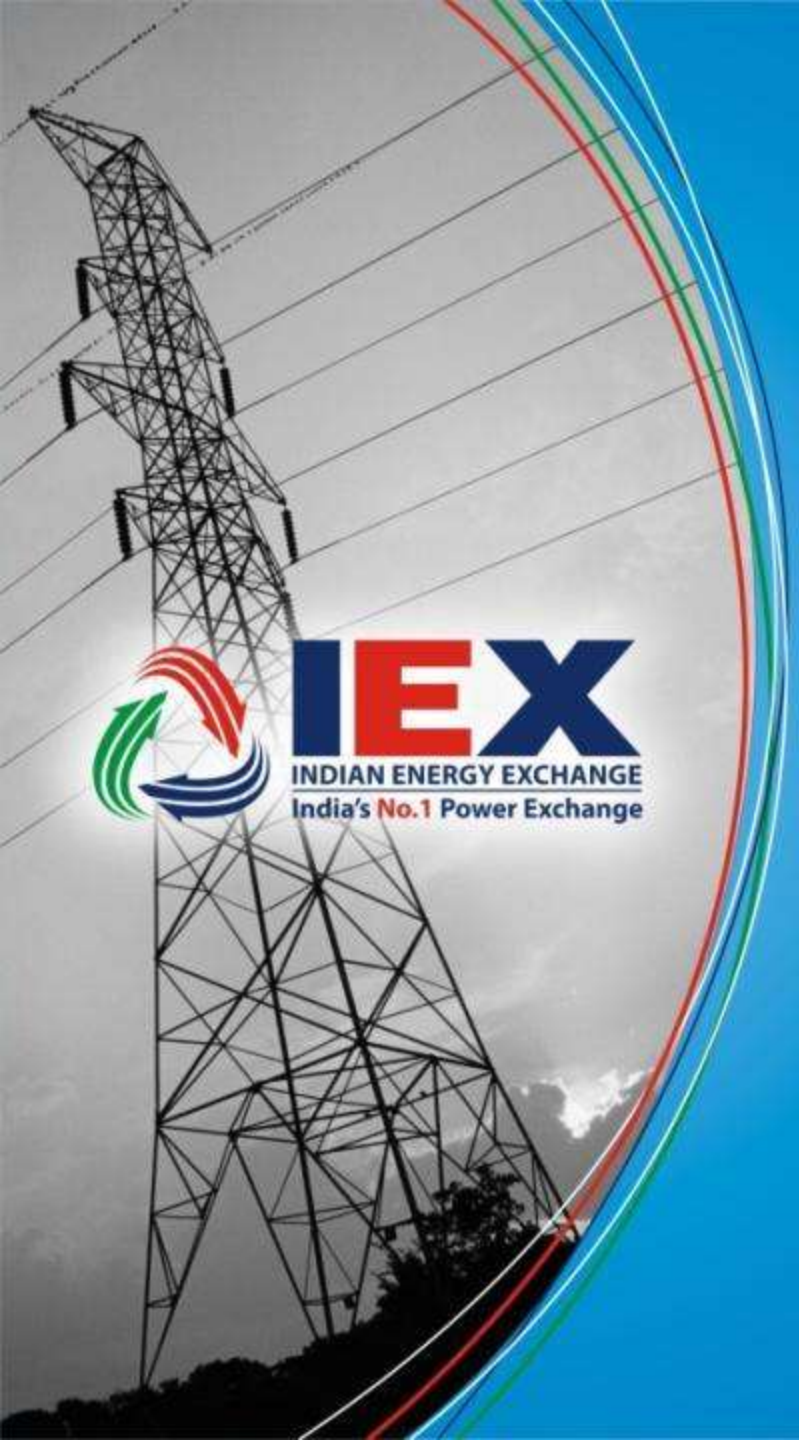


Trading on Power Exchange: IEX

21st April 2015, IIT Kanpur

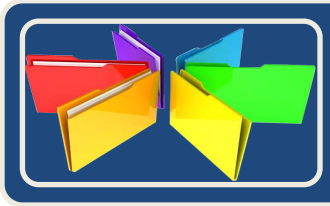
Email: info@iexindia.com

www.iexindia.com

April 2015

In this presentation

Introduction to Indian Power Market



Product Portfolio

Trading Mechanism

Market snapshot

- Participation
- Volume
- Price

Trade @ IEX

Indian Power Market: Present Status

Long Term
Upto 25 Years

Power Purchase Agreements — 89%

Medium Term
3 months- 3years

Short-Term
Intraday - 3 months

OTC
Licensed traders *(61)*

OTC Intraday- 3 months

6%

Exchanges
1. Intra-day
2. DAM
3. DAC
4. Daily
5. Weekly

3%

Balancing Market
Real Time

Unscheduled Interchange — 2%

Company Snapshot

IEX
INDIAN ENERGY EXCHANGE
India's No.1 Power Exchange

96% Market Share ~80,000MWh average daily trade

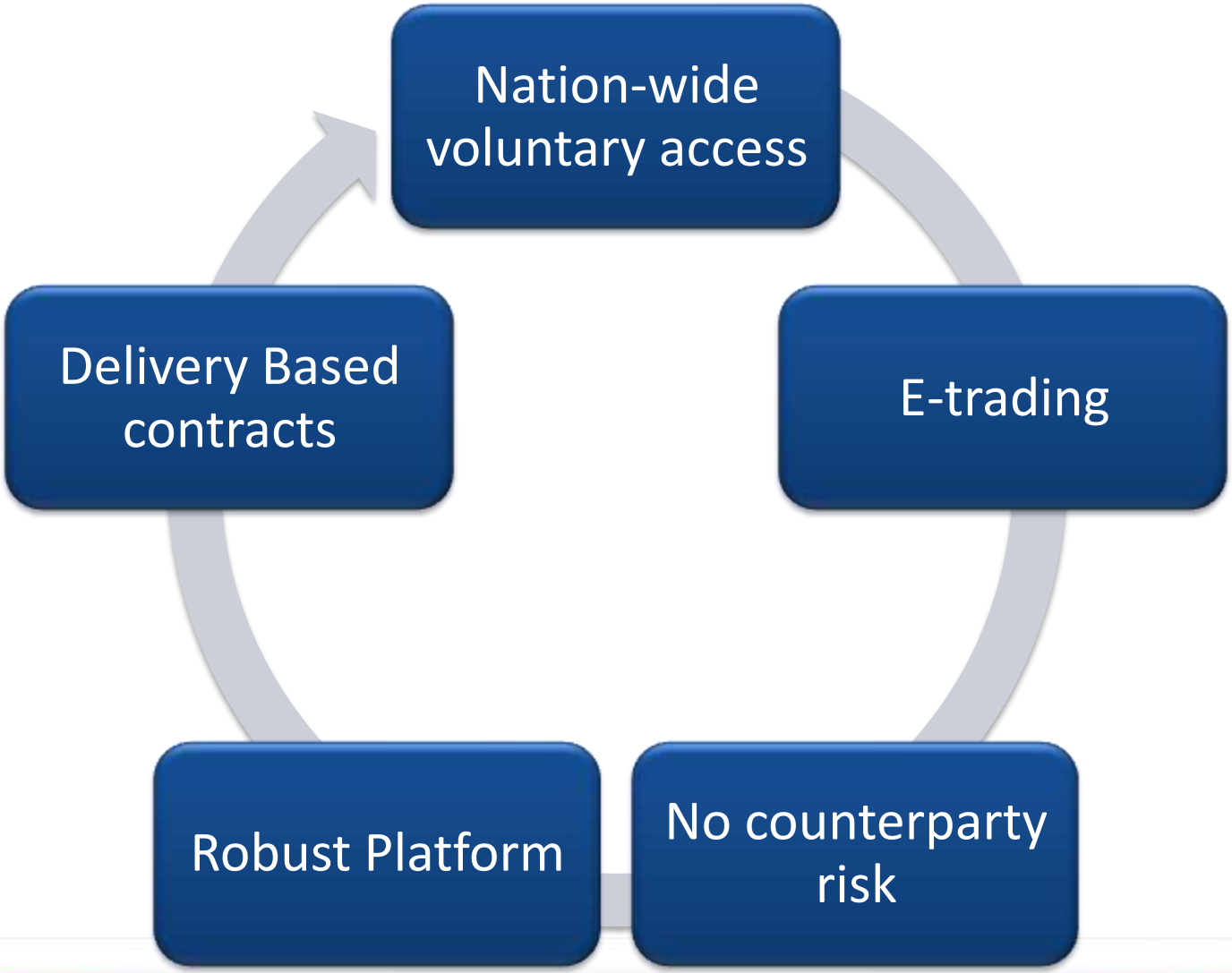
3400+ Participants **3000+** Industries

Transparency

Liquidity

Competition

What benefits does the Power Exchange provide?



