Open Access in Inter-State Transmission

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Outline

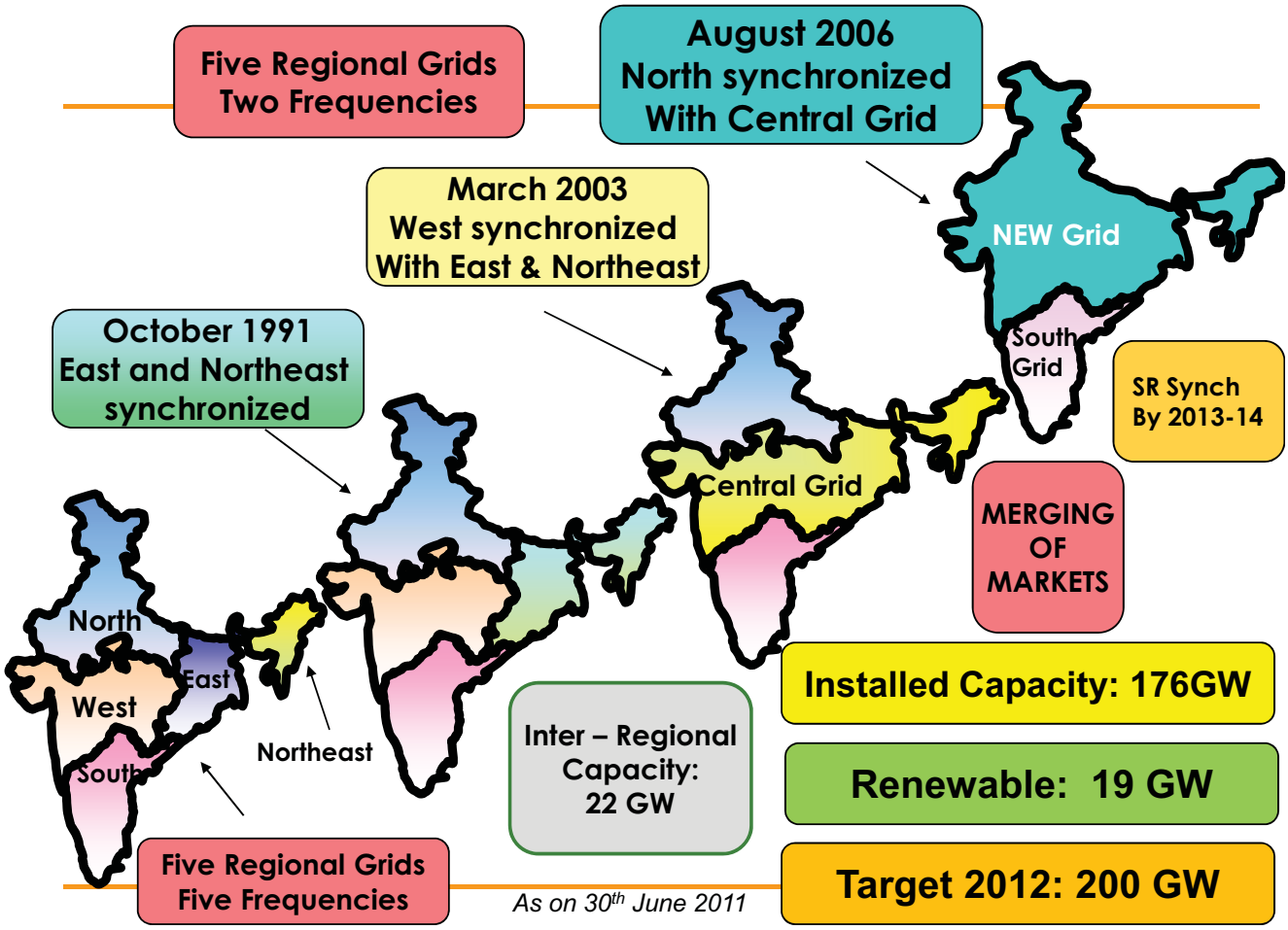
- **Short Term Open Access**
  - Bilateral Transactions
  - Collective Transactions through Power Exchange
- **Congestion Management**
- **Experience Gained**

Policy Initiatives

- **Electricity Act 2003**
  - *An Act to **consolidate 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**, rationalisation of electricity tariff, **ensuring transparent policies** regarding subsidies, **promotion of efficient and environmentally benign policies** constitution of Central Electricity Authority, Regulatory Commissions and establishment of Appellate Tribunal and for matters connected therewith or incidental thereto.*
- **Subordinate Legislations**
  - National Electricity Policy 2005
  - Tariff Policy
  - Standards (Metering, Connectivity)
- **Competitive Bidding Guidelines**
- **Independence of System Operation**

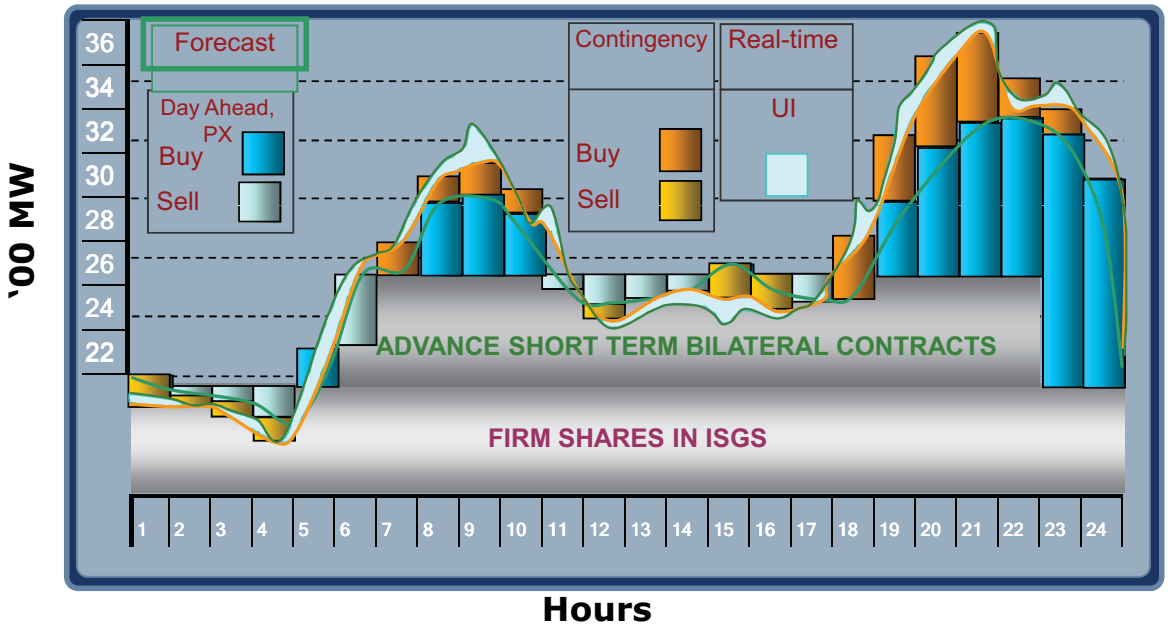
Regulatory Initiatives for Development of Indian Electricity Market

- **Indian Electricity Grid Code (IEGC)**
  - Revised in 2010 to facilitate integration of Renewable
- **Regulations for Handling Imbalances (UI)**
- **Open Access in Inter-State Transmission**
  - OTC Market
- **Power Market Regulations**
  - Power Exchange Operations
- **Regulations for Congestion Management**
- **Regulation on Transmission Pricing (PoC)**
- **Renewable Energy Certificates (REC)**
- **Direction for development of Ancillary Services**



