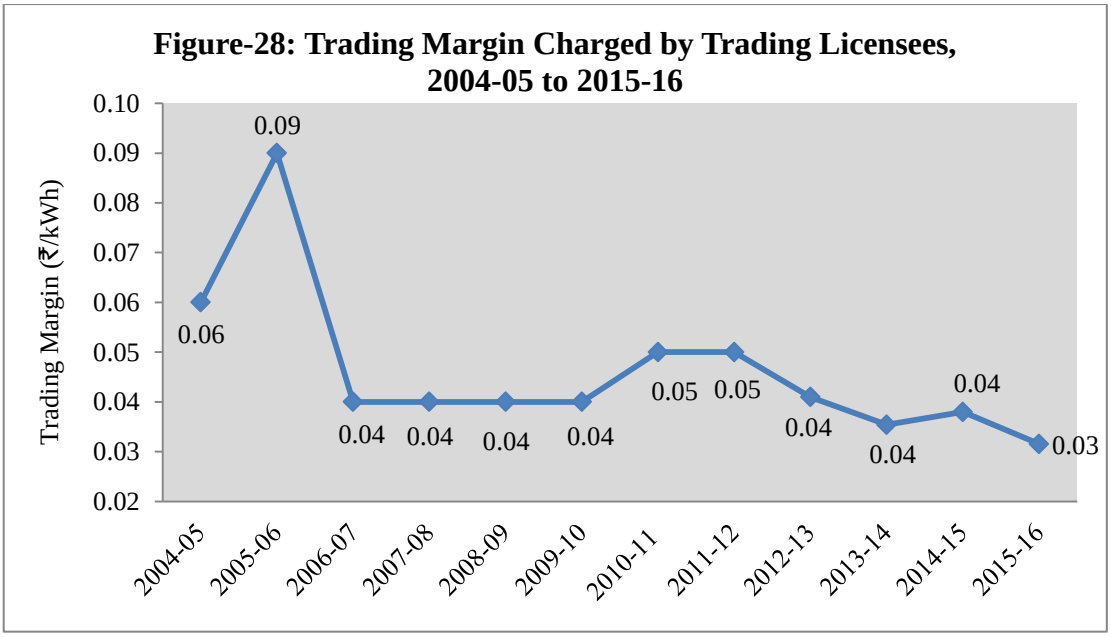
During the year 2004-05 (when trading started through licensees), the licensees voluntarily charged 5 paise/kWh or less as the trading margin. However, trading margin increased in 2005 and the weighted average trading margin charged by the licensees went up to 10 paise/kWh during April to September 2005 period. The Commission then decided to regulate the margin and fixed the trading margin at 4 paise/kWh vide "CERC (Fixation of Trading Margin) Regulations" notification dated 26.1.2006. As a result of these trading

margin regulations, the licensees charged trading margin of 4 paise or less from 26.1.2006 onwards until revised Trading Margin Regulations, 2010 came into existence on 11.1.2010 (Table-18 & Figure-28).

Based on feedback and experience with 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. The trading licensees have been charging the trading margin accordingly, and weighted average trading margin for bilateral transactions during 2004-05 to 2015-16 is given in Table-18.

Table -18: Trading Margin Charged by Trading Licensees, 2004-05 to 2015-16

Period	Trading Margin (₹/kWh)
2004-05	0.06
2005-06	0.09
2006-07	0.04
2007-08	0.04
2008-09	0.04
2009-10	0.04
2010-11	0.05
2011-12	0.05
2012-13	0.04
2013-14	0.04
2014-15	0.04
2015-16	0.03
Note 1: Weighted Average Trading Margin is computed based on all Inter-state Trading Transactions excluding Banking Transactions	



Weighted average trading margin charged by the trading licensees for bilateral transactions for different sale price ranges during 2015-16 is provided in Table-19 below.

Table -19: Trading Margin Charged by Trading Licensees during 2015-16

Sale Price of Electricity Transacted by Trading Licensees(₹/kWh)	Weighted Average Trading Margin Charged by Trading Licensees(₹/kWh)
When Sale Price is less than or Equal to ₹3/kWh	0.021
When Sale Price is greater than ₹3/kWh	0.033
Note 1: Weighted Average Trading Margin is computed based on all Inter-state Trading Transactions excluding Banking Transactions	

7. Open Access Consumers on Power Exchanges

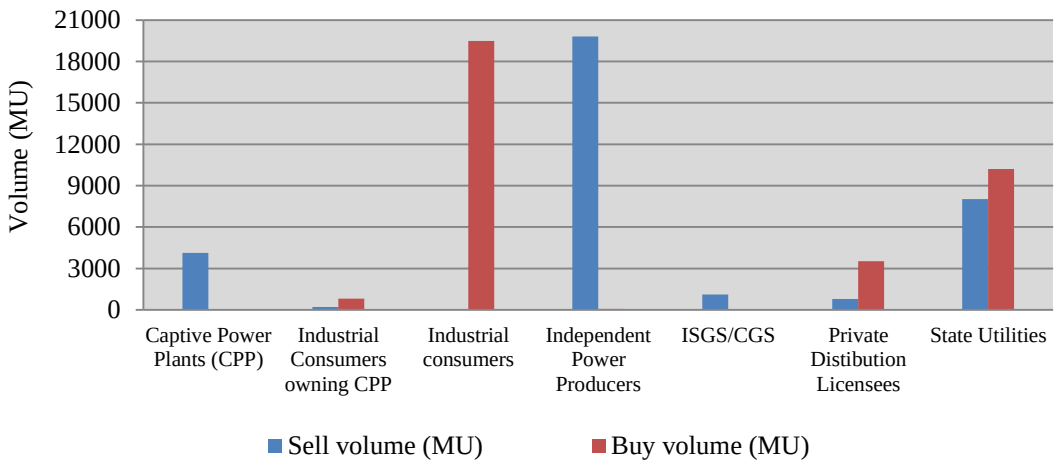
This section contains analysis of various types of participants and analysis of open access consumers in day ahead market of power exchanges.