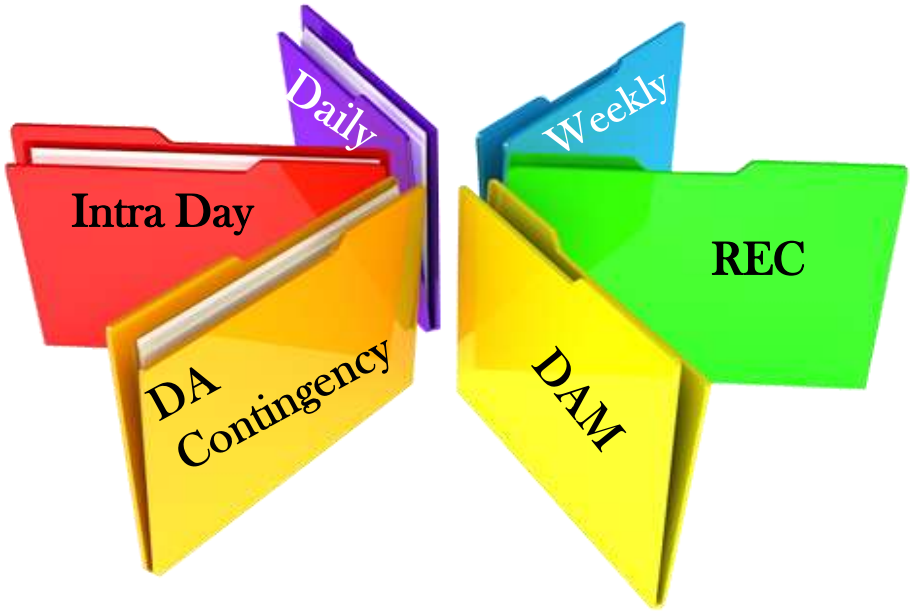
IEX capabilities

- Spot Auction (Closed or Open) for real time prices
- Continuous Trading for Long-term contracts
- Automated matching engine
- Online risk management system
- Online clearing & banking interface for margins & trade proceeds payment
- Derivatives - for Hedging & Price Discovery
  - **Forwards**
  - **Futures**
- Physical or financial settlement

IEX Self Regulating Institution

- Due diligence before Membership
- Networth Criteria
- Security deposit & Margins
- Voluntary participation
- IEX Central Counterparty
- SLDC Clearance

Understanding exchange mechanism



PX Product Portfolio

IEX Market Segments

Delivery-based Contracts

Day-Ahead Market
since June,08

Closed , Double-sided Auction
10-12 am bidding
Each 15-min block , 0.1 MW min NOC required

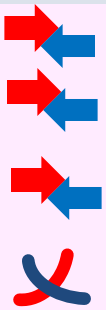
Term-Ahead Market
since Sep,09

Day-Ahead Contingency – *Another window 3-5pm*

Intra-Day *- for the same day starting 2 pm*

Daily- *for rolling seven days (delivery starting after 4 days)*

Weekly- *for 1 week (Monday-Sunday)*



Renewable Energy Certificates
since Feb,11

Green Attributes as Certificates
Sellers : *RE generators not under feed in tariffs*
Buyers: *Obligated entities*
1MWh equivalent to 1 REC

Next… Energy Saving Certificates

Auction

Continuous

Contract Characteristics

	TERM AHEAD MARKET				
Contract Characteristic	**Day Ahead Market**	**Intraday Contracts**	**Day Ahead Contingency**	**Daily Contracts**	**Weekly Contracts**
Delivery	Next day	1400 -2400 Hrs same day	For next day	From 4th day to next 7 days	For next week
Auction Type	**Closed Auction**	Continuous trading	Continuous trading	Continuous trading	Open Auction
Contracts	**15 min**	Hourly	Hourly	Block of Hours (Fixed)	Block of Hours (Fixed)
Trade Availability	All Days; 1000-1200	All days; 1000-1700	All Days; 1500-1700	All Days; 1200-1500	Wed & Thurs; 1200-1600
Financial Settlement	Pay-In- D-1; Pay Out – D+1	Pay in: T+1 Pay out: T+1	Pay in: T+1 Pay out: T+2	Pay-In- D-1; Pay Out – D+1	Pay-In- D-1; Pay Out – D+1

T = Trade
D = Delivery

Day-Ahead Market

(Collective Market)

Features of Day Ahead Market

A closed double-sided anonymous auction for **each 15-min time block** for the following day

The intersection between the aggregated sale and purchase curves defines the market clearing price (MCP)

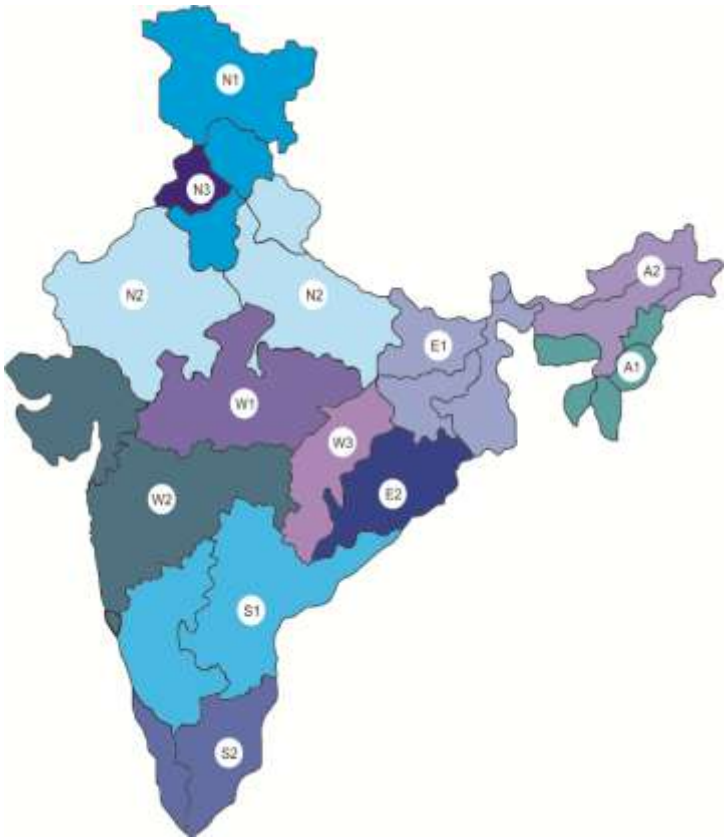
12 Bid areas defined

Congestion Management through market splitting and determining Area Clearing Price (ACP) specific to an area

Bid types: Portfolio Orders or Block Orders

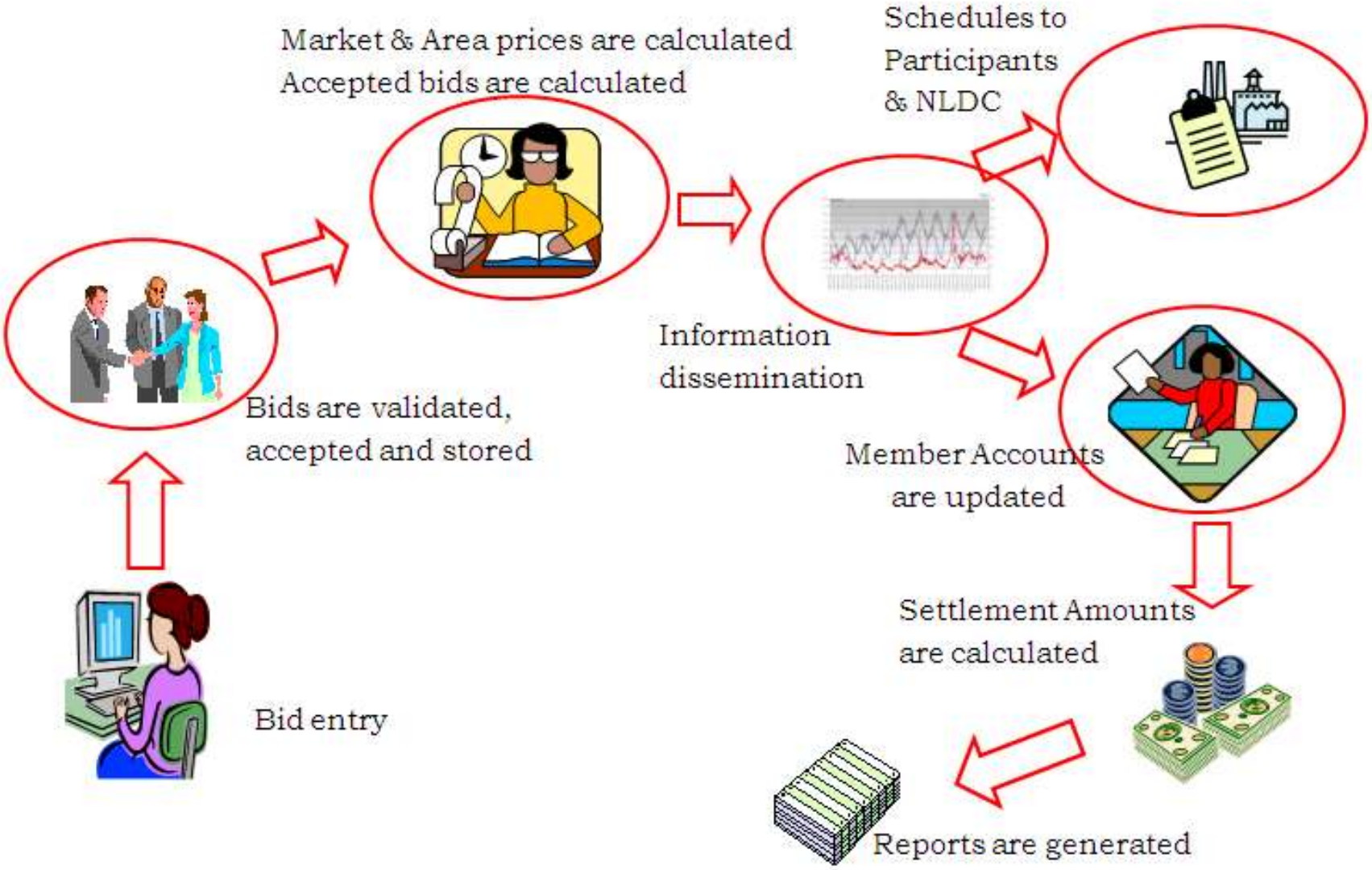
Minimum bid=Re.1 for 0.1MWh

Minimum Price & Volume Step = 0.1p * 0.1 MWh



12 Bid Areas

Market Place Functionality(DAM)



DAM trading process

Bidding

10:00 am to 12:00 pm

Bids for 15- min each or block bids can be placed

Matching

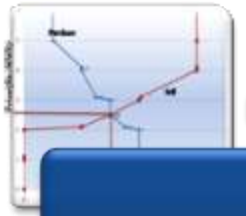
12:00 pm to 1:00 pm

MCP &MCV calculated

Review corridor and funds availability

1:00 pm to 2:00 pm

Corridor availability and funds verified



Result

3:00 pm

Final ACV and ACP calculated. Market splitting if congestion

Confirmation

5:30 pm

Collective transaction confirmation by NLDC

Scheduling

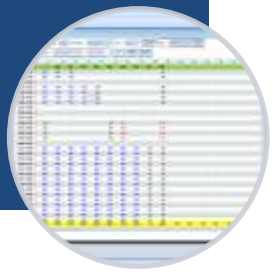
6:00 pm

Final Schedule sent to RLDC for incorporation

Bid Types

- Bids for each 15 min can be entered
- Varying price and quantum pairs
- Allow partial execution