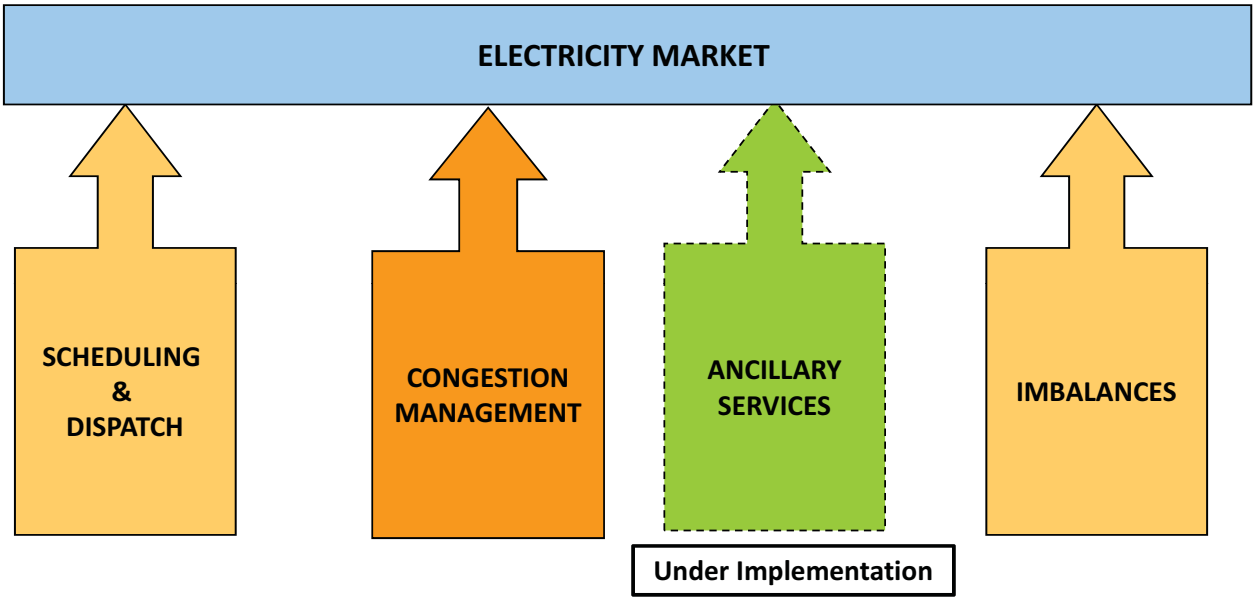
A Typical Dispatch

Surpluses/Deficits - Balance supply and demand



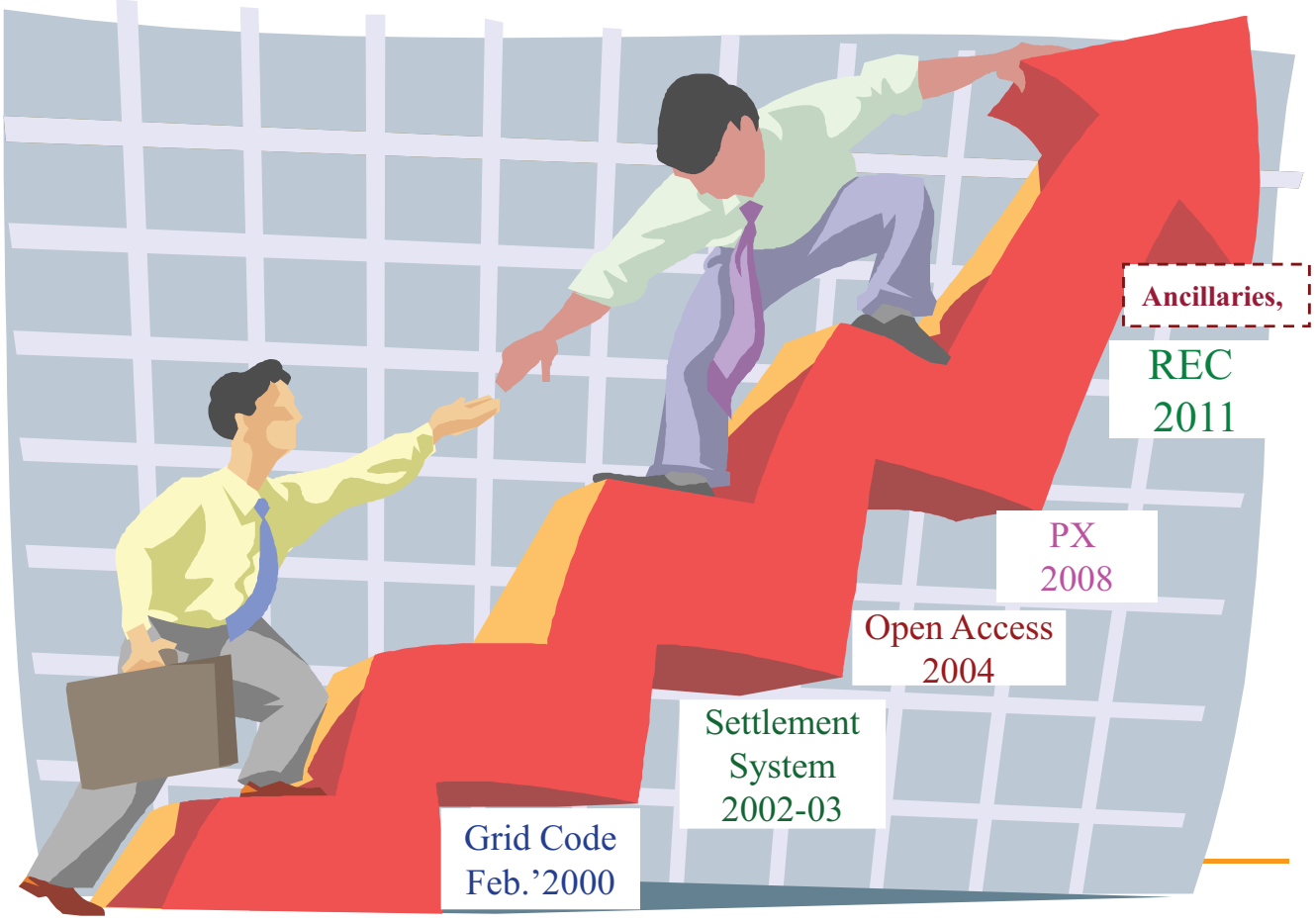
Market Design

Four Pillars of Market Design



"Making Competition Work in Electricity", Sally Hunt

Evolution of Power Market in India



INDIAN ELECTRICITY MARKET

ENABLERS
Legislation **Indian Electricity Act 2003**
National Electricity Policy **12-Feb-2005, Para 5.7.1(d)**
Regulation **IEGC-Feb 2000** **ABT Order-Jan2000** **Open Access-May-2004** **Power Exchange-Feb-2007**
Execution CTU/STU, RLDC/SLDC **Grid & Market Operation** **Control Centres & SEMs** **ABT settlement: in stages 2002-03**

STRUCTURE
Balancing Mechanism **Frequency linked** **Unscheduled Interchange**
Short-term Bilateral **Contingency** **Day-ahead**
Day-ahead Power Exchange **Multiple Power Exchanges**
Short-term Bilateral **First-come-first served** **Three-month ahead**
Long-term Bilateral **Shared resources (ISGS)** **Own resources**

A Benchmark Order by FERC, USA

2003: Legal Mandate

- **Electricity Act, 2003**
  - Key feature : Competition
  - Non-discriminatory open access

- **Definition as Per Act:**
- **(47) " open access" means the non-discriminatory provision for the use of transmission lines or distribution system or associated facilities with such lines or system by any licensee or consumer or a person engaged in generation in accordance with the regulations specified by the Appropriate Commission;"**

2003-2004: Consultative Process

- **CERC Concept Paper – August 2003**
  - Open Access in inter-State Transmission
- **Some of the Issues covered**
  - Legal framework
  - Scheduling and Despatch
  - Transmission Pricing Design
    - Cost based or Market based approach
  - Transmission Pricing Options
    - Contract path
    - Incremental Postage Stamp
  - Nodal Agency
  - Types of services
  - Declaration of TTC/ATC

2004: First CERC OA Regulations

- **Reservation of Transmission Capacity**
- **Products :**
  - Long-Term Open Access (LTOA for > 25 years)
    - Nodal Agency : CTU
  - Short Term Open Access (STOA < 1 year)
    - Ndoal Agency : RLDC where point of drawal is located
    - only one product i.e.; First cum First Served basis.
- **Congestion Management :**
  - Explicit Auctioning : through e-bidding without any price cap.
- **Transmission charge**
  - Postage Stamp
    - 5 for Regional Transmission System and
    - 6 for inter-regional Transmission System
    - 25% of the Long term transmission charges (Rs./MW/Day)