7.1 Various Types of Participants on Power Exchanges

There are seven types of participants in IEX, as shown in Figure-29. It can be observed from the figure that major sellers of electricity through IEX were independent power producers followed by state utilities, and captive power plants. It can also be

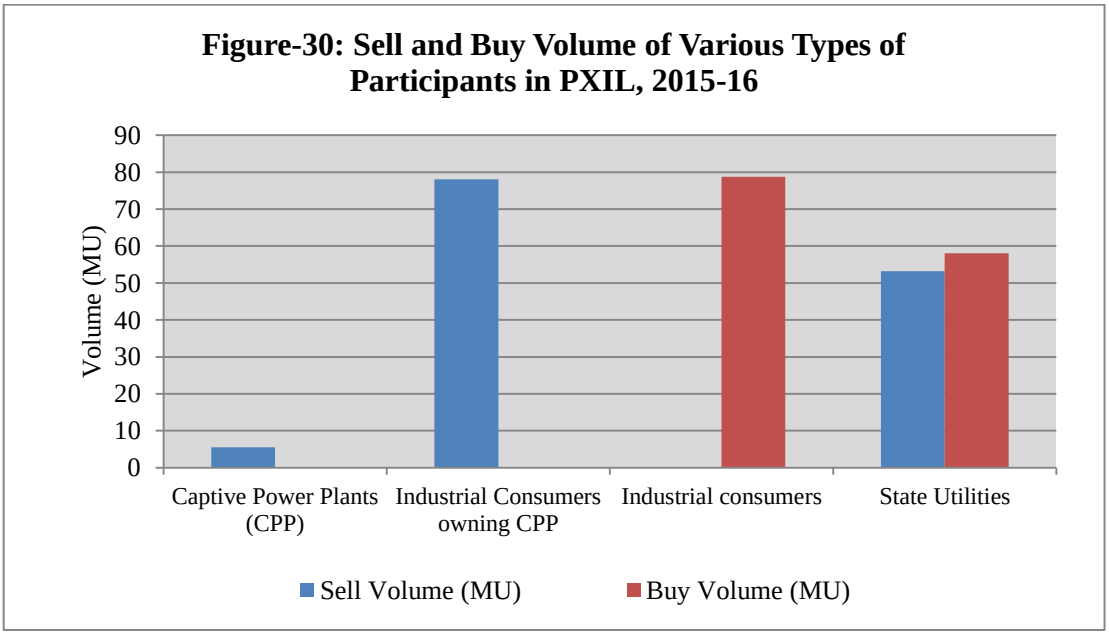
observed that major buyers of electricity through IEX were industrial consumers followed by state utilities, and private distribution licensees.

Figure-29: Sell and Buy Volume of Various Types of Participants in IEX, 2015-16



There are four types of participants in PXIL, as shown in Figure-30. It can be observed from the figure that major sellers of electricity through PXIL were industrial consumers owning CPP, and state utilities . It can also be observed that major buyers of electricity through PXIL were industrial consumers and state utilities.

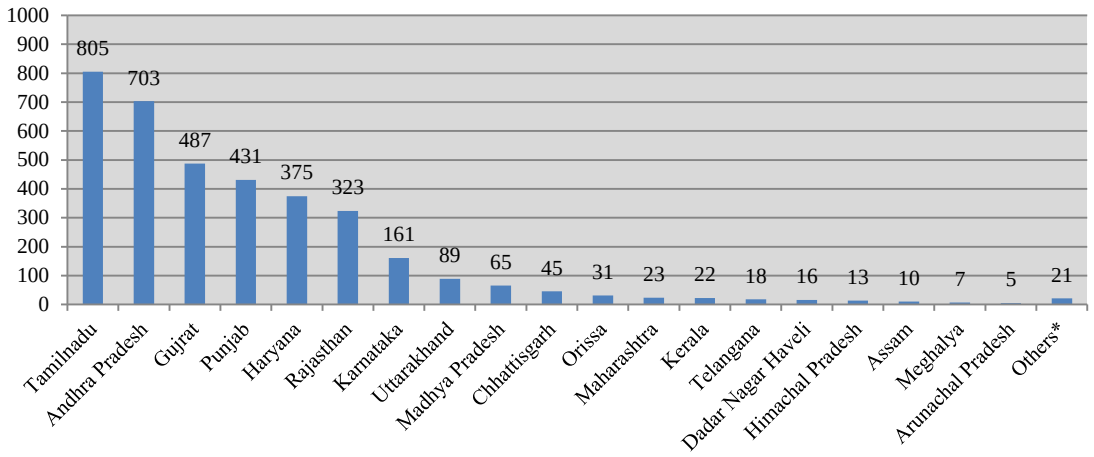
Figure-30: Sell and Buy Volume of Various Types of Participants in PXIL, 2015-16



7.2 Analysis of Open Access Consumers on Power Exchanges

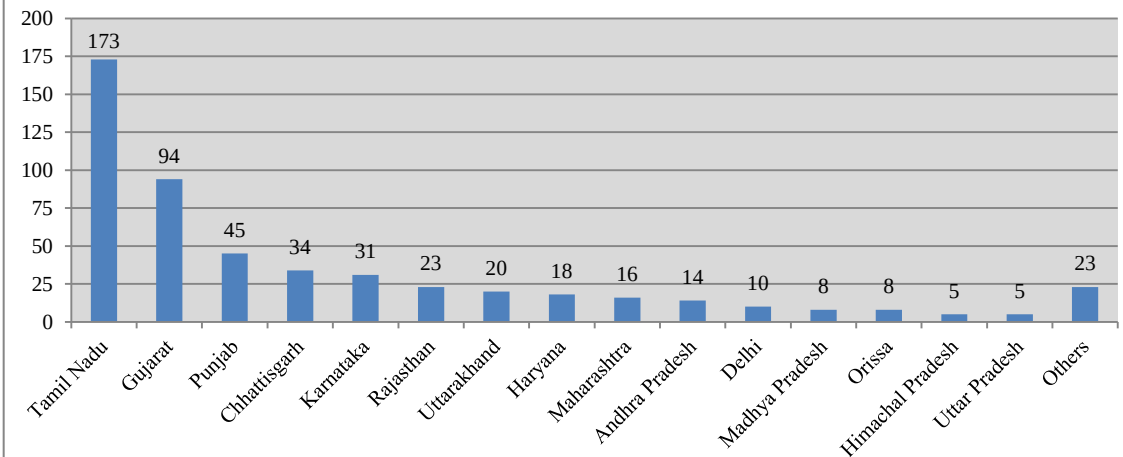
The year 2010-11 witnessed collective open access transactions, a significant development in procurement of power by the industrial consumers through power exchanges. It can be observed that 3650 Open Access (OA) Consumers were procuring part of their power requirements through IEX at the end of March 2016. These consumers were mostly located in Tamil Nadu, Andhra Pradesh, Gujarat, Punjab, Haryana, Rajasthan and Karnataka (Figure-31). During the year 2015-16, these OA consumers procured 20284MU of electricity through IEX. In 2015-16, the weighted average price of electricity bought by OA consumers at IEX was lower (₹2.56/kWh) when compared to the weighted average price of total electricity transacted through IEX (₹2.72/kWh).

Figure-31: State-wise Number of Open Access Consumers in IEX as on March 2016



About 527 OA consumers procured a part of their power requirements through PXIL. These consumers were mostly located in Tamil Nadu, Gujarat and Punjab (Figure-32). During the year, these OA consumers procured about 78.78MU of electricity through PXIL. In 2015-16, the weighted average price of electricity bought by open access consumers at PXIL was lower (₹2.61/kWh) when compared to the weighted average price of total electricity transacted through PXIL (₹2.66/kWh).