Single/Portfolio Bid

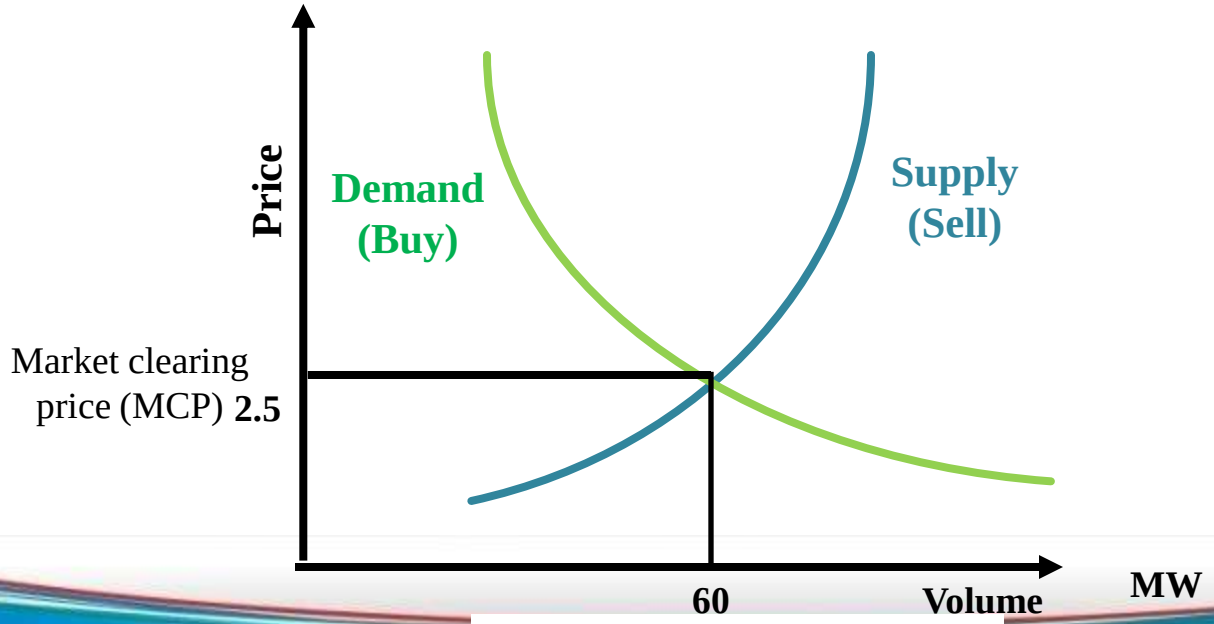


- Block Bid for any 15 min
- Mother or child bid
- No circular links
- No partial execution

Block Bid

Model Price Calculation algorithm

	Price Tick (Rs.)	0	1	1.1	2	2.1	2.5	3	3.1	4	4.1	5	---	---	----	20
Bid Quantum by different portfolios	Portfolio A, MW	20	20	20	20	20	20	20	10	0	0	0	0	0	0	0
	Portfolio B, MW	60	60	60	60	50	40	40	40	40	40	20	20	20	20	20
	Portfolio C, MW	40	20	0	0	-40	-60	-80	-81	-120	-120	-120	-120	-120	-120	-120
Total Buy Quantum received, MW		120	100	80	80	70	60	60	50	40	40	20	20	20	20	20
Total Sell Quantum received, MW		0	0	0	0	-40	-60	-80	-81	-120	-120	-120	-120	-120	-120	-120
Net Transaction, MW		120	100	80	80	20	0	-20	-21	-80	-100	-100	-100	-100	-100	-100



Market Clearing Volume (MCV)

Algorithm of Price Calculation

- Step 1: Unconstrained Solution (w.r.t. Transmission Capacity)

  - Find MCP and MCV; Demand=Supply on aggregated net curve.

- Step 2: After receiving the actual ATC, examine bid area for bottlenecks.
- If a bottleneck is found, the market is split in two partial calculation area: Source (surplus) and sink (deficit).
- A new ACP is found in both source and sink.

  - Surplus → Lower ACP than MCP

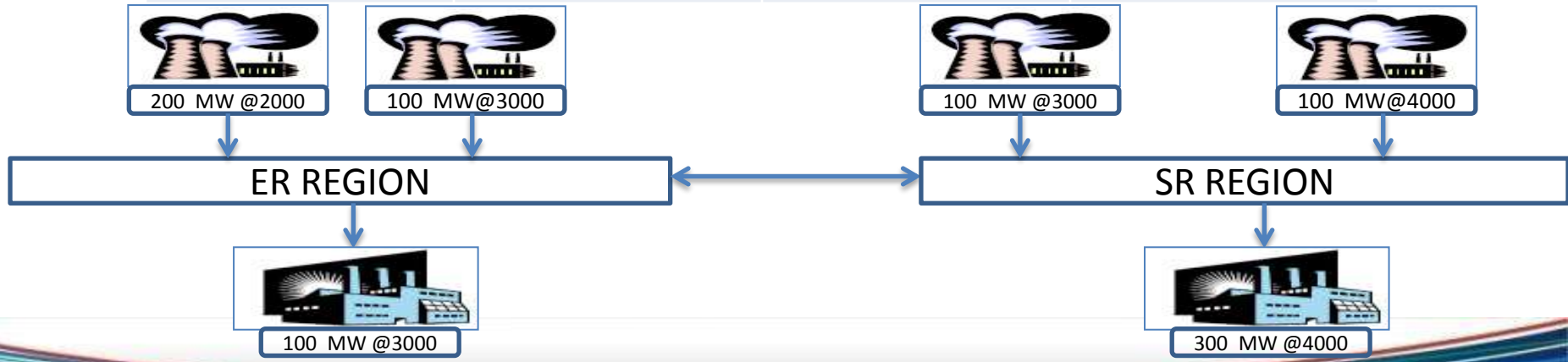
  - Deficit → Higher ACP than MCP.

- Each partial calculation area is examined for bottlenecks in the same way.
- When no more bottlenecks are found internally in the calculation area, the recursion stops.

Illustration of Price Matching and Market Splitting

- Two regions have been considered i.e. ER and SR.
- Four Sellers and Two Buyers in a 15-Min Block are taken with following Bid Scenario: -

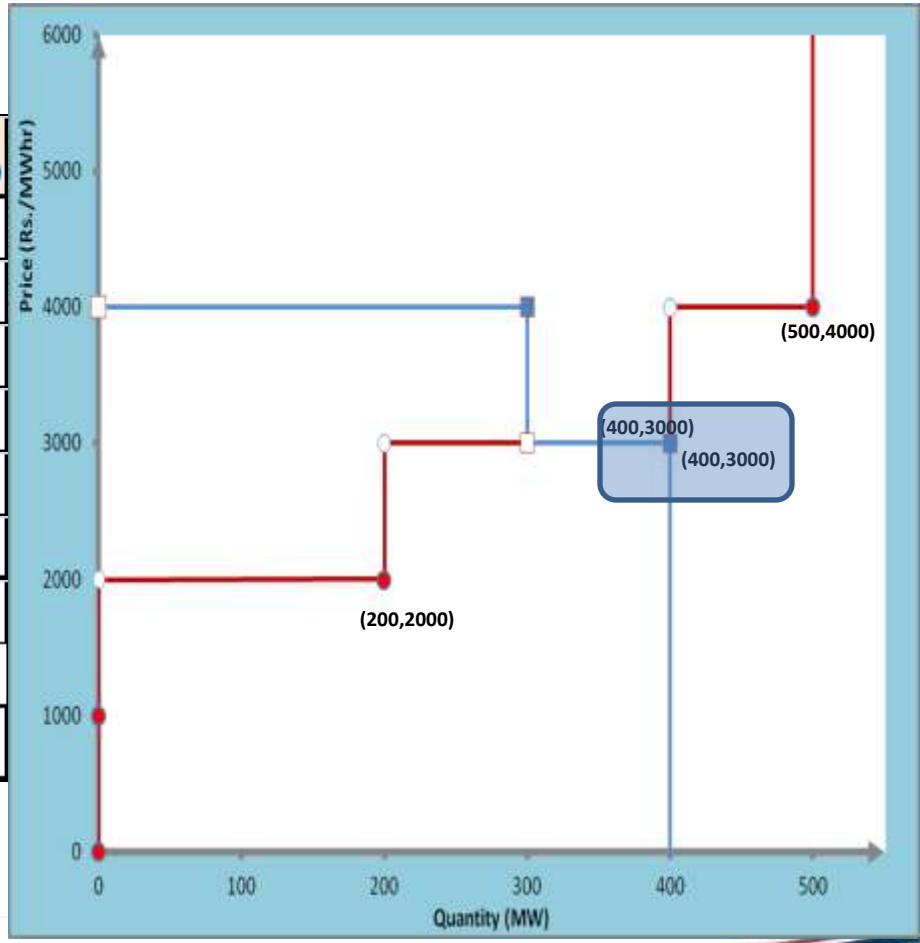
	Portfolio Code	Quantity (MW)	Price (Rs./MWhr)
ER Seller-1		200	2000
ER Seller-2		100	3000
SR Seller-1		100	3000
SR Seller-2		100	4000
SR Buyer		300	4000
ER Buyer		100	3000



Understanding Price Matching

ER Seller-1 200 MW@ 2000/MWhr	ER Seller-2 100 MW@ 3000/MWhr	SR Seller-1 100 MW@ 3000/MWhr	SR Seller-2 100 MW@ 4000/MWhr	SR Buyer 300 MW@ 4000/MWhr	ER Buyer 100 MW@ 3000/MWhr

Price (Rs./MWh)	0	999	1000	1999	2000	2999	3000	3001	3999	4000	4001	6000	8000	10000	20000
ER Seller-1	0	0	0	0	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200
ER Seller-2	0	0	0	0	0	0	-100	-100	-100	-100	-100	-100	-100	-100	-100
SR Seller-1	0	0	0	0	0	0	-100	-100	-100	-100	-100	-100	-100	-100	-100
SR Seller-2	0	0	0	0	0	0	0	0	0	-100	-100	-100	-100	-100	-100
SR Buyer	300	300	300	300	300	300	300	300	300	300	0	0	0	0	0
ER Buyer	100	100	100	100	100	100	100	0	0	0	0	0	0	0	0
Total Buy (MW)	400	400	400	400	400	400	400	300	300	300	0	0	0	0	0
Total Sell (MW)	0	0	0	0	-200	-200	-400	-400	-400	-500	-500	-500	-500	-500	-500
Net (Buy-Sell)	400	400	400	400	200	200	0	-100	-100	-200	-500	-500	-500	-500	-500