Margins for Short Term Open Access Trades

- **Short-term open access granted depending upon**
  - Inherent design margin
  - Margins available due to variations in power flows
  - Margins available due to in-built spare transmission capacity created to cater to future load growth

2005: First Amendment

- **Introduced New products under Short-Term Open Access**
  - Advance Scheduling upto 3 month in advance
  - First-cum-First Served basis
  - Day-Ahead
  - Intra-day
- **Congestion Management :**
  - E-bidding with a price cap
- **Transmission Charges**
  - Postage Stamp (5 for RTS and 6 for (IR)
    - 25% of Regional Transmission System
    - 50% of Inter-Regional Transmission System
    - 1/4th / ½ / 1 stamp depending upon continuous time period (<6 Hrs, 6 to 12 HRs, > 12 Hours)

2006: Second Amendment

- **Feedback to Regulator**
  - by system Operator
  - Under utilization of transmission corridors
  - Pseudo Congestion
- **CERC issued 2nd Amendment**
  - “use it or loose it”

2006-2007: Consultative Process for PX

- **CERC Staff Paper (2006) on**
  - "Developing a common platform for Electricity Trading"
  - Issues discussed
    - One PX or Multiple PX
    - Voluntary or Mandatory
    - Ownership and Management of PX
    - Regulation of PX or Light Handed Regulation
    - Price Discovery Mechanism
    - Assignment of Transmission Capacity
    - Congestion Management
- **CERC guidelines for (Feb.2007)**
  - the grant of permission for setting up and operation of Power Exchange

2008: CERC Open Access Regulations,

- **Effective 01.04.2008**
- **Regulations cover Short-term Open Access**
- **Transactions categorized as Bilateral and Collective (through Power Exchange)**
- **Earlier Products of Short-Term retained under Bilateral Transactions**
- **Nodal Agency**
  - Bilateral : RLDCs
  - Collective : NLDC
- **Transmission Charges moved from "Contract Path" to "Point of Connection" for Collective Transaction**

CERC Open Access Regulations, 2008

- **Both Buyers and Sellers of Collective transactions to bear transmission charges and absorb transmission losses**
- **Inter-Regional links - No Separate treatment.**
- **Emphasis on "Scheduling" rather than "Reservation"**
- **SLDC consent mandated along with application**
- **In case of Congestion – e-Bidding without Price Cap**
- **Exit Option provided with payment of up to 5 days open access charges.**
- **Transmission Charges collected shall be disbursed to CTU(25%) and long term customers(75%)**
- **Moving towards empowerment of SLDCs**

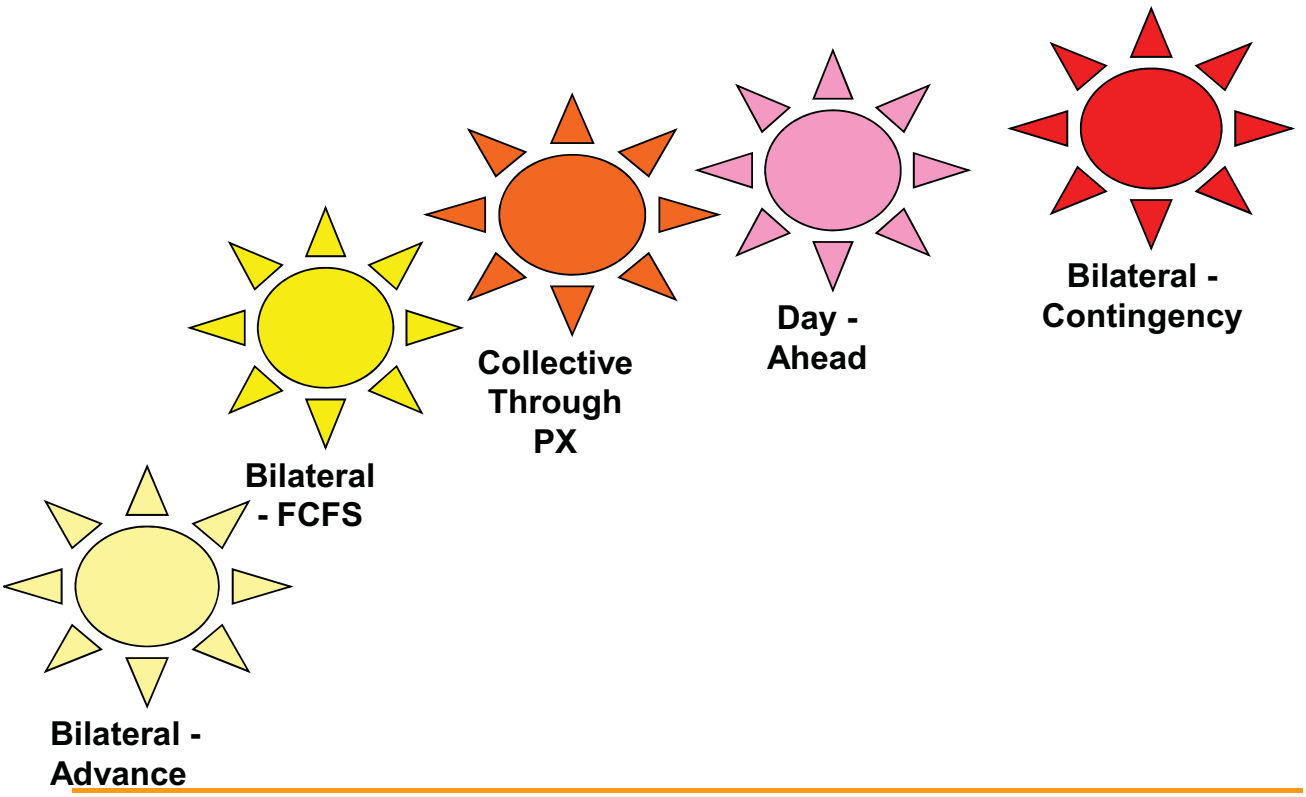
CERC Open Access Regulations, 2008

- **Thrust on Empowerment of SLDCs**
- **SLDC Concurrence [Clause 8(2)]**
  - NOC/Standing Clearance to be obtained by State Utilities/Intra-State Entities from the SLDC for trading through PX
  - SLDC to respond within 3 days
  - SLDCs may charge appropriate fee for such NOC/Standing Clearance (as per SERC or Rs. 5000 if not notified by SERC)

2009: Amendment to OA Regulations,2008

- **Exit Option**
  - From 5 day charges to 2 day charges
- **PX – allowed for bilateral transaction**
- **Concept of Deemed Concurrence**
- **Redressal Mechanism**
  - Central Regulator
- **STOA Transmission Charges**
  - increased around 3 times
  - Comparable with Long Term charges

STOA Products



Power Exchange Implementation in India

Regulator's Approach

- **CERC Guidelines for setting up of a Power Exchange:**

"The general approach of the Commission is to allow operational freedom to the PX within an overall framework. The regulation would be minimal and restricted to requirements essential for preventing derailment/accidents and collusion. Private entrepreneurship would be allowed to play its role. The Commission shall keep away from governance of PX, which would be required to add value and provide quality service to the customers"

CERC Power Market Regulations, 2010 (1)

- **Scope & Extent**
  - OTC Markets
  - Power Exchange Market
  - Other Power Exchange Markets
    - Derivatives
- **Types of Contracts**
  - Delivery based OTC Contracts
  - Financially settled electricity derivatives contracts transacted in OTC market
  - Delivery based contracts transacted on Exchange
  - REC Contracts
  - Capacity, Ancillary, Derivative based contracts (future)

CERC Power Market Regulations, 2010 (2)

- **Prior to grant of permission to Power Exchange, CERC may examine**
  - Type of contract (day ahead, term ahead etc);
  - Price Discovery methodology and matching rules proposed;
  - Transaction period – When transaction shall commence and for what tenure transaction session shall continue before delivery commences;
  - Risk Management mechanism
    - Margining mechanism
    - Final Price Settlement mechanism
  - Delivery mechanism, delivery duration