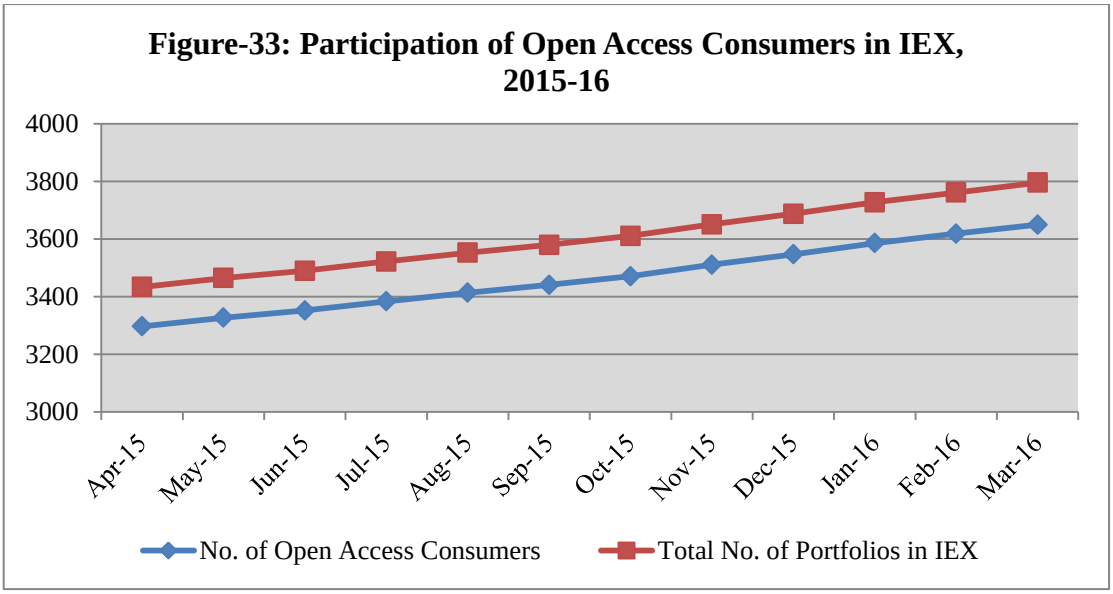
Figure-32: State-wise Number of Open Access Consumers in PXIL as on March 2016



In Table-20 & Figure-33, a month-wise comparison is made between the number of OA consumer participants and the total number of portfolios in IEX. It can be seen that the number of OA consumers as a percentage of total number of portfolios in IEX was varying from 96.01% to 96.20% during 2015-16. It can be observed from the figure that there is an increasing trend in the number of OA consumers and total number of portfolios in IEX.

Table-20: Number of Open Access Consumers in IEX, 2015-16

Month	No. of Open Access Consumers	Total No. of Portfolios in IEX	% of Open Access Consumers
Apr-15	3297	3434	96.01%
May-15	3327	3465	96.02%
Jun-15	3352	3490	96.05%
Jul-15	3384	3522	96.08%
Aug-15	3414	3553	96.09%
Sep-15	3441	3580	96.12%
Oct-15	3471	3611	96.12%
Nov-15	3511	3651	96.17%
Dec-15	3547	3688	96.18%
Jan-16	3586	3728	96.19%
Feb-16	3619	3762	96.20%
Mar-16	3650	3796	96.15%

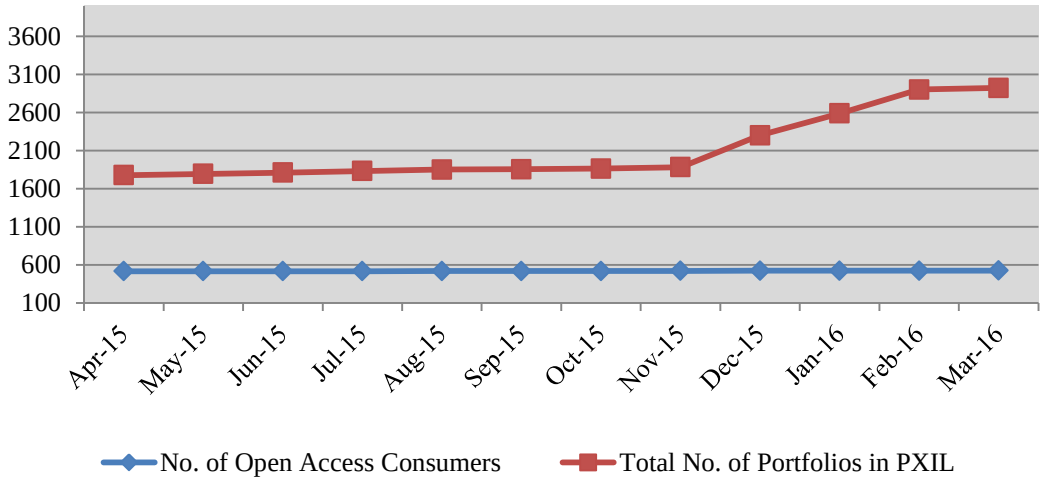


In Table-21 & Figure-34, month-wise comparison is made between the number of OA consumer participants and the total number of portfolios in PXIL. It can be seen that the number of OA consumers as a percentage of total number of portfolios in PXILwas varying from 18.02% to 29.12% during 2015-16. It can be observed from the figure that there is an increasing trend in the number of OA consumers and total number of portfolios in PXIL.

Table-21: Number of Open Access Consumers in PXIL, 2015-16

Month	No. of Open Access Consumers	Total No. of Portfolios in PXIL	% of Open Access Consumers
Apr-15	518	1779	29.12%
May-15	518	1795	28.86%
Jun-15	519	1813	28.63%
Jul-15	519	1834	28.30%
Aug-15	520	1852	28.08%
Sep-15	521	1856	28.07%
Oct-15	522	1865	27.99%
Nov-15	523	1885	27.75%
Dec-15	526	2303	22.84%
Jan-16	526	2589	20.32%
Feb-16	526	2902	18.13%
Mar-16	527	2924	18.02%

Figure-34: Participation of Open Access Consumers in PXIL, 2015-16

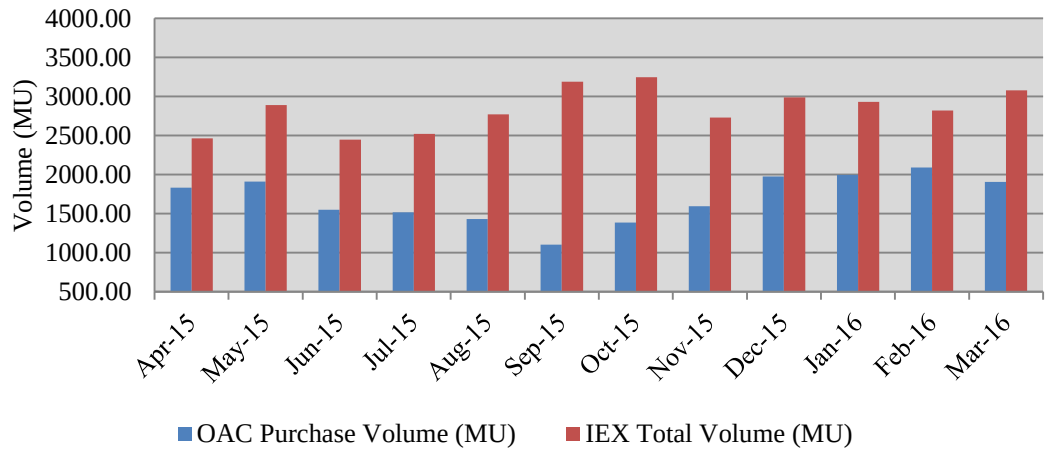


In Table-22 & Figure-35, month-wise comparison is shown between purchase volume of OA consumers and total volume of IEX. During 2015-16, volume of electricity procured by OA consumers as a percentage of total volume transacted in IEX was varying from 34.61% to 74.37%. For the year as a whole, the volume procured by OA consumers as a percentage of total volume transacted in IEX was 59.54%.