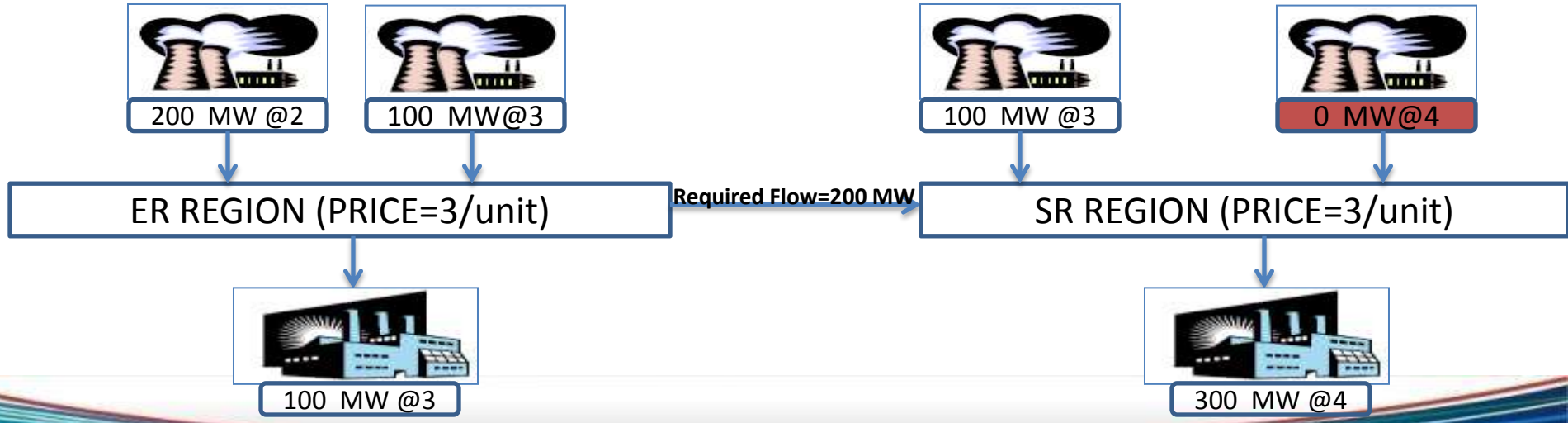
Market Clearing Price (MCP)= Rs. 3000/MWhr

Market Clearing Volume(MCV)= 400 MW

REQUIREMENT OF CORRIDOR FROM NLDC

ER		SR
Net Demand ➔100	Net Required Flow- 200 MW	Net Demand ➔300
Net Supply ➔ 300		Net Supply ➔ 100
Net ➔ 100 – 300 = -200		Net ➔ 300-100 =200

Demand and Supply gap in two regions get balanced by unconstrained flow between the two regions hence a common MCP is derived.



Constraint Solution (Market Splitting)

Congestion was reported by NLDC from ER to SR corridor and flow is constrained to 100MW. Due to flow constraint, system will "Split" the market in to two regions i.e. Deficit (SR Region) and Surplus region (ER Region),and will again run the calculation chronology for both the regions separately considering the flow constraint and will derive the ACP and ACV.

	Price (Rs./kWh)	0	999	1000	1999	2000	2999	3000	3001	3999	4000	4001	6000	8000	10000	20000
ER-Surplus Region	ER Seller-1	0	0	0	0	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200
	ER Seller-2	0	0	0	0	0	0	-100	-100	-100	-100	-100	-100	-100	-100	-100
	ER Buyer	100	100	100	100	100	100	100	0	0	0	0	0	0	0	0
	Net (Buy-Sell)	100	100	100	100	-100	-100	-200	-300	-300	-300	-300	-300	-300	-300	-300

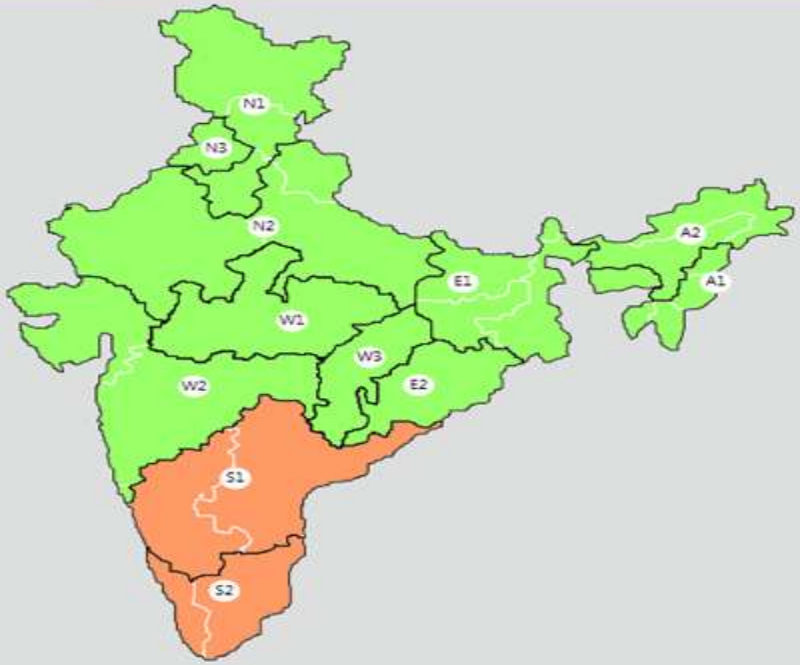
Flow Towards SR of 100 MW

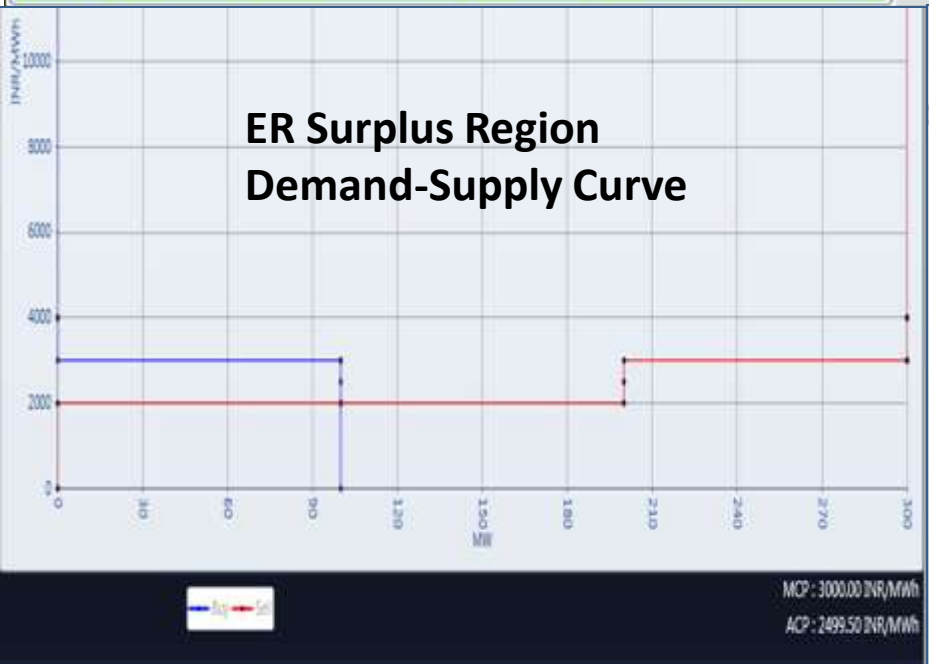
	Price (Rs./kWh)	0	999	1000	1999	2000	2999	3000	3001	3999	4000	4001	6000	8000	10000	20000
SR-Deficit Region	SR Seller-1	0	0	0	0	0	0	-100	-100	-100	-100	-100	-100	-100	-100	-100
	SR Seller-2	0	0	0	0	0	0	0	0	0	-100	-100	-100	-100	-100	-100
	SR Buyer	300	300	300	300	300	300	300	300	300	300	0	0	0	0	0
	Net (Buy-Sell)	300	300	300	300	300	300	200	200	200	100	-200	-200	-200	-200	-200

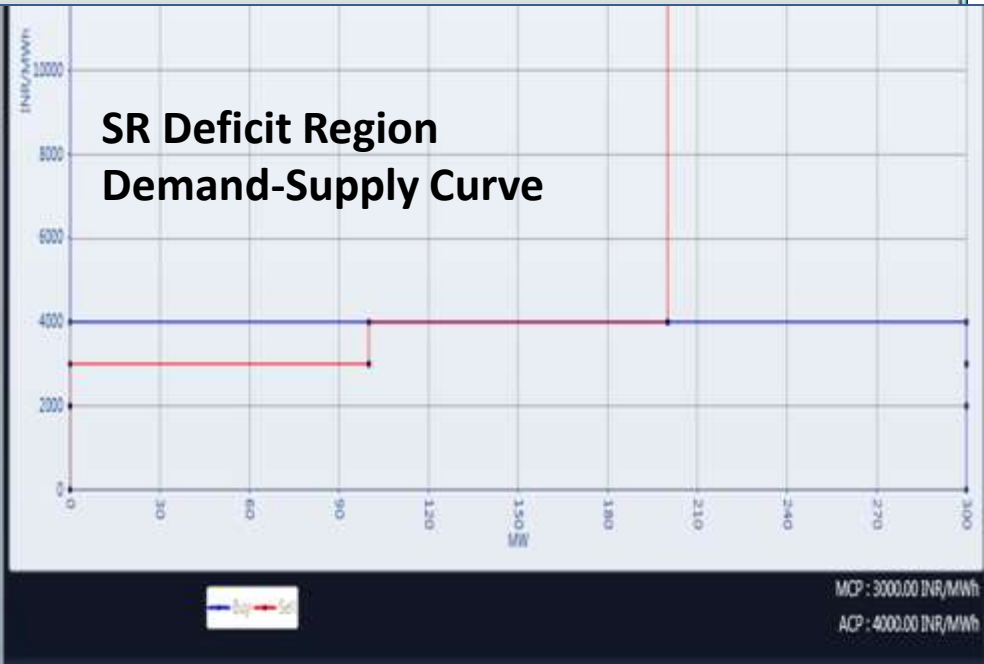
Price Calculation Details

Delivery Date : 26 Jul 2014 | Prov./Final : * Provisional | Run Count : * 9 | Period : * 00:15 - 00:30 | 26 Jul 2014 17:31:49

Area	Price	Actual Price	Buy Quantity	Sell Quantity	Exchange
1	2499.50	2499.50000000	100.00	200.00	-100.00
2	4000.00	4000.00000000	300.00	200.00	100.00
MCP	3000.00	3000.00000000	400.00	400.00	0.00







Risk Management System- DAM

Trader Member

- D-1 At 09:30 Hrs : Pre-trade Margin Check.
  - equal to the initial margins or average of last 7 days' trading value, whichever is more.
- D-1 At 12:30 Hrs : Preliminary Obligation Margin Check
  - Preliminary Obligation =< Funds Available (incl initial margin)
  - Block funds.
- D-1 At 15:30 Hrs : Pay-ins
- At D+1 14:00 Hrs : Pay-out.