CERC Power Market Regulations, 2010 (3)

Objectives of the Power Exchange (Regulation 10)

- **Ensure fair, neutral, efficient and robust price discovery**
- **Provide extensive and quick price dissemination**
- **Design standardised contracts and work towards increasing liquidity in such contracts**
  - *Explanation: Liquidity is a measure of ease of entering or exiting into a transaction (generally large transaction) with minimal impact in the market price of the transacted contract.*

CERC Power Market Regulations, 2010 (4)

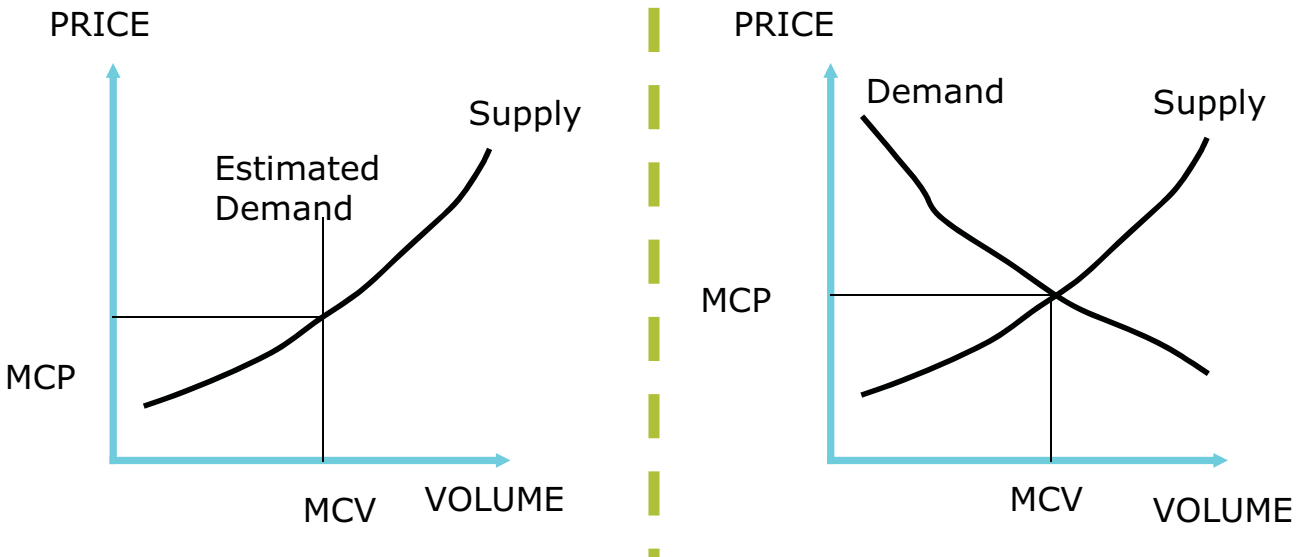
Principles of Price Discovery (Regulation 11)

- **The economic principle of social welfare maximisation and to create buyer and seller surplus simultaneously during price discovery.**
- **The bidding mechanism shall be double sided closed bid auction on a day ahead basis.**
- **The price discovered for the unconstrained market shall be a uniform market clearing price for all buyers and sellers who are cleared**
- **In case of congestion in transmission corridor, market splitting mechanism shall be adopted.**
- **The delivery / drawl of power shall be considered at the regional periphery.**

CERC Power Market Regulations, 2010 (5)

- **Other Provisions**
  - Prudential Norms
  - Governance Issues
  - Ownership Patterns
  - Registration – Fees
  - Membership
  - Clearing House
  - Interface with System Operator

Auction Models



One Side Auction

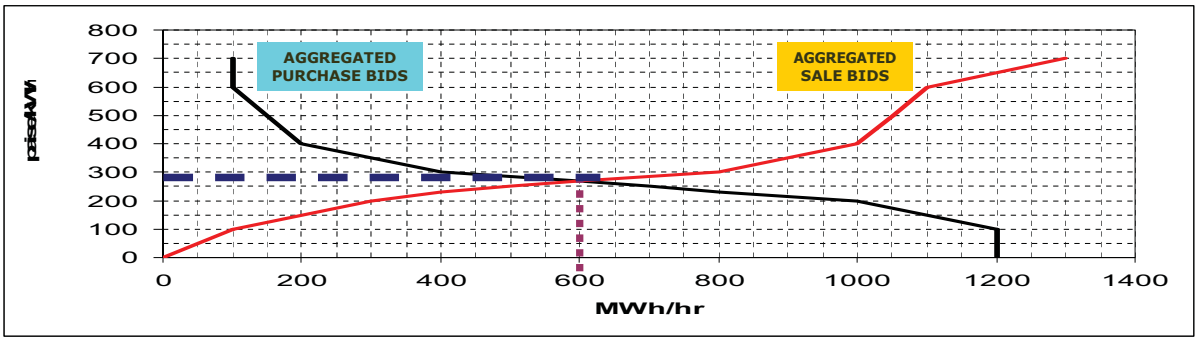
Two Side Auction

MCP = Market Clearing Price

MCV = Market Clearing Volume

Price Calculation Algorithm -Day ahead– Hourly Bids

PRICE-paise/kWh	0	100	200	230	250	270	300	400	500	600	700
PARTY A-ZONE-1	600	600	600	400	400	400	400	200	150	100	100
PARTY B-ZONE-1	600	600	400	400	300	200	0	0	-50	-100	-200
PARTY C-ZONE-2	0	-100	-100	-100	-200	-300	-400	-500	-500	-500	-500
PARTY D-ZONE-2	0	0	-200	-300	-300	-300	-400	-500	-500	-500	-600
SUM, PURCHASE	1200	1200	1000	800	700	600	400	200	150	100	100
SUM, SALES	0	-100	-300	-400	-500	-600	-800	-1000	-1050	-1100	-1300
NET TRANSACTION	1200	1100	700	400	200	0	-400	-800	-900	-1000	-1200