Table-22: Volume of Purchase by Open Access Consumers in Day Ahead Market of IEX, 2015-16

Month	OAC Purchase Volume (MU)	IEX Total Volume (MU)	% OAC Purchase Participation
Apr-15	1831.87	2463.31	74.37%
May-15	1910.57	2890.60	66.10%
Jun-15	1549.49	2447.45	63.31%
Jul-15	1514.16	2521.06	60.06%
Aug-15	1428.93	2768.77	51.61%
Sep-15	1103.51	3188.40	34.61%
Oct-15	1386.70	3245.87	42.72%
Nov-15	1591.89	2728.54	58.34%
Dec-15	1976.76	2987.35	66.17%
Jan-16	1994.23	2929.26	68.08%
Feb-16	2091.70	2817.89	74.23%
Mar-16	1904.68	3078.02	61.88%
Total	**20284.49**	**34066.52**	**59.54%**

Figure-35: Open Access Consumer Purchase Volume and Total Volume in IEX, 2015-16

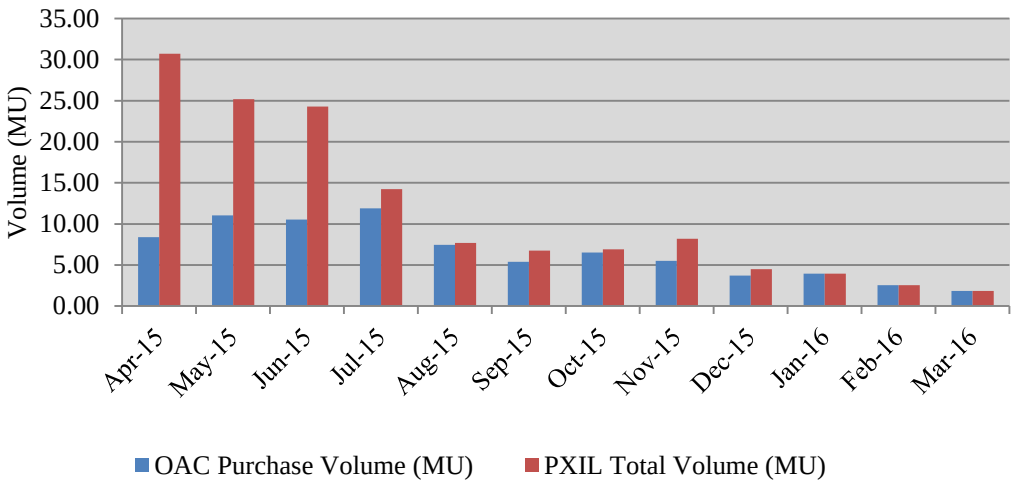


In Table-23 & Figure-36, month-wise comparison is shown between purchase volume of OA consumers and total volume of PXIL. During 2015-16, volume of electricity procured by OA consumers as a percentage of total volume transacted in PXIL was varying between 27.40% and 100%. For the year as a whole, the volume procured by OA consumers as a percentage of total volume transacted in PXIL was 57.58%.

Table-23: Volume of Purchase by Open Access Consumers in Day Ahead Market of PXIL, 2015-16

Month	OAC Purchase Volume (MU)	PXIL Total Volume (MU)	% OAC Purchase Participation
Apr-15	8.41	30.69	27.40%
May-15	11.03	25.18	43.79%
Jun-15	10.55	24.28	43.46%
Jul-15	11.89	14.25	83.47%
Aug-15	7.45	7.70	96.77%
Sep-15	5.38	6.77	79.44%
Oct-15	6.51	6.92	94.17%
Nov-15	5.50	8.20	67.07%
Dec-15	3.72	4.51	82.53%
Jan-16	3.95	3.95	100.00%
Feb-16	2.54	2.54	100.00%
Mar-16	1.85	1.85	100.00%
Total	**78.78**	**136.84**	**57.58%**

Figure-36: Open Access Consumer Purchase Volume and Total Volume in PXIL, 2015-16



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

Table-24 and Table-25 show top 10 sellers and buyers of electricity through traders(bilateral trader segment transactions). The same data for IEX is shown in Table-26 and Table-27, and for PXIL in Table-28 and Table-29. It 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, state government agencies, and captive power plants. The major buyers from traders and at power exchanges are mostly state distribution companies.

Table-24: Major Sellers of Electricity through Traders, 2015-16

S.No.	Seller	State	Volume (MU)	Volume transacted through Traders	Weighted Average Sale Price ₹/kWh
1	JSW Energy Ltd	Karnataka	2921.36	18.71%	5.95
2	Sterlite Energy Ltd.	Odisha	1412.54	9.05%	3.54
3	Jaypee Nigrie Super Thermal Power Plant	Madhya Pradesh	1338.96	8.58%	3.23
4	Jindal Power Ltd	Himachal Pradesh	1114.66	7.14%	3.67
5	GMR Kamalanga Energy Ltd.	Odisha	988.36	6.33%	3.46

6	Adani Power Ltd.	Gujarat	869.07	5.57%	3.41
7	Himachal Pradesh SEB	Himachal Pradesh	764.06	4.89%	4.64
8	Vedanta Limited	Odisha	695.63	4.46%	3.73
9	Simphapuri Energy (P) Ltd.	Andhra Pradesh	599.17	3.84%	5.26
10	Korba West Power Company Ltd.	Chhattisgarh	515.10	3.30%	3.06
Note : Volume sold by major sellers and total volume transacted through traders does not include the volume through banking arrangement					

Table-25: Major Buyers of Electricity through Traders, 2015-16

S.No.	Buyer	State	Volume (MU)	Volume transacted through Traders	Weighted Avearage Purchase Price (₹/kWh)
1	Telangana State Power Coordination Committee	Telangana	2999.61	19.21%	5.31
2	CESC & WBSEDCL	West Bengal	2473.45	15.84%	3.24
3	APPCC & APSPDCL	Andhra Pradesh	2171.65	13.91%	5.03
4	Punjab State Power Corporation Ltd	Punjab	1357.05	8.69%	3.44
5	Haryana Power Purchase Centre	Haryana	996.00	6.38%	4.33
6	Noida Power Company Ltd & UPPCL	Uttar Pradesh	802.40	5.14%	3.60
7	Rajasthan Discoms Power Procurement Centre and JVVNL	Rajasthan	624.99	4.00%	3.65
8	KSEB	Kerala	563.26	3.61%	5.26
9	BEST	Maharasthra	496.39	3.18%	3.66
10	Tata Power Company Ltd	Maharasthra	484.34	3.10%	3.35
Note : Volume Bought by major buyers and total volume transacted through tradrs does not include the volume through banking arrangements					

From Table-25, it can be seen that the weighted average purchase prices of electricity of major buyers such as APPCC, BSEB and KSEB from traders (bilateral

transactions) were higher than the weighted average price for the entire bilateral trader segment (₹4.28/kWh).