Professional Member

- D-1 At 09:30 Hrs : Pre-trade Margin Check.
  - equal to the 100% of the bid value to be provided by Client directly to IEX in Client Settlement account
- D-1 At 15:30 Hrs : Pay-ins
- At D+1 14:00 Hrs : Pay-out.

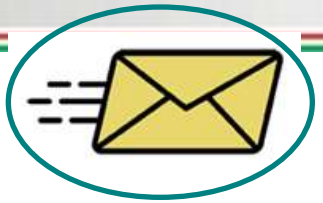
Term-Ahead Market

(Bilateral Market)

Market Place Functionality(TAM)

Prov. Format-1 & Format-2 generated electronically & sent to Members

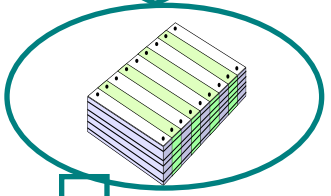
Member obtains SLDC Clearance



Member sends the SLDC Clearance to IEX

IEX applies to Nodal RLDC

Receipt of Nodal RLDC Acceptance by IEX

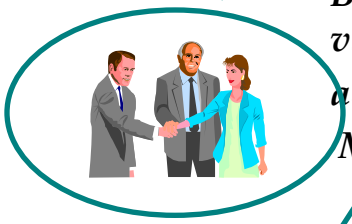


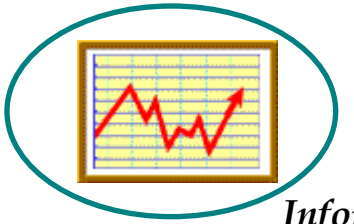
Reports are generated

Financial Settlement

Margins are collected

Bids are validated, accepted and Matched





Information dissemination

Bid entry

TWS Screen

Pending Buy Order

Buy 10 MW @ Rs 4500/MWh

Pending Sell Order

Sell 15 MW @ RS 5500/MWh

Trading Engine

Buy 10 MW @ RS 4500/MWh

Sell 15 MW @ RS 5500/MWh

Buy 10 MW @ Rs 4500/MWh

Sell 15 MW @ Rs 5500/MWh

TWS Screen

Pending Buy Order

Buy 10 MW @ RS 5000/MWh

Buy 10 MW @ RS 4500/MWh

Pending Sell Order

Sell 15 MW @ Rs 5500/MWh

Trading Engine

Buy 10 MW @ RS 5000/MWh

Buy 10 MW @ 5000/MWh

TWS Screen

Pending Buy Order

Buy 10 MW @ RS 4500/MWH

Buy 10 MW @ 4500

Pending Sell Order

Sell 5 MW @ Rs 5000/MWh

Trading Engine

Sell 15 MW @ Rs 5000/MWh

Trade 10 MW @ RS 5000/MWh

Bid Modified

Sell 15 MW @ RS 5000/MWh

Risk Management in DAM/TAM

	Proprietary/Trading Licensee Members		Professional Members	
	Initial Margin	Basis/Additional Margin	Initial Margin	Basis/Additional Margin
Day-Ahead Market	Margin equal to Last 7 Days Average of Buy turnover		As per Bank Balance including Hair Cut Factor	
TAM-Intraday	105% of order	-	105% of order Value	-
TAM-DAC	105% of order Value	-	105% of order Value	-
TAM-Daily	5% of order Value	50% of Trade Value	5% of order Value	50% of Trade Value
TAM-Weekly	5% of order Value	50% of Trade Value	5% of order Value	50% of Trade Value
REC	100% of order Value	-	100% of order Value	-
Member Client RMS	Credit facility can be provided by Trader Member to their clients		No credit or funding facility by Professional Members to their clients	

Timelines for payment of Charges: DAM/TAM

NLDC Charges

- Application Fees is paid in advance = T
- NLDC Scheduling & Operational Charges is paid on T+1
- Transmission Charges CTU is paid on T+1

SLDC Charges

- SLDC Scheduling & Operational Charges is paid on T+1
- Transmission Charges STU is paid on T+1
- Area Transmission Charges (ATU) is paid on T+1
- Area Load Dispatch Centre (ALDC) is paid on T+1

RLDC Charges

- Application Fees/PoC/SLDC/RLDC charges is paid on Within 3 working days of Acceptance

T = Trade Date

Renewable Energy Certificate

REC Market Participants : Buyers

Obligated Entities

- Distribution Companies
- Open Access Consumers
- Industries consuming Captive Power

Voluntary Entities

- Corporates under CSR
- Individuals

Salient Features of REC Mechanism

Participation	Voluntary
REC Denomination	1 REC = 1 MWh
Validity	1095 Days after issuance*
Categories	1. Solar REC 2. Non-Solar REC
Trading Platform	Power Exchanges only
Banking/Borrowing	Not Allowed
Transfer Type	Single transfer only , repeated trade of the same certificate is not possible
Solar RECs	*Floor Price: Rs 3,500 /MWh *Forbearance Price: Rs 5,800/MWh
Non Solar RECs	Floor Price: Rs 1,500/MWh Forbearance Price: Rs 3,300/MWh
Penalty for Non-compliance	'Forbearance' Price (Maximum Price)
Price Guarantee	Through 'Floor' Price (Minimum Price)

*CERC Order dated: 30 Dec'14

REC Mechanism

Procedure for ACCREDITION (Through State nodal Agency)

Procedure for REGISTRATION (Through Central Agency NLDC)

Procedure for ISSUANCE (Through Central Agency NLDC)

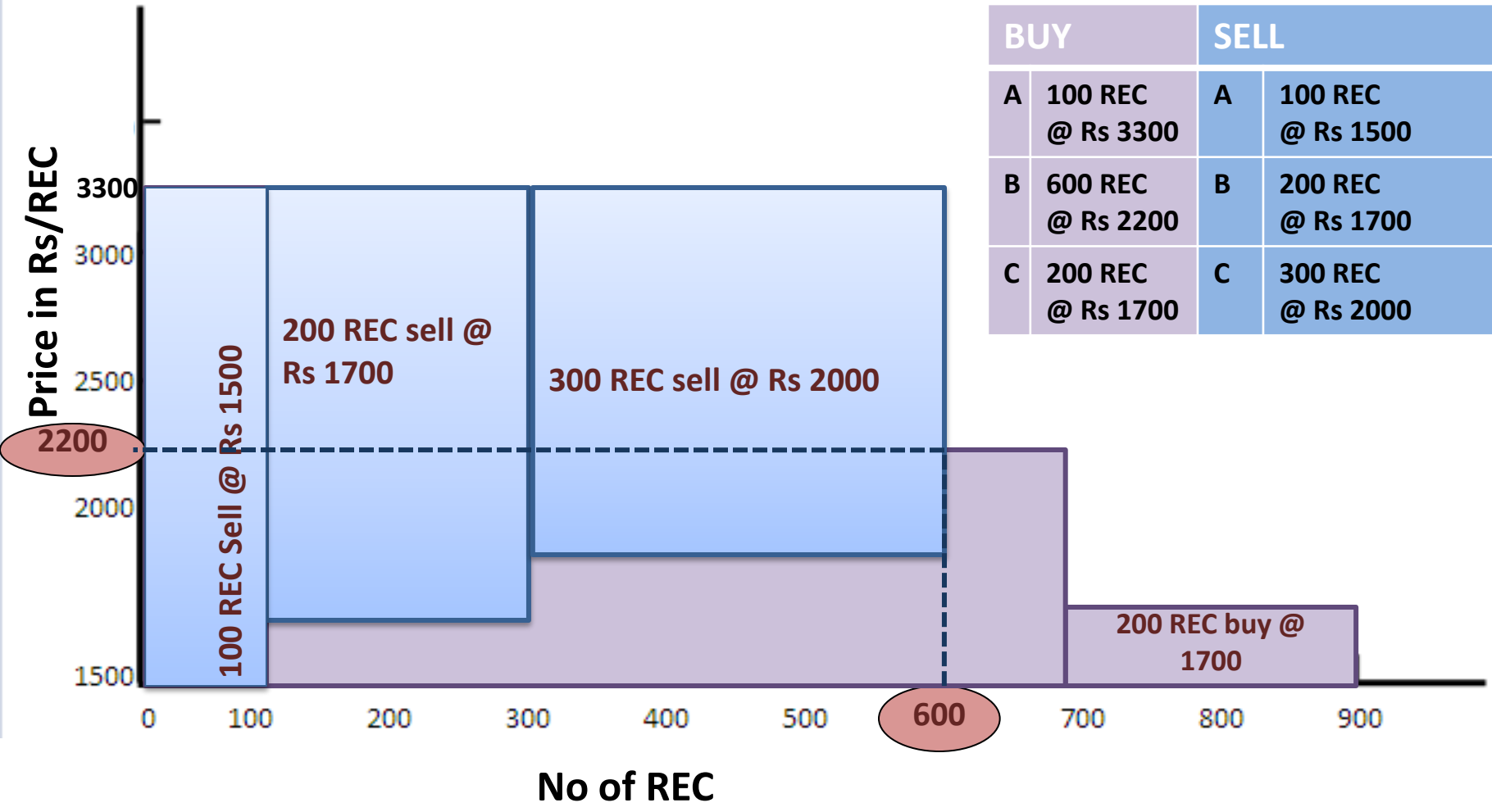
Procedure for TRADING & REDEMPTION(Through PXs)