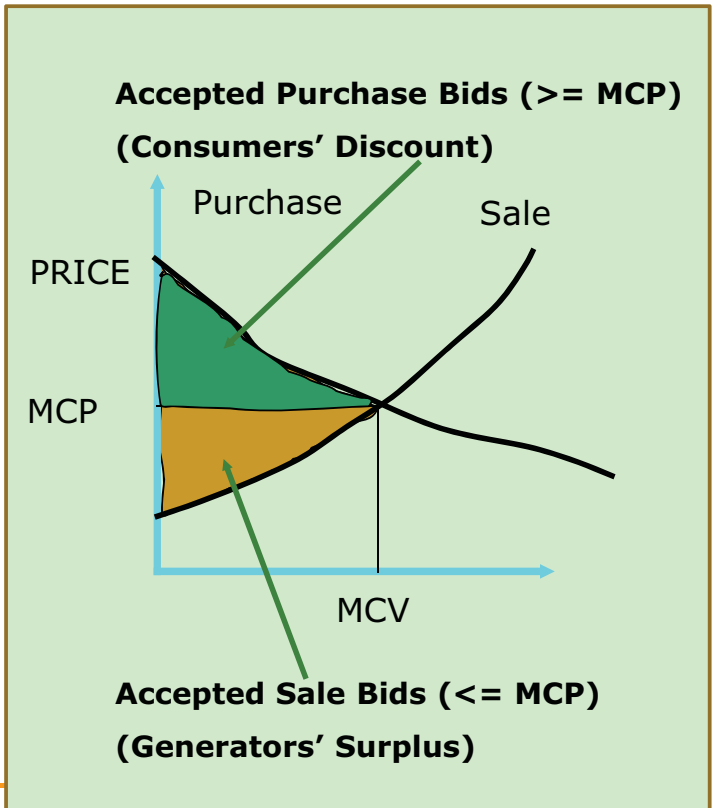


Market Clearing Price (MCP) : 270 p
Market Clearing Volume (MCV): 600MW

Power Exchange Operations

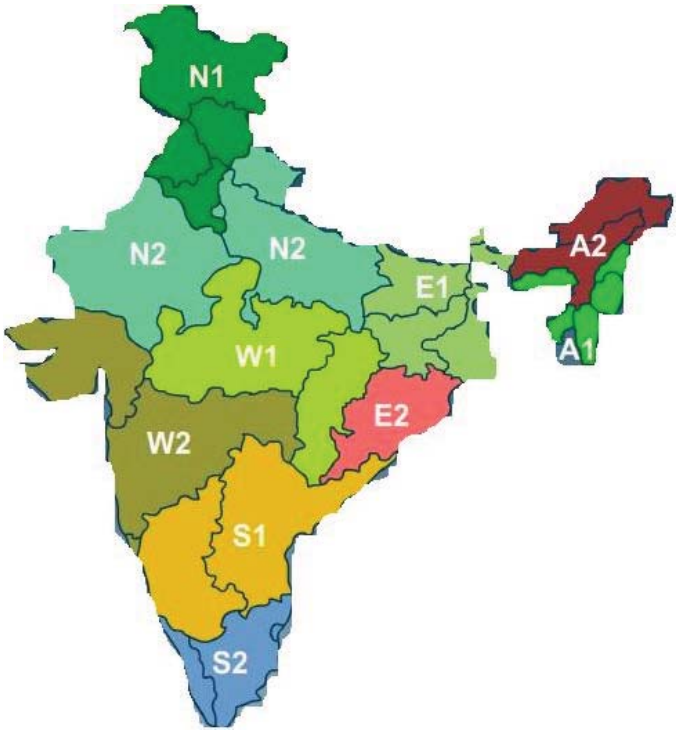
Salient Features

- **Multiple Power Exchanges**
  - Competition amongst Exchanges
- **Voluntary participation**
- **Double sided bidding**
- **Uniform pricing**
- **Day-ahead exchange**
- **Hourly bids**
- **Congestion management by market splitting**

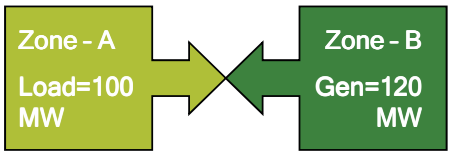


Demarcation into Bid Areas

Area	Region	States
N1	North	JK, HP, CHD, PUN, HAR
N2	North	RAJ,DEL, UP, UTT
W1	West	MP, CHTG
W2	West	MAH,GUJ, GOA, DD,DNH
S1	South	AP, KAR, GOA
S2	South	TN, KER, PONDY
E1	East	WB, SIK, BIH, JHAR
E2	East	ORISSA
A1	North-East	TRIP, MEGH, MANI, MIZO
A2	North-East	AS, AP, NAGA



Congestion Management - Market Splitting

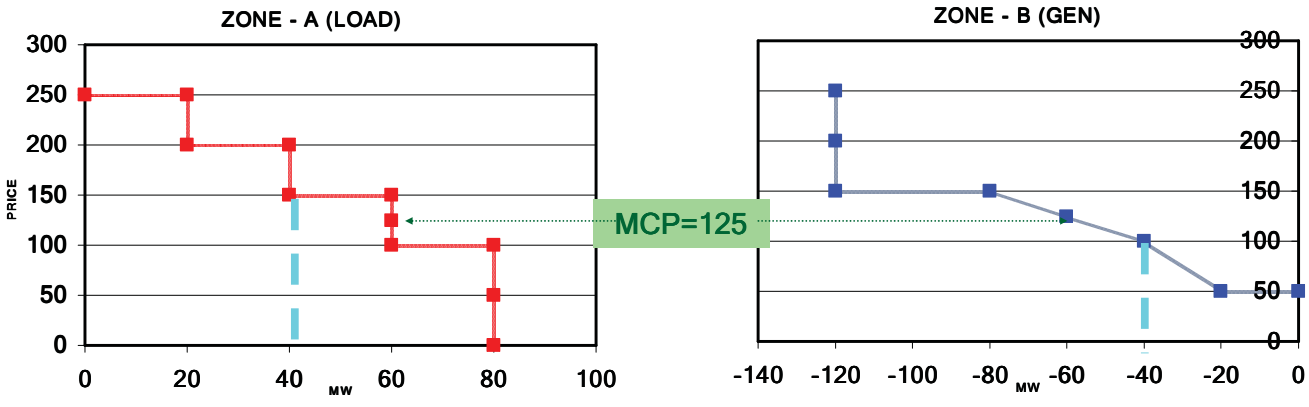


Case - I : No Transmission Constraint

Case - II : Constraint = 40 MW

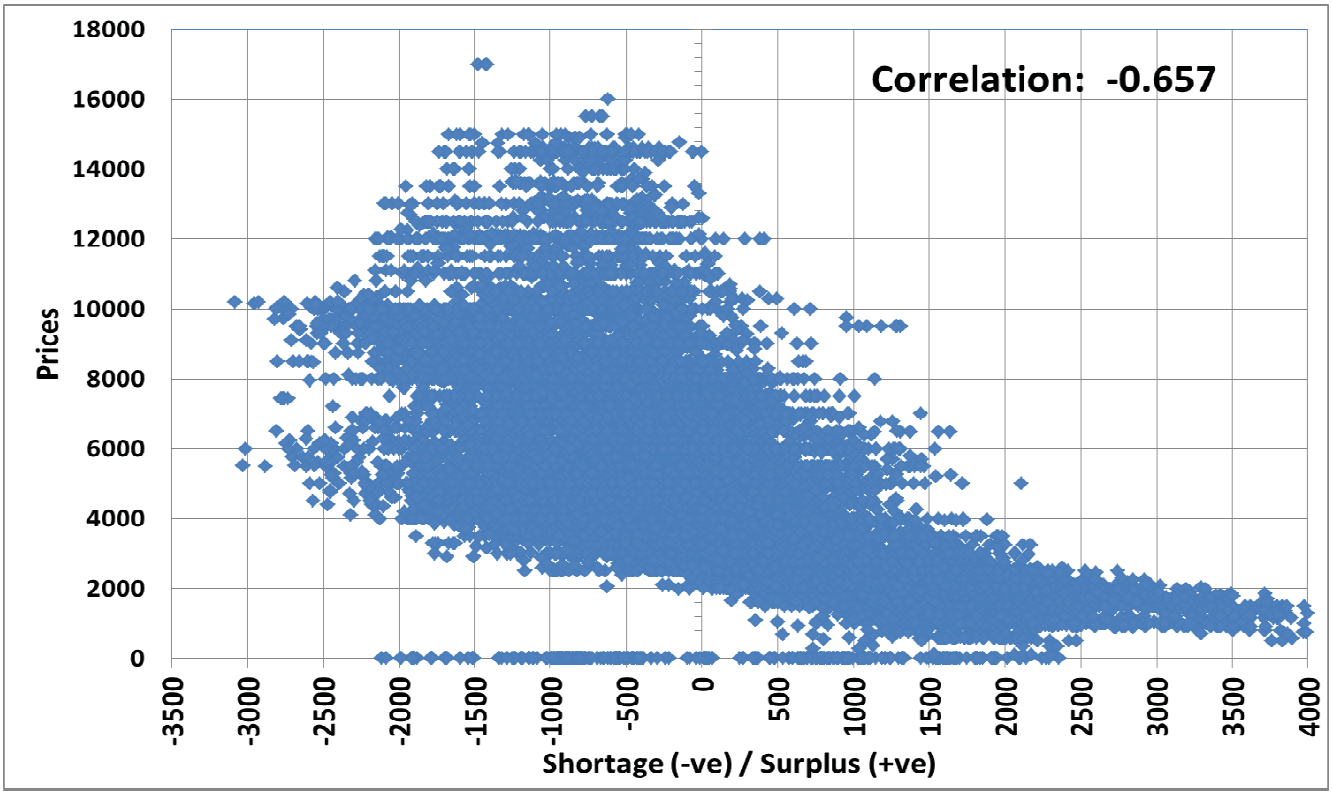
Solution:

- Increase price in Zone A to reduce demand to 40 MW
- Decrease price in Zone B to reduce supply to 40 MW