Table-26: Major Sellers of Electricity in the Day Ahead Market of IEX, 2015-16

S.No.	Name of Seller	State/Regional Entity	Sell Volume (MU)	Volume Transacted in IEX	Weighted Average Sell Price (₹/KWh)
1	JITPL	Regional Entity	3768.31	11.06%	2.45
2	GOHP	Himachal Pradesh	2201.43	6.46%	2.80
3	Jindal Power Ltd	Regional Entity	1957.33	5.75%	2.67
4	Vedanta Ltd	Regional Entity	1760.23	5.17%	2.61
5	Adani Power Ltd	Gujarat	1651.08	4.85%	2.60
6	Korba West Power Company Ltd	Regional Entity	1385.07	4.07%	2.51
7	TPCIL	Regional Entity	1008.03	2.96%	2.91
8	Jindal Steel and Power Ltd	Regional Entity	965.42	2.83%	2.48
9	Karcham Wangtoo HEP	Himachal Pradesh	963.36	2.83%	2.86
10	Haryana Power Purchase Centre	Haryana	835.53	2.45%	2.94
Note: Total Volume transacted through Day Ahead Market in IEX was about 33956 MU.					

Table-27: Major Buyers of Electricity in the Day Ahead Market of IEX, 2015-16

S.No.	Name of Buyer	State/Regional Entity	Buy Volume (MU)	Volume Transacted in IEX	Weighted Average Buy Price (₹/kWh)
1	BSPHCL	Bihar	2310.66	6.78%	2.62
2	Essar Steel India Ltd.	Regional Entity	2261.32	6.64%	2.40
3	WBSEDCL	West Bengal	1245.77	3.66%	2.94
4	BRPL	Delhi	1223.87	3.59%	3.03
5	UPCL	Uttarakhand	1103.89	3.24%	2.90
6	APSPDCL	Andhra Pradesh	1047.20	3.07%	4.40

7	JVVNL	Rajasthan	824.97	2.42%	3.41
8	MSEDCL	Maharashtra	723.74	2.12%	2.68
9	Reliance Infra Ltd (D)	Maharashtra	710.43	2.09%	2.72
10	KSEB	Kerala	665.61	1.95%	3.95
Note: Total Volume transacted through Day Ahead Market in IEX was about 33956 MU.					

From Table-27, it can be seen that the weighted average prices of electricity for major buyers such as WBSEDCL, BRPL, UPCL, APSPDCL, JVVNL and KSEB in the day ahead market of IEX were higher than the weighted average price for the entire day ahead market of IEX (₹2.72/kWh).

Table-28: Major Sellers of Electricity in the Day Ahead Market of PXIL, 2015-16

S. No	Name of the Seller	State/Regional Entity	Sell Volume (MU)	Volume transacted in PXIL	Weighted Average Sell Price (₹/kWh)
1	NDMC	Delhi	36.83	26.92%	2.75
2	Jindal Power Ltd	Chhattisgarh	36.78	26.88%	2.69
3	Jaypee Karcham Hydro Corporation Ltd	Uttar Pradesh	25.76	18.83%	2.39
4	Jindal India Thermal Power Ltd	Orissa	9.46	6.92%	2.55
5	Greenko Budhil Hydro Power (P) Ltd	Himachal Pradesh	5.52	4.04%	2.71
6	Gridco Ltd	Orissa	5.06	3.70%	3.39
7	MPPTCL	Madhya Pradesh	3.55	2.60%	2.70
8	JVVNL	Rajasthan	3.37	2.46%	2.62
9	Vedanta Ltd	Orissa	3.22	2.35%	2.81
10	MSEDCL	Maharashtra	3.01	2.20%	2.18
Note:Total Volume transacted in the Day Ahead Market in PXIL was about 136.84 MU.					

From Table-29, it can be seen that the weighted average prices of electricity for major buyers such as Bansali Engineering Polymers Ltd, KSEB and Astral Poly Technic Ltd in the PXIL Day Ahead Market were higher than the weighted average price for the entire day ahead market of PXIL (₹2.66/kWh).

Table-29: Major Buyers of Electricity in Day Ahead Market of PXIL, 2015-16

S.No.	Name of the Buyer	State/ Regional Entity	Buy Volume (MU)	Volume transacted in PXIL	Weighted Average Buy Price ₹/kWh
1	UPCL	Uttarakhand	50.6	37%	2.61
2	IFFCO Plant	Gujarat	17.16	13%	2.63
3	Bodal Chemicals Ltd	Gujarat	17.07	12%	2.62
4	Bhansali Engineering Polymers Ltd	Rajasthan	14.55	11%	2.78
5	Orient Abrasives Ltd	Gujarat	9.43	7%	2.57
6	KSEB	Kerela	5.73	4%	3.37
7	Oracle Granito Ltd	Gujarat	4.48	3%	2.41
8	Jay Chemical Industries Ltd	Gujarat	3.04	2%	2.47
9	City Tiles Ltd	Gujarat	2.94	2%	2.44
10	Astral Poly Technik Ltd	Gujarat	2.91	2%	2.88
Note: Total Volume transacted through PXIL was about 136.84 MU.					

9. Effect of Congestion on 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-30 and Table-31.

Annual details of congestion in power exchanges are shown in Table-30. It can be observed from the table that there is an increasing trend in the unconstrained cleared volume and actual volume transacted (excluding the year 2014-15). Unconstrained cleared volume and actual volume transacted increased from 8.10 BU and 7.09 BU respectively in 2008-09 to 36.36BU and 34.20BU respectively in 2015-16. It can also be observed from the table that there is an increasing trend in 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 from 2010-11 to 2012-13 and a declining trend from 2012-13 to 2015-16. Congestion has been reduced since grid integration (integration of NEW Grid and SR Grid) in December 2013, leading to 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.

Table-30: Congestion in Power Exchanges, 2009-10 to 2015-16

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
1	2	3	4 (2-3)	5 (4/2)
2009-10	8.10	7.09	1.01	12%
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%
** This power would have been scheduled had there been no congestion.*				

Source: IEX, PXIL & NLDC

During 2015-16, in the IEX, the unconstrained cleared volume and the actual volume transacted were 36.21BU and 34.06BU respectively (Table-31). The actual transacted volume was 5.93% lesser than unconstrained volume. During the same year, in PXIL, the unconstrained cleared volume and the actual volume transacted were 0.15BU and 0.14BU respectively. The actual transacted volume was 8.49% lesser than unconstrained volume.