Trading at IEX

Trading Day	Last Wednesday of every Month
Market Clearing	Closed Double sided auction
Trading Time	1300-1500 Hrs
By 1530 Hrs	Verification by Central agency for Valid REC by cleared seller at IEX
By 1600 Hrs	Central agency confirms REC
By 1630 Hrs	IEX finalizes trade
By 1700 Hrs	Buyer & Sellers informed to Central Agency
By 1800 Hrs	Invoice raised *(proof of REC trade)*

Cleared volume : 600 RECs **MCP:** Rs 2200/REC

BUY		SELL	
A	100 REC @ Rs 3300	A	100 REC @ Rs 1500
B	600 REC @ Rs 2200	B	200 REC @ Rs 1700
C	200 REC @ Rs 1700	C	300 REC @ Rs 2000



REC: Fee & Charges

State Nodal Agency

Accreditation	Fee & Charges
Application Processing Fee	Rs. 5000
Accreditation Charges (One Time – for 5 Years)	Rs. 30,000
Annual Charges	Rs. 10,000
Re-Validation Fees (After 5 Years	Rs. 15000

Central Agency

Registration	Fee & Charges
Application Processing Fee	Rs. 1000
Registration Charges (One Time – for 5 Years)	Rs. 5000
Annual Charges	Rs. 1000
Re-Validation Fees (After 5 Years	Rs. 5000

Central Agency

Issuance	Fee & Charges
Fees Per REC issued	Rs. 4.0

IEX

Redemption	Fee & Charges
Fees Per REC traded	Rs. 20

Market Snapshot

Participation

Volume

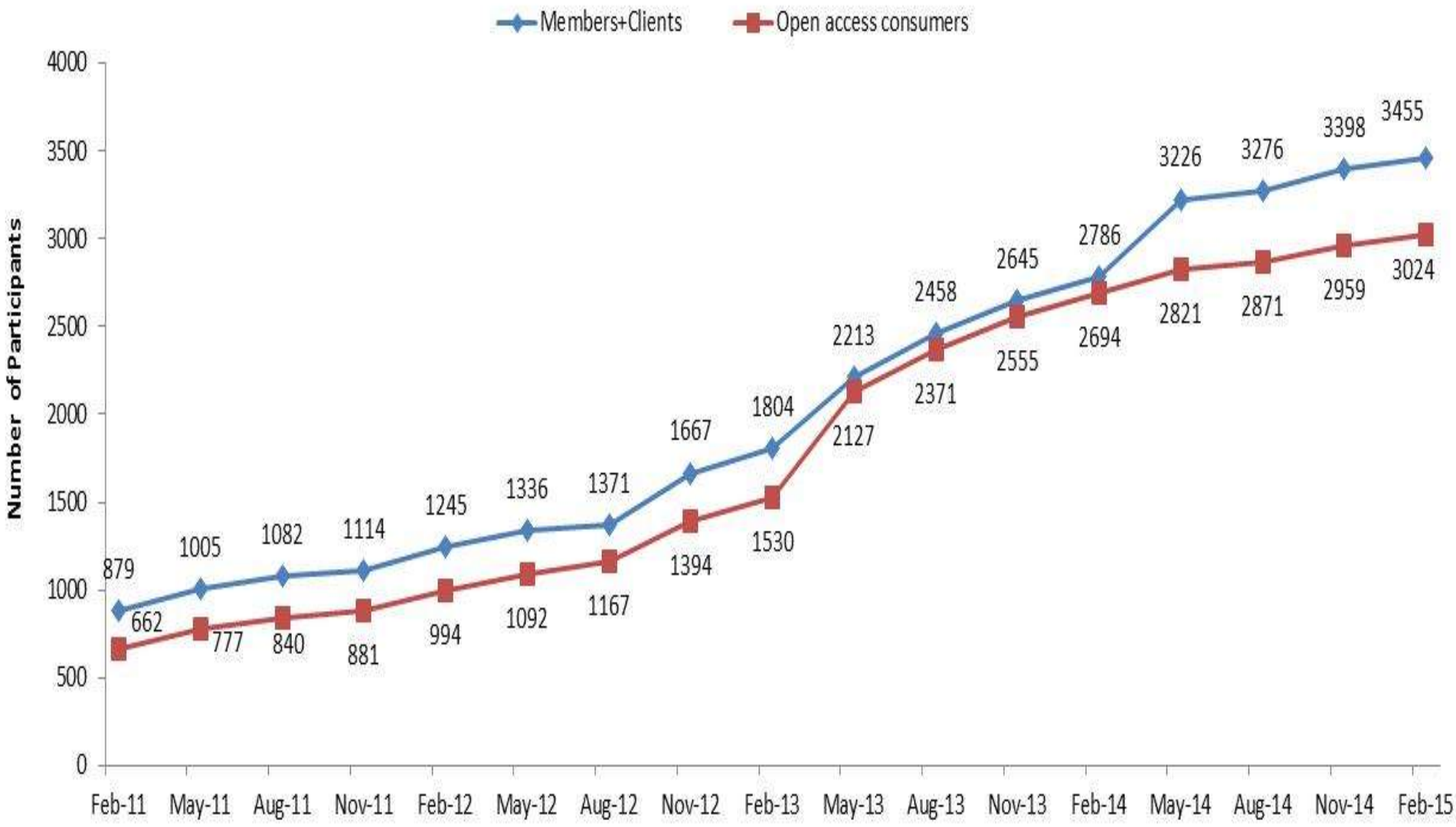
Prices

Key statistics: Electricity & REC Market

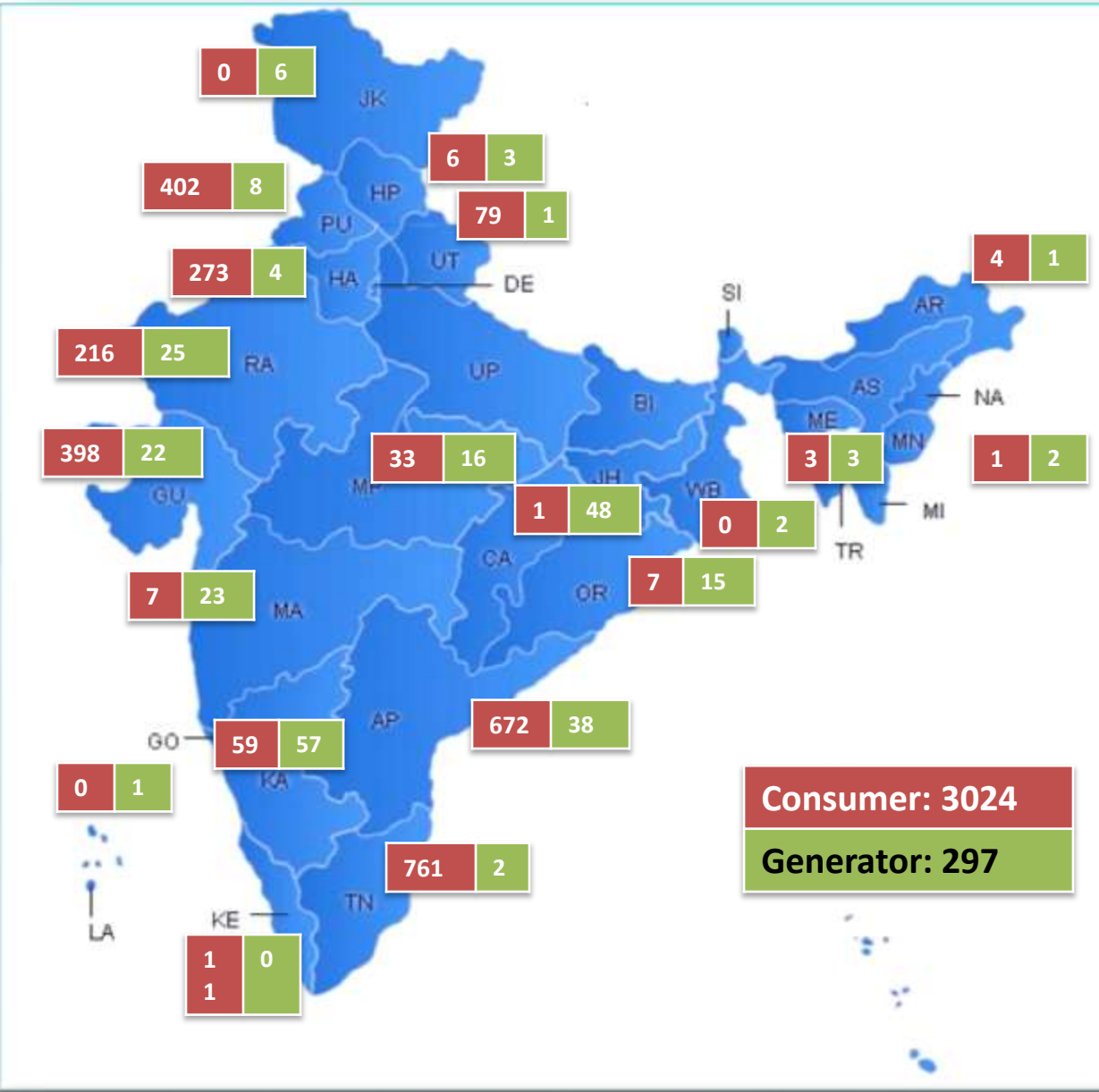
	ELECTRICITY	REC
Market Share (FY 13-14)	96%	77%
State Utilities	29 States I 5 UTs	16 States I 5 UTs
Generators	297	701
Industrial Consumers	3024	1604
Average Daily Volume	~80,000 MWh *Highest : 131,356 MWh*	>3 million RECs *Highest: 4,23,731 RECs*