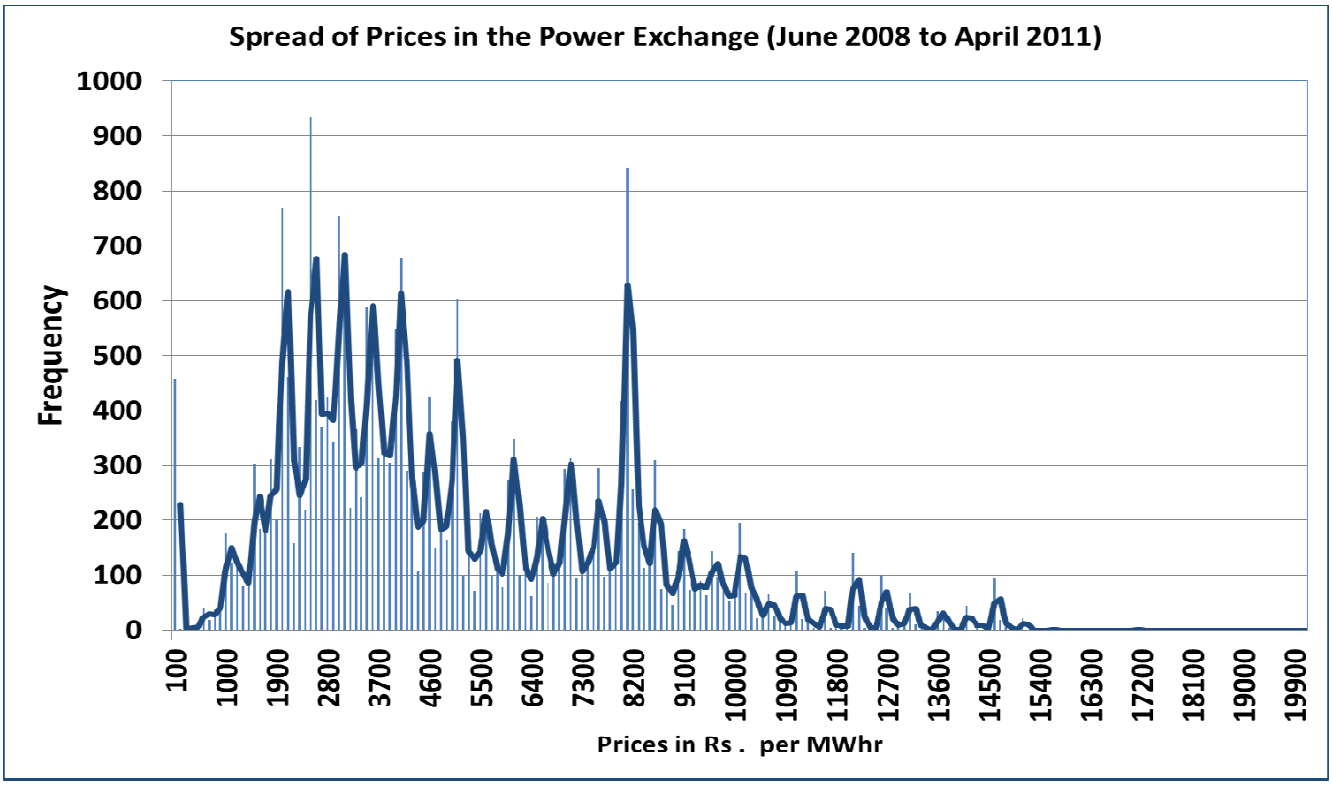
Cost of Congestion: 2000

Correlation: Prices & Shortage/ Surplus

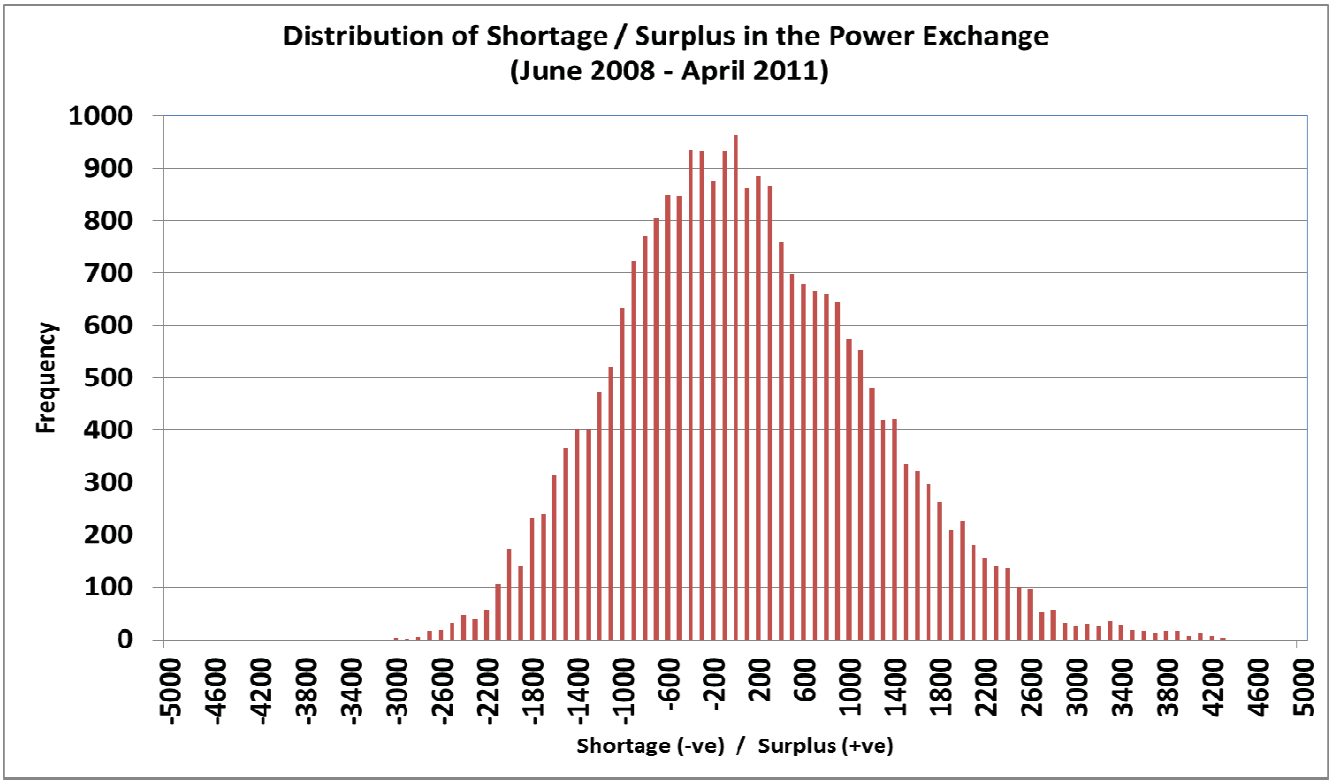


Data: June-08 to Apr-11; IEX

Distribution of Prices in Power Exchange (IEX)



Distribution of Shortage / Surplus (IEX)



CASE OF MCV INCREASE AFTER CONGESTION

- **Day ahead Market saw increase in Cleared Volume after congestion is declared in particular time blocks due to:**
  - Block –bids
  - New Sell/Buy bid getting cleared in Final iteration

DateTime		Purchase Bid(MWh)	Sell Bid(MWh)	Unconstrained MCV(MWh)	Constrained MCV (MWh)
15-10-2010	00-01	2367.1	2385.1	1807.3	1807.3
	01-02	2265.7	2537.7	1959.9	1959.9
	02-03	2276.1	2797.7	2196	2196
	03-04	2423.6	2732.7	2154.9	2154.9
	04-05	3223.7	2879.6	2454.7	2345.7
	05-06	3487.1	2914.8	2489.9	2380.9
	06-07	2193.1	2346.8	1920.7	1635.7
	07-08	2230.3	2223.2	1798.4	1633.9
	08-09	2274.6	2248.7	1798.9	1704.1
	09-10	2220.8	2194.7	1766.4	1649.4
	10-11	2355.3	2502.3	2079	1818.6
	11-12	2429.6	2396.3	1974	1841.9
	12-13	2285.1	2358.3	1936	1865.2
	13-14	2245.4	2402.2	1955.8	1862.7
	14-15	2294.3	2437.6	2015.3	1888.3
	15-16	2339	2402.4	1980.1	1905.98
	16-17	2104.4	2367.4	1945.1	1883.3
	17-18	2138.1	1682.4	1268.82	1268.82
	18-19	2112.4	1770.6	1515.2	1525.3
	19-20	2328.9	1965.6	1847.2	1856
	20-21	2213.6	2009.8	1746.1	1753.3
	21-22	2002.4	2004.6	1556.6	1565.9
	22-23	2173.9	1905.1	1322.1	1322.1
	23-24	2031.1	2218.7	1699.3	1699.3