Table-31: Congestion in Power Exchanges, 2015-16

	Items	IEX	PXIL	Total
A	Unconstrained Cleared Volume* (MU)	36210.32	149.54	36359.86
B	Actual Cleared Volume and hence scheduled (MU)	34063.32	136.84	34200.16
C	Volume of electricity that could not be cleared and hence not scheduled because of congestion (MU) (A-B)	2147.00	12.70	2159.70

D	Volume of electricity that could not be cleared as % to Unconstrained Cleared Volume	5.93%	8.49%	5.94%
** This power would have been scheduled had there been no congestion.*				

Source: IEX, PXIL & NLDC

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 2009-10 to 2015-16 is provided in Table-32.

Table-32: Annual Congestion Charges of Power Exchanges, 2008-09 to 2015-16

Year	Congestion Charges in IEX (₹ Crore)	Congestion Charges in PXIL (₹ Crore)	Total (₹ Crore)
2008-09	5.27	0.00	5.27
2009-10	255.40	22.39	277.79
2010-11	273.14	86.61	359.75
2011-12	419.13	65.62	484.76
2012-13	417.37	35.93	453.30
2013-14	387.23	5.10	392.33
2014-15	502.41	1.64	504.05
2015-16	214.08	0.14	214.22

Source: NLDC

Chapter-III

Tariff of Long-term Sources of Power

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; (e) the promotion of co-generation and generation of electricity from renewable sources of energy; etc.

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 notified competitive bidding guidelines 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 1year. 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 in private sector. The details on tariff of central public sector power generating companies, tariff (levelised tariff) of power projects under Case-1 bidding, have been provided below.

1. Tariff of Central Public Sector power generating companies

In 2015-16, the central public sector power generating companies (NTPC, NHPC, NLC, NEEPCO, etc.)/central government owned generating companies accounted for about 37.12% of the total power generation in the country.

The prices paid by distribution companies to procure power from central government owned generating companies in 2015-16 (under long-term Power Purchase Agreements) are shown in Table-33 and 34. It can be seen that, on an average, the distribution companies paid between ₹1.63 and ₹10.93 per kWh for procuring power from coal based stations, between ₹4.70 and ₹8.16 per kWh from natural gas based power stations, between ₹8.19 and ₹21.98 per kWh from liquid fuel based power stations (Table-33), and between ₹0.79 per kWh and ₹7.65 per kWh from hydro stations (i.e. excluding latest hydro stations of Teesta-LDP and Parbati-III) (Table-34).

Table-33: Tariff of Central Thermal Power Stations, 2015-16

Sl. No.	Name of the Generating Station	Installed Capacity (MW) as on March, 2016	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	0.85	1.74	2.58
2	Rihand STPS (St-II)	1000	0.92	1.64	2.56
3	Rihand STPS (St-III)	1000	1.72	1.60	3.32
4	Singrauli STPS	2000	0.52	1.31	1.84
5	Vindhyachal STPS (St-I)	1260	0.83	1.54	2.37
6	Vindhyachal STPS (St-II)	1000	0.81	1.52	2.33
7	Vindhyachal STPS (St-III)	1000	1.18	1.46	2.64

8	Vindhyachal STPS (St-IV)	1000	1.70	1.52	3.23
	Vindhyachal STPS (St-V)	500	1.56	1.45	3.01
9	Korba STPS (St-I & II)	2100	0.59	1.04	1.63
10	Korba STPS (St-III)	500	1.53	1.03	2.56
11	Ramagundam STPS (St-I&II)	2100	0.58	2.29	2.87
12	Ramagundam STPS (St-III)	500	0.88	2.33	3.21
13	Talcher TPS	460	1.15	1.38	2.53
14	Talcher STPS (St-I)	1000	0.79	1.33	2.13
15	Talcher STPS (St-II)	2000	0.76	1.33	2.08
16	Sipat STPS (St-I)	1980	1.46	1.17	2.64
17	Sipat STPS (St-II)	1000	1.27	1.19	2.47
	Sub-Total (A)	**21400**			
B.	**Non-Pit head Generating Stations**				
18	FGUTPP TPS (St-I)	420	0.84	2.67	3.51
19	FGUTPP (St-II)	420	0.91	2.65	3.56
20	FGUTPP (St-III)	210	1.51	2.62	4.13
21	NCTP Dadri (St-I)	840	1.26	3.64	4.90
22	NCTP Dadri (St-II)	980	1.87	3.42	5.29
23	Farrakka STPS (St-I&II)	1600	0.95	2.65	3.60
24	Farrakka STPS (St-III)	500	1.97	2.66	4.63
25	Tanda TPS	440	1.06	2.82	3.88
26	Badarpur TPS	705	1.69	4.24	5.94
27	Kahalgaon STPS (St-I)	840	1.03	2.35	3.38
28	Kahalgaon STPS (St-II)	1500	1.30	2.21	3.51
29	Simhadri (St-I)	1000	1.00	2.46	3.46
30	Simhadri (St-II)	1000	1.59	2.46	4.06
31	Mauda STPS (St-I)	1000	7.81	3.11	10.93
32	Barh STPS (St-II)	1320	2.29	3.30	5.59
	Sub-Total (B)	**12775**			
	Total Coal (A+B)	**34175**			
II: Natural Gas (APM & Non-APM)/LNG/Liquid Fuel based generating stations of NTPC					
A: Using Natural Gas(APM) as Fuel					
1	Anta CCGT	419.33	2.15	3.21	5.36
2	Auraiya GPS	663.36	1.67	3.83	5.49

3	Dadri CCGT	829.78	1.17	3.53	4.70
4	Faridabad GPS	431.59	2.12	3.02	5.14
5	Gandhar GPS	657.39	4.87	2.89	7.77
6	Kawas GPS	656.20	3.05	2.96	6.01
	Total APM Gas	**3658**			
B: Using Natural Gas(Non-APM) as Fuel					
1	Gandhar GPS	657.39	4.87	3.28	8.16
2	Kawas Gas	656.20	3.05	3.32	6.38
	Total Non-APM Gas	**1314**			
C: Using LNG as Fuel					
1	Anta CCGT	419.33	2.15	6.04	8.19
2	Auraiya GPS	663.36	1.67	7.78	9.44
3	Dadri CCGT	829.78	1.17	9.02	10.18
4	Faridabad GPS	431.59	2.12	7.76	9.88
5	Gandhar GPS	657.39	4.87	9.10	13.97
6	Kawas GPS	656.20	3.05	9.00	12.05
	Total Naphtha/HSD	**3658**			
D: Using Liquid Fuel (Naphtha/HSD) as Fuel					
1	Anta CCGT	419.33	2.15	8.08	10.23
2	Auraiya GPS	663.36	1.67	10.33	12.00
3	Dadri CCGT	829.78	1.17	7.64	8.81
4	Kayamkulam CCGT	359.58	14.42	7.56	21.98
	Total Liquid Fuel	**2272**			