IEX Data as on 28 February, 2015

Increasing Participation



State wise Participation on IEX

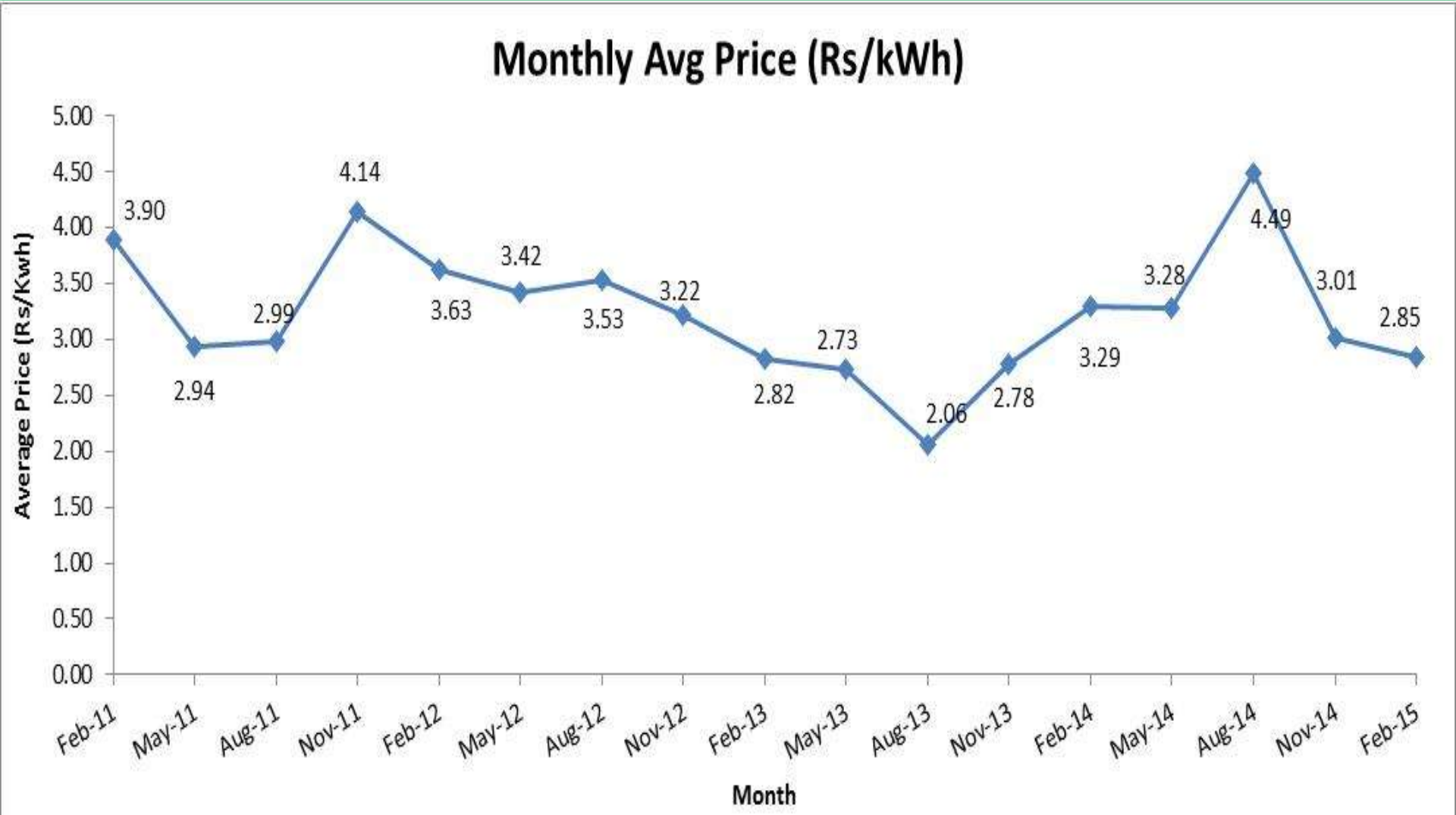


Consumer: 3024

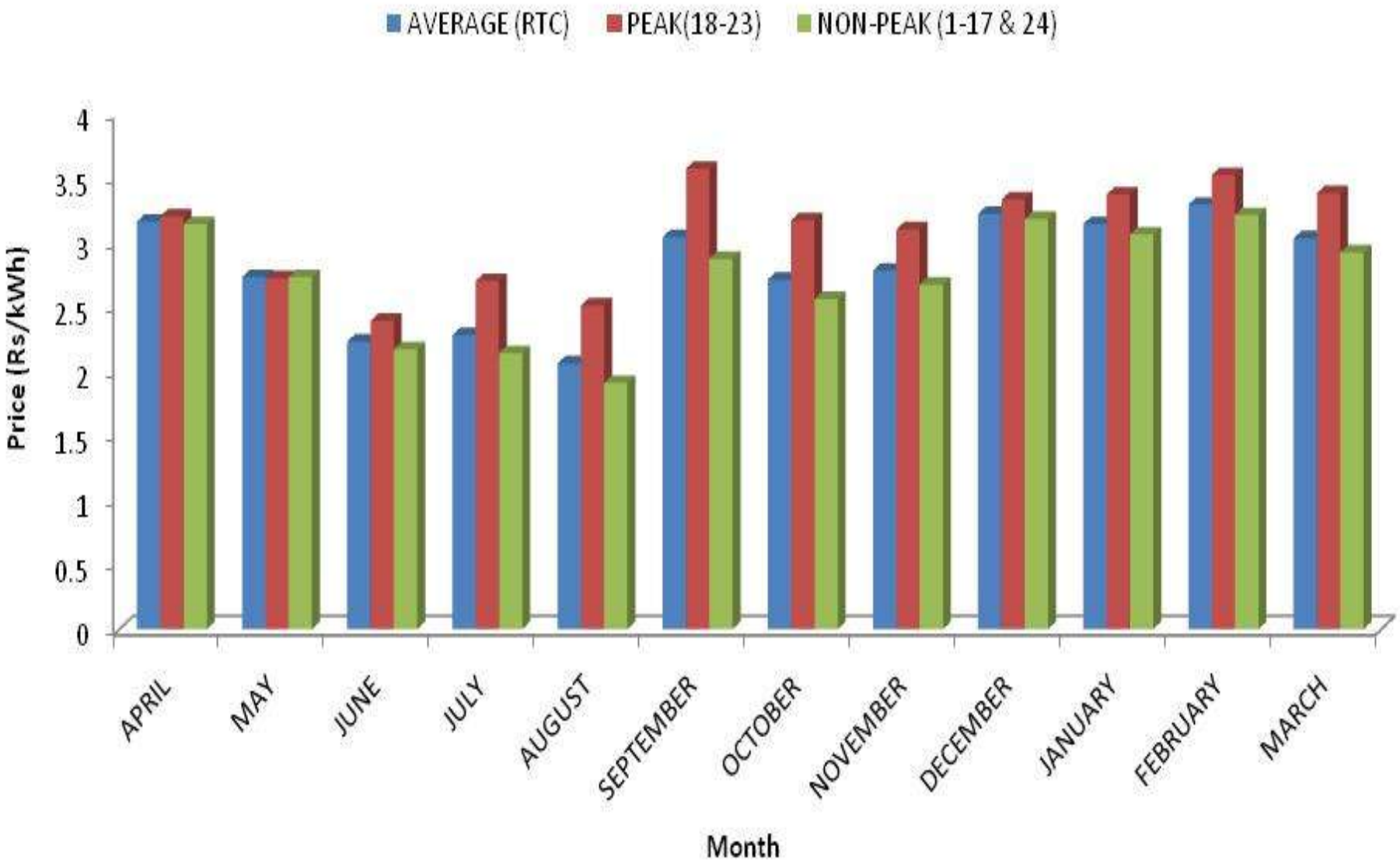
Generator: 297

No Open Access	
Consumers	**Generators**
Uttar Pradesh	Uttar Pradesh
Jammu & Kashmir	Delhi
Himachal Pradesh	Bihar
Delhi	Jharkhand
Bihar	Tamil Nadu
Goa	Kerala
Jharkhand	Union Territories
Sikkim	NE States (except Meghalaya)
DVC	
Chattisgarh	
West Bengal	
Union Territories (except Daman & Diu)	
NE States (except Assam, Meghalaya & Arunachal Pradesh)	