SOURCE:IEX Website

Transmission Congestion Management: Methods

- **Pricing Based**
  - Explicit Auction
  - Implicit Auction
  - Market Splitting
- **Remedial**
  - Counter Trade
  - Re-dispatching

Congestion Management in Multi Exchange Scenario (1)

- **ISSUE**
  - Sharing of available margins
- **Possible Methods**
  - Priority Based Rules
  - Explicit Auction
  - Merging of Bids
- **Priority Based Rules**
  - Lowest MCP
  - Highest MCV
  - Highest MCP X MCV
  - Maximization of Social Welfare, consumer surplus, etc.
  - May not lead to an overall economy

Congestion Management in Multi Exchanges Scenario (2)

- **Explicit Auctioning amongst Exchanges**
  - Inter-dependencies in the Indian scenario
  - Difficult to implement
- **Merging of bids obtained by each Power Exchange**
  - Equivalent to system operator interfacing with only one Exchange
  - Confidentiality issues
- **Pro – rata rationing of available margins**
  - Simple to implement
  - Sub-optimal method
  - Possibility of over-estimation of capacity
  - Further complications
    - Arising out of inter-dependencies in the Indian scenario

Implementation in India

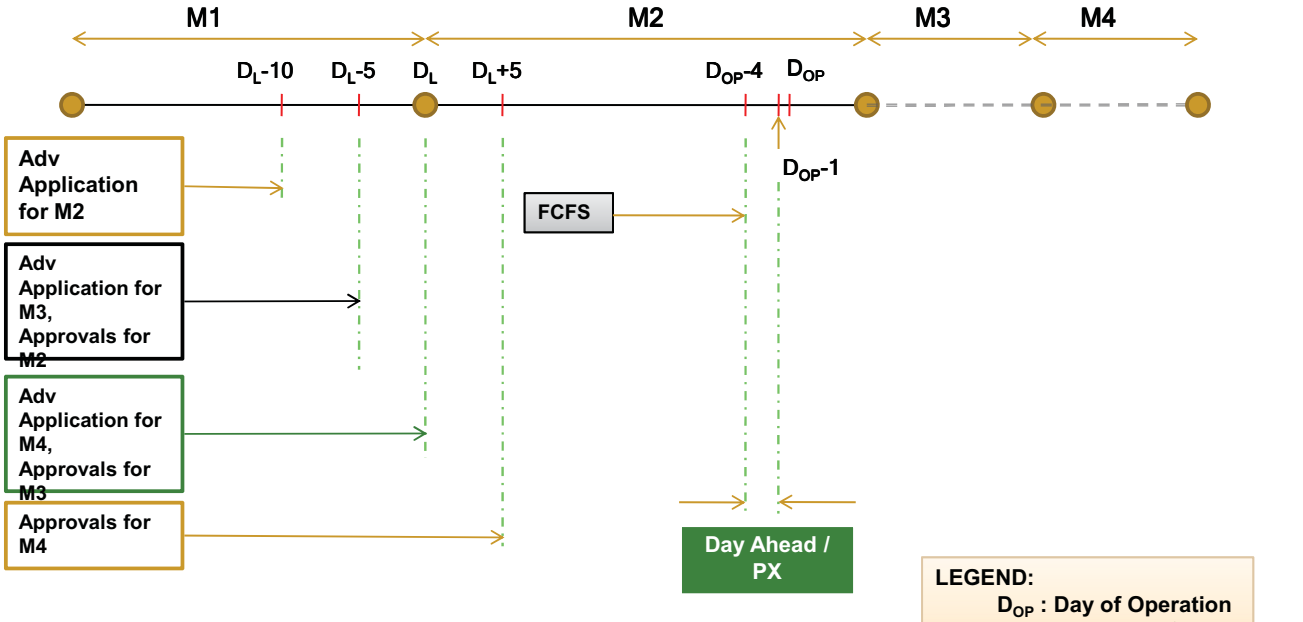
- **Worldwide, one Power Exchange dealing with physical delivery in one market**
- **Pro-rata sharing of available margins**
  - Applied on cleared trade volumes on each area and each corridor
  - Interim arrangement
  - Debate on for a more optimal method

Discovery of Multiple Prices & Interplay

- **Prices discovered in Power Exchange**
  - Reflection of anticipated UI price for the next day

- **Multiple Prices**
  - Collective Transactions:
    - Two prices – one for each exchange
  - Two Grids – two UI Prices
  - In case of congestion, market split
    - Area prices
    - Multiple exchanges

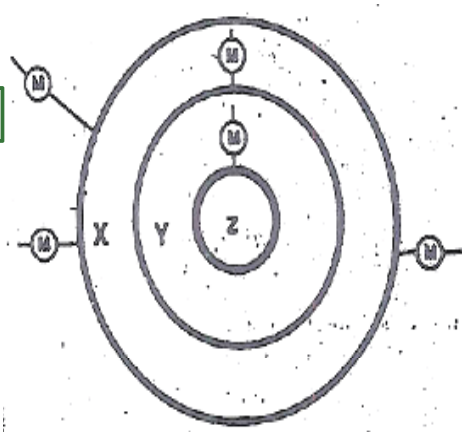
Time Line For Open Access



New Open Access Regulations w.e.f. 01-April-2008

Control Area Issues

Nested Control Areas



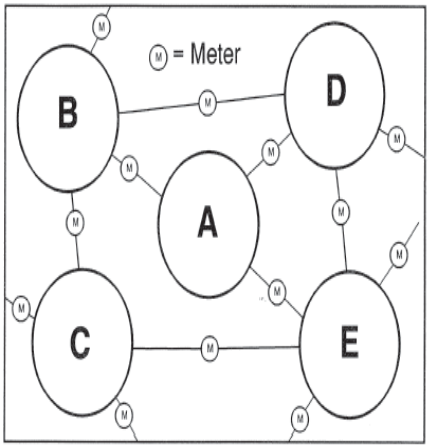
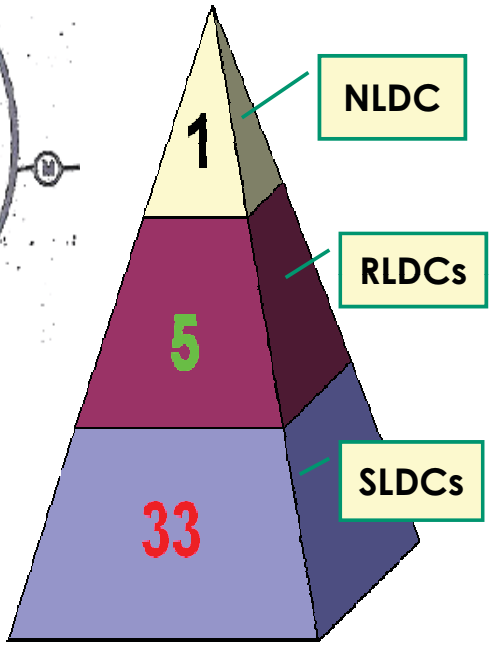


Figure 2 — Control area metering

Control Area Metering



Comparison of CERC Regulations on Short-Term Open Access (Regulation 2004, Amendment 2005 and Regulations 2008))