Table-34: Composite Tariff of Central Hydro Power Stations, 2015-16

Name of Generating Company	Name of the Generating Station	Type	Installed Capacity (MW)	Annual Fixed Charges (₹/Lakhs)	Composite Tariff (₹/kWh)
NHPC					
1	Baira siul	Pondage	180	12623	1.85
2	Loktak	Storage	105	13502	3.45
3	Salal	ROR	690	28276	1.05
4	Tanakpur	ROR	123	11041	2.80
5	Chamera-I	Pondage	540	30146	2.08
6	Uri-I*	ROR	480	33853	1.50
7	Rangit	Pondage	60	10074	3.41
8	Chamera-II*	Pondage	300	34314	2.63

9	Dhauliganga-I	Pondage	280	29231	2.96
10	Dulhasti	ROR	390	95214	5.74
11	Teesta-V*	Pondage	510	49710	2.22
12	Sewa-II*	Pondage	120	18790	4.05
13	Chamera-III*	Pondage	231	39043	4.05
14	Chutak*	ROR	44	11985	6.47
15	Uri-II*	ROR	240	32772	3.35
16	Nimoo Bazgo*	Pondage	45	12326	5.91
17	Teesta-LDP*	Pondage	132	34793	6.72
18	Parbati-III*	ROR	520	28819	4.73
	Total		**4990**		
NHDC					
1	Indira Sagar*	Storage	1000	57751	2.95
2	Omkareshwar*	Storage	520	42587	5.11
	Total		**1520**		
THDC					
1	Tehri Stage-I*	Storage	1000	145824	6.05
2	Koteshwar*	Pondage	400	38316	3.81
	Total		**1400**		
SJVNL					
1	Naptha Jhakri*	RoR	1500	155756	2.59
2	Rampur HP	RoR	412	52076	3.19
	Total		**1912**		
NEEPCO					
1	Khandong	Storage	50	3940	1.63
2	Kopili Stage-I	Storage	200	10479	1.01
3	Doyang	Storage	75	9779	4.94
4	Ranganadi	Pondage	420	25491	1.56
5	Kopili Stage-II	Storage	25	1377	1.83
	Total		**770**		
** Tariff is not determined yet for the year 2015-16, therefore, tariff allowed for billing is provided.*					

2. Levelised tariff of power projects under Case-I Bidding

Table-35 indicates long-term levelised tariff for power available from power projects bid in the year 2014-15 under Case-I. During 2014-15, the price of the power projects under Case-I for long-term varied in the range of ₹3.60 per kWh to ₹4.29 per kWh.

Table-35: Capacity Contracted under Case-I Bidding Route, 2014-15

S. No	State	Name of the Developer/ Plant	Capacity (MW)	Levelized Tariff (₹/KWh)	Fuel Type	Date of LOI	Medium /Long Term
1	Kerala	Jindal Power Ltd	200	3.6	Domestic Coal	07.11.2014	Long Term
2	Kerala	Jindal Power Ltd	150	4.29		20.12.2014	
3	Kerala	Jabua Power Ltd	115	4.15		07.11.2014	
4	Kerala	Jabua Power Ltd	100	4.29		20.12.2014	
5	Kerala	Bharat Aluminium Company Ltd	100	4.29		28.11.2014	
6	Kerala	Jindal Thermal Power Ltd	100	4.29		20.12.2014	
7	Kerala	Bhavanapadu Thermal Power Project	100	4.29		20.12.2014	
Source: Forum of Regulators							

Chapter-IV

Transactions of Renewable Energy Certificates

1. Background of Renewble Energy Certificate Mechanism

The Renewble 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, 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. An REC can be issued within three months of generation and is valid for one year thereafter. 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 was 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 18 November 2010.

2. Trading of Renewble Energy Certificates on Power Exchanges

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 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. The forbearance price and floor price notified by CERC are as under:

Table-36: Forbearance and Floor Price for REC transactions w.e.f 1st March 2015

Type of REC	Floor Price (₹/MWh)	Forbearance Price (₹/MWh)
Solar	3500	5800
Non-Solar	1500	3300

The first REC trading session was held on power exchanges in March 2011. Number of RECs transacted on power exchanges increased significantly from 10.15 lakh in 2011-12 to 49.55 lakh in 2015-16. The growth in the RECs transacted on power exchanges has been shown in Table-37.

Table-37: Growth of Renewable Energy Certificates transacted on Power Exchanges, 2011-12 to 2015-16

Financial Year	Number of buyers	Number of sellers	Number of RECs transacted (Lakhs)	% increase in Number of RECs Transacted
2011-12	397	168	10.15	-
2012-13	802	487	25.90	155%
2013-14	1083	703	27.49	6%
2014-15	821	906	30.62	11%
2015-16	632	966	49.55	62%

Note: Number of buyers and sellers are upto November 2015

Source:NLDC

The volume and price of RECs transacted in both power exchanges in 2015-16 has been provided in Table-38 and Table-39. The market clearing volume of Solar RECs transacted in 2015-16 on IEX and PXIL were 465456 and 182745 respectively and the weighted average of market clearing price of these RECs was ₹3500/MWh on both power exchanges. Market clearing volume of Non-Solar RECs transacted in 2015-16 on IEX and PXIL were 2673434 and 1633518 respectively and the weighted average of market clearing price of these RECs was ₹1500/MWh on both power exchanges.

The gap between the volume of buy and sell bids of RECs placed through power exchanges shows that there was less demand for both Solar RECs and Non-Solar RECs. For Solar RECs, the ratio of buy and sell bids was 0.02 in both IEX and PXIL. For Non-Solar RECs, the ratio of buy and sell bids was 0.03 in both IEX and PXIL .

Table-38 : Renewable Energy Certificates transacted on Power Exchanges, 2015-16

Sr.No.	Details of REC Transactions	RECs transacted on IEX		RECs transacted on PXIL	
		Solar	Non-Solar	Solar	Non-Solar
A	Volume of Buy Bid	465456	2673434	182745	1633518
B	Volume of Sell Bid	22767196	88991809	9379755	64401356
C	Ratio of Buy Bid to Sell Bid Volume	0.02	0.03	0.02	0.03
D	Market Clearing Volume (MWh)	465456	2673434	182745	1633518
E	Market Clearing Price (₹/MWh)	3500	1500	3500	1500

Month-wise volume and price of RECs transacted through power exchanges are shown in the following table (Table-39).