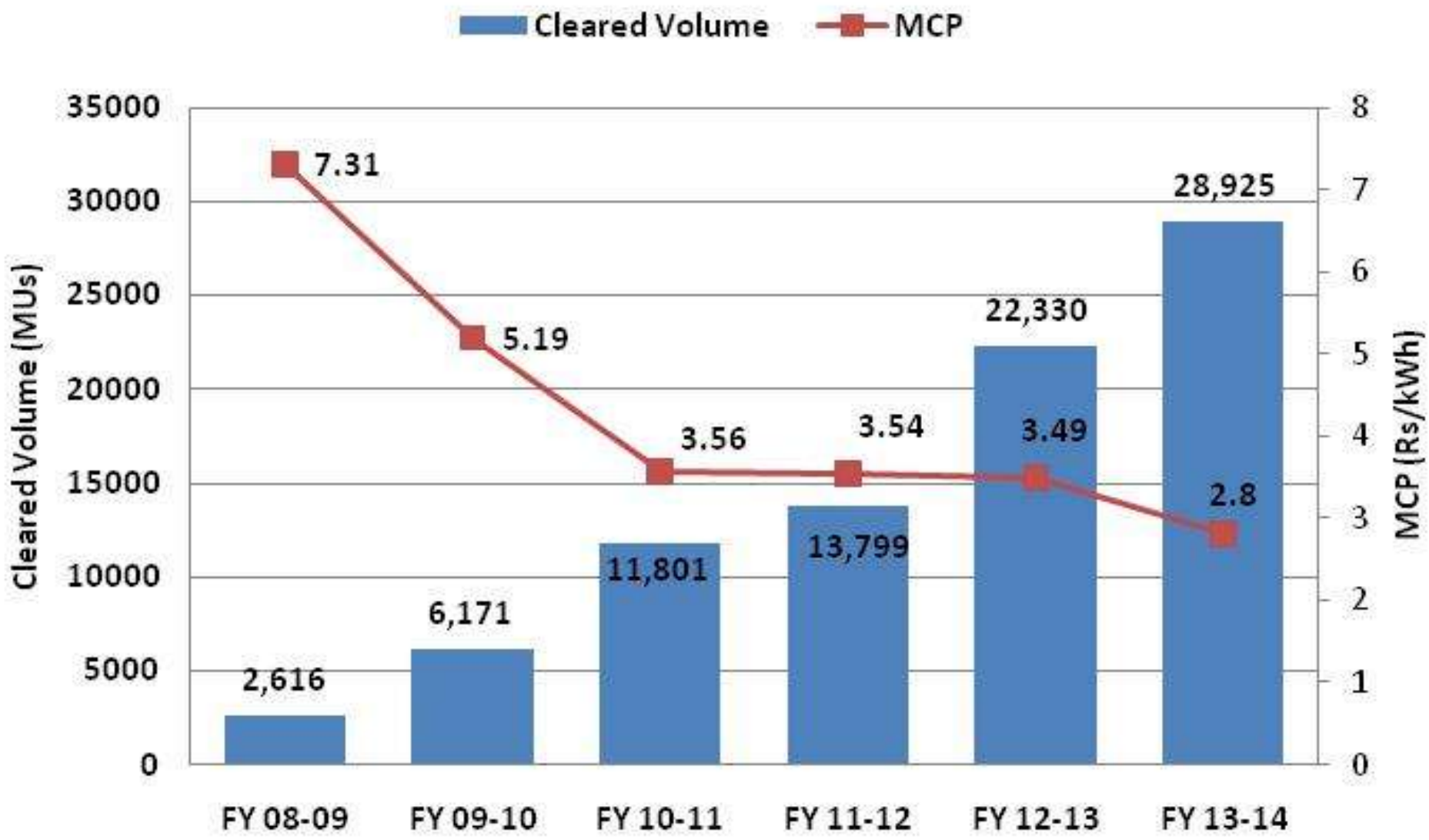
IEX monthly Average MCP in DAM



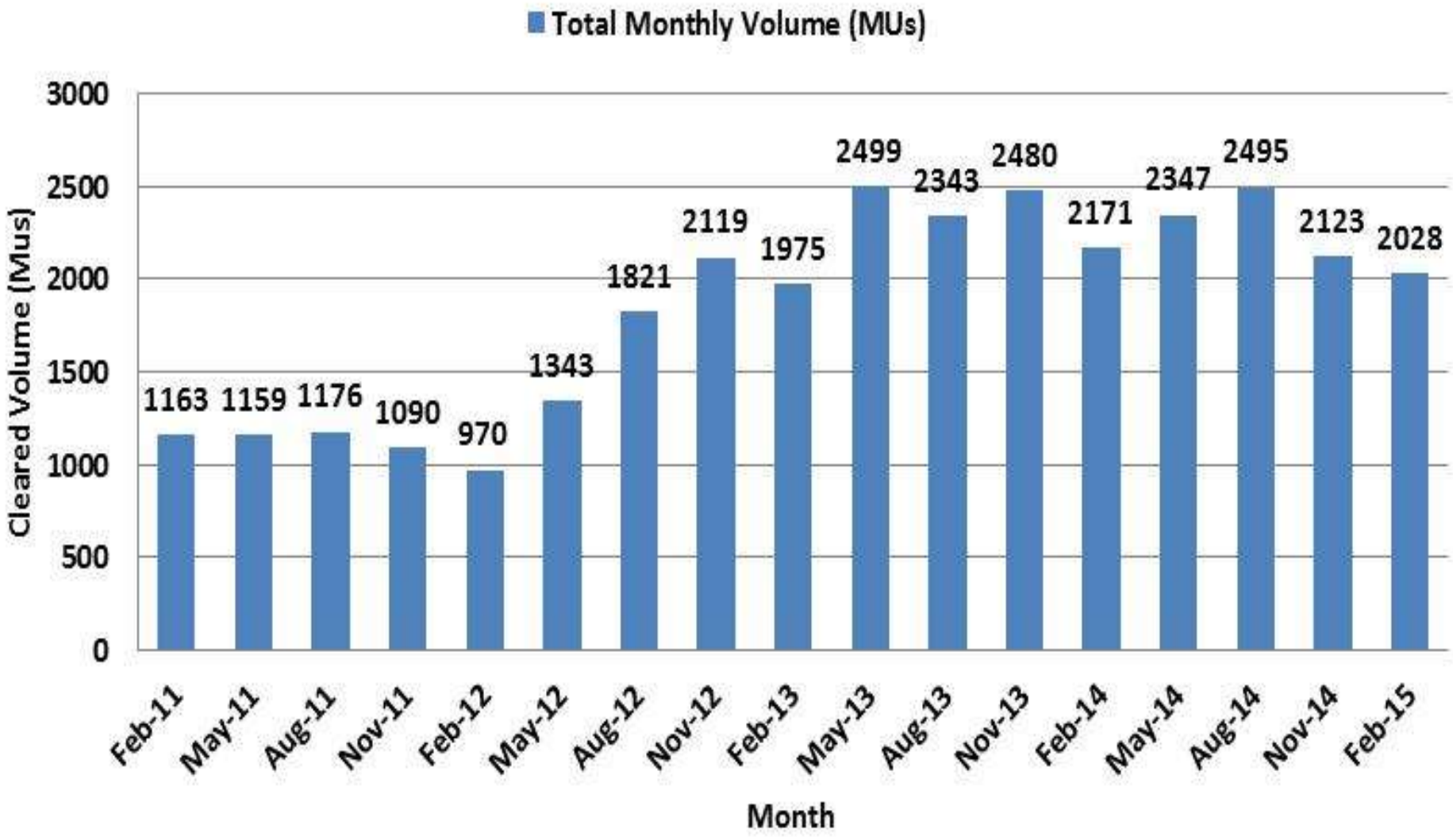
IEX Monthly Prices
(FY 13-14)



DAM Cleared Volume v/s MCP

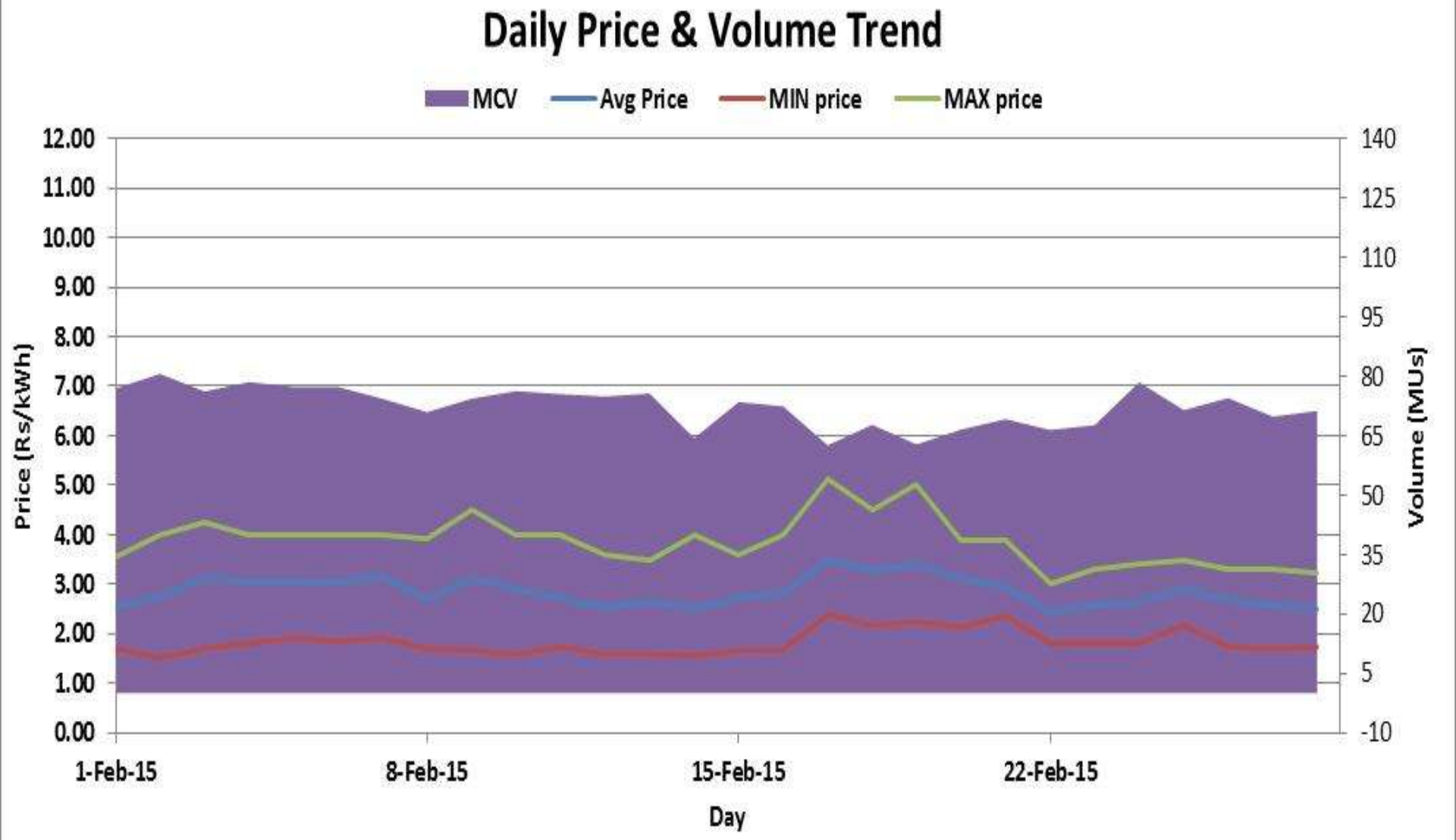


IEX Monthly Cleared Volume



IEX Day Ahead Market Price & Volume Trend

February 2015



TAM: Performance so far

Weekly	Day-ahead Contingency
2,666,443 MWh	311,005 MWh

Total Volume traded

3,747 MUs

Intraday	Daily
457,635 MWh	312,434 MWh

IEX Initiatives

Continuous communication with Users

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IEX hourly Trade Prices displayed on its website

IEX Monthly Bulletin

Thank You for your attention

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