Table-39 : Volume and Price of Renewable Energy Certificates Transacted on Power Exchanges, 2015-16

Month	IEX		PXIL	
	Volume of REC Transactions (MWh)	Weighted Average Price of REC Transactions (₹/MWh)	Volume of REC Transactions (MWh)	Weighted Average Price of REC Transactions (₹/MWh)
Solar				
Apr-15	6721	3500	1801	3500
May-15	80867	3500	2322	3500
Jun-15	22682	3500	966	3500
Jul-15	16782	3500	1170	3500
Aug-15	26402	3500	15526	3500
Sep-15	8630	3500	1390	3500
Oct-15	11945	3500	1906	3500
Nov-15	41102	3500	46665	3500
Dec-15	58682	3500	2920	3500
Jan-16	41188	3500	16232	3500
Feb-16	41658	3500	48578	3500
Mar-16	108797	3500	43269	3500
Non-Solar				
Apr-15	38481	1500	17131	1500
May-15	211533	1500	45046	1500
Jun-15	128180	1500	33665	1500
Jul-15	108042	1500	47229	1500
Aug-15	77236	1500	30045	1500
Sep-15	147805	1500	35794	1500
Oct-15	68663	1500	142779	1500
Nov-15	89107	1500	142438	1500
Dec-15	806993	1500	91446	1500
Jan-16	164004	1500	180515	1500
Feb-16	232450	1500	354051	1500
Mar-16	600940	1500	513379	1500

Annexure-I

List of Transmission Licensees as on 31.03.2016

S.No.	Name of Licensee	Date of grant of licence
1	Powerlinks Transmission Ltd.	13.11.2003
2	Torrent Power Grid Ltd (Formerly known as Torrent Power Transmission (P) Ltd)	16.05.2007
2	Jaypee Powergrid Ltd	01.10.2007
3	Essar Power Transmission Company Ltd.	10.04.2008
3	Parbati Koldam Transmission Company Ltd	15.09.2008
4	Western Region Transmission (Maharashtra) (P) Ltd	30.12.2008
4	Western Region Transmission (Gujrat) (P) Ltd	30.12.2008
5	Teestavalley Power Transmission Ltd., New Delhi	14.05.2009
5	North East Transmission Company Ltd., New Delhi	16.06.2009
6	East - North Inter - Connection Company Ltd.	28.10.2010
6	Talcher - II Transmission Company Ltd.	08.11.2010
7	Cross Border Power Transmission Company Ltd, Gurgaon	01.12.2010
7	North Karanpura Transmission Company Ltd.	16.12.2010
8	Jindal Power Ltd, Chattisgarh	09.05.2011
8	Raichur Sholapur Transmission Company Ltd	24.08.2011
9	Jabalpur Transmission Company Ltd	12.10.2011
9	Bhopal Dhule Transmission Company Ltd	12.10.2011
10	Powergrid NM Transmission Ltd	20.06.2013
10	Torrent Energy Ltd	16.07.2013
11	Adani Transmission (India) Ltd	29.07.2013
11	Aravali Power Co. Ltd.	07.11.2013
12	Kudgi Transmission Ltd	07.01.2014
12	Powergrid Vizag Transmission Ltd	08.01.2014
13	Darbhanga - Motihari Transmission Company Ltd	30.05.2014
13	Purulia & Kharagpur Transmission Company Ltd	30.05.2014
14	Patran Transmission Company Ltd	14.07.2014
14	Unchahar Transmission Ltd	21.07.2014
15	RAPP Transmission Company Ltd	31.07.2014
15	NRSS XXXI (B) Transmission Ltd	25.08.2014
16	NRSS XXXI (A) Transmission Ltd	04.09.2014
16	NRSS XXIX Transmission Ltd	14.11.2014
17	Powergrid Jabalpur Transmission Ltd	15.06.2015
17	DGEN Transmission Company Ltd	24.06.2015
18	Gadarwara (B) Transmission Ltd	10.07.2015
18	POWERGRID Warora Transmission Ltd	05.08.2015
19	Maheshwaram Transmission Ltd	23.11.2015

19	Raipur-Rajandgaon-Warora Transmission Ltd	29.02.2016
20	Chhattisgarh-WR Transmission Ltd	29.02.2016
20	Sipat Transmission Ltd	07.03.2016
21	POWERGRID Southern Interconnector Transmission System Ltd	14.03.2016
21	Alipurduar Transmission Ltd	21.03.2016

Annexure-II

List of Trading Licensee as on 31.3.2016

Sr. No.	Name of Trading Licensee	Date of Issue of License	Present 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	Reliance Energy Trading (P) Ltd	30.06.2004	I
5	NTPC Vidyut Vyapar Nigam Ltd	23.07.2004	I
6	National Energy Trading & Services Ltd	23.07.2004	I
7	Karam Chand Thapar & Bros Ltd	27.01.2005	I
8	JSW Power Trading Company Ltd.	25.04.2006	I
9	GMR Energy Trading Ltd	14.10.2008	I
10	Global Energy (P) Ltd.	28.11.2008	I
11	Knowledge Infrastructure Systems (P) Ltd	18.12.2008	I
12	Shree Cement Ltd	16.03.2010	I
13	Jai Prakash Associates Ltd	23.03.2011	I
14	Statkraft Markets (P) Ltd	21.06.2012	I
15	Pan India Network Infravest Ltd	18.11.2013	I
16	IL&FS Energy Development Company Ltd	04.09.2014	I
17	Essar Electric Power Development Corporation Ltd	14.12.2005	II
18	RPG Power Trading Company Ltd	23.09.2008	II
19	Mittal Processors (P) Ltd	12.02.2009	II
20	Manikaran Power Ltd	29.06.2012	II
21	Instinct Infra & Power Ltd	07.09.2005	III
22	PCM Power Trading Corporation Ltd	01.09.2010	III
23	My Home Power (P) Ltd	26.04.2011	III
24	DLF Energy (P) Ltd	07.03.2012	III
25	Arunachal Pradesh Power Corporation (P) Ltd	11.09.2012	III
26	Solar Energy Corporation of India	01.04.2014	III
27	IPCL Power Trading (P) Ltd	10.02.2015	III
28	Gita Power & Infrastructure (P) Ltd	20.10.2015	III
29	Visa Power Trading Company Ltd	28.06.2007	IV
30	Greenko Energies (P) Ltd	22.01.2008	IV
31	Vandana Vidyut Ltd	03.04.2008	IV
32	Audhunic Alloys & Power Ltd	26.06.2008	IV
33	Ambitious Power Trading Company Ltd	16.09.2008	IV
34	Shyam Indus Power Solutions (P) Ltd	11.11.2008	IV
35	Customised Energy Solutions India (P) Ltd	08.06.2011	IV

36	Newfields Advertising (P) Ltd	30.04.2013	IV
37	Vedprakash Power (P) Ltd	19.08.2013	IV
38	Parshavnath Power Projects (P) Ltd	19.05.2014	IV
39	Provestment Services Ltd	27.01.2015	IV
40	Phillip Commodities India Pvt. Ltd.	21.01.2016	IV

Historical Volatility Formula:

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

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

where

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

Herfindahl-Hirschman Index (HHI)

Formula for computing the HHI is as under:

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

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

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

- A HHI index below 0.01 (or 100) indicates a highly competitive index.
- A HHI index below 0.15 (or 1,500) indicates an unconcentrated index.
- A HHI index between 0.15 to 0.25 (or 1,500 to 2,500) indicates moderate concentration.
- A HHI index 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 one, the normalized Herfindahl index ranges from 0 to 1.