S. No.	Old Regulations (06.05.2004 to 31.03.2005)	Amended Regulations (w.e.f. 01.04.2005)	Regulations, 2008 (w.e.f. 01.04.2008)
1.	Transmission Charges a. Intra Regional – 25% of Long Term Charges b. Inter Regional – 25% of Long Term Charges	Transmission Charges a. Intra Regional – 25% of Long Term Charges b. Inter-Regional - 50% of Long Term Charges	Transmission Charges: Bilateral: - Rs.30/MWh – intra- regional - Rs.60/MWh – Between adjacent regions - Rs90/MWh – Wheeling through one or more region Collective Transactions (Px): -Rs. 30/MWh for each point of injection and drawal
2.	Retention by CTU a. Intra Regional – 25% of Charges collected b. Inter Regional – 25% of Charges collected c. Balance disbursed to States	Retention by CTU a. Intra Regional - 25% of Charges Collected b. Inter Regional - 12.5% of Charges collected c. Balance disbursed to States	Retention by CTU - 25% by CTU - Balance 75% to be disbursed to States

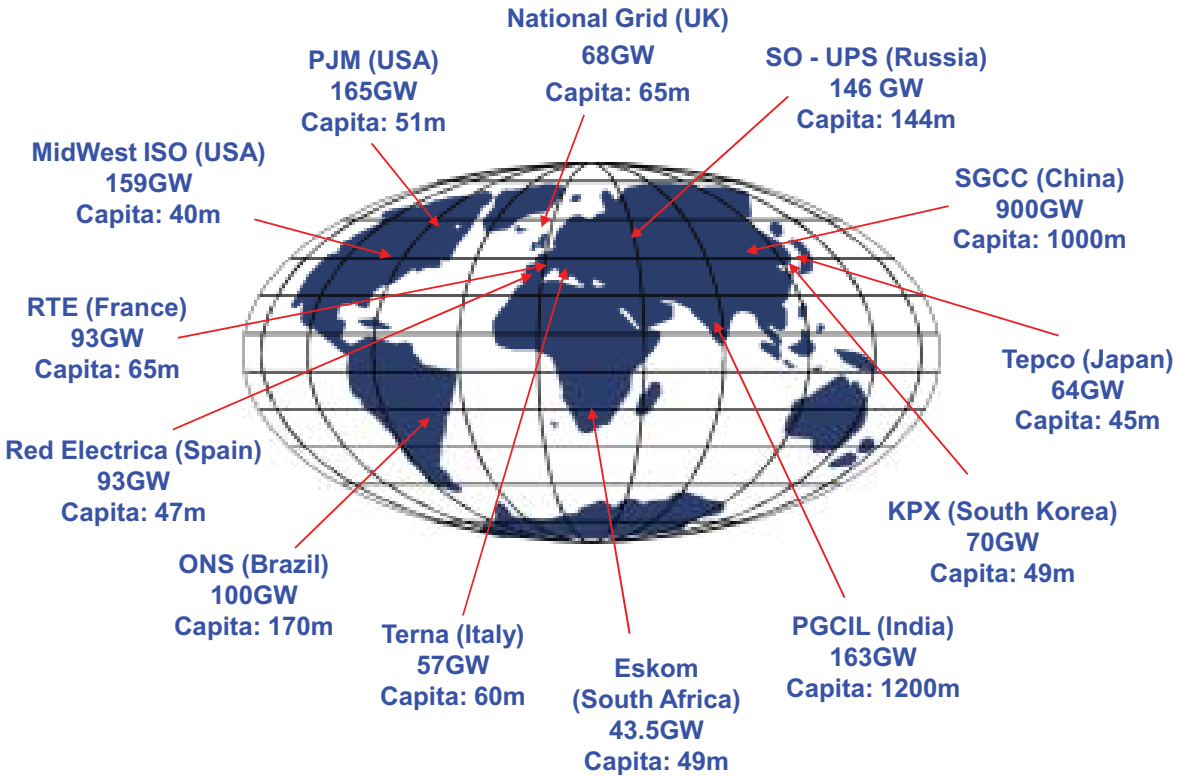
Comparison of CERC Regulations on Short-Term Open Access (Regulation 2004, Amendment 2005 and Regulations 2008))

3.	RLDC Charges a. Application fee – Rs. 5000/- b. Scheduling Charges – Rs. 3000/day for each RLDC involved c. Handling &Service Charges - 2% of total charges	RLDC Charges a. Application fee – Rs. 5000/- b. Scheduling Charges – Rs. 3000/day for each RLDC involved c. Handling & Service Charges – Nil	RLDC Charges : Bilateral: a. Application fee – Rs. 5000/- b. Scheduling Charges – Rs. 2000/day for each RLDC involved c. Handling & Service Charges – Nil Collective Transactions: a. Application fee – Rs. 5000/- b. Scheduling Charges – Rs. 5000/day to NLDC for each State involved -NLDC to Share with RLDCs
4.	Open Access Duration - Up to One year maximum - single application possible	Open Access Duration - Up to Three Months max. - single application possible	Open Access Duration Bilateral -Up to 3 months - separate application for each month - Collective: - Only Day ahead

Comparison of CERC Regulations on Short-Term Open Access (Regulation 2004, Amendment 2005 and Regulations 2008))

5.	ST Rate - in Rs/MW/Day - Min. Charges for one day	ST Rate - in Rs./MW/Day -Charges as per continuous block of upto 6 hours, 12 hours and more than 12 hours	Rate -in Rs/MWh - Based on Scheduled Energy
6.	Congestion Management - E-Bid without price cap	Congestion Management - E-Bid with price cap	Congestion Management Bilateral: - E-Bid without price cap Collective: - NLDC in coordination with Px

Indian Power System : Amongst the Largest in the World

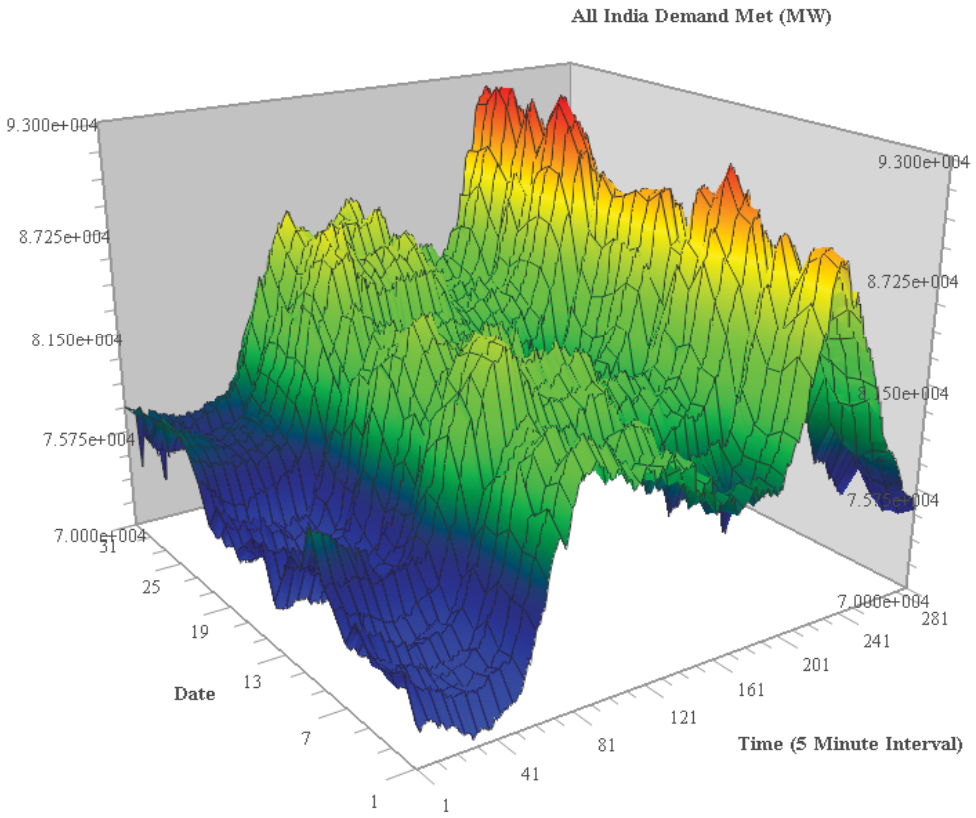


Source: VLPGO, 2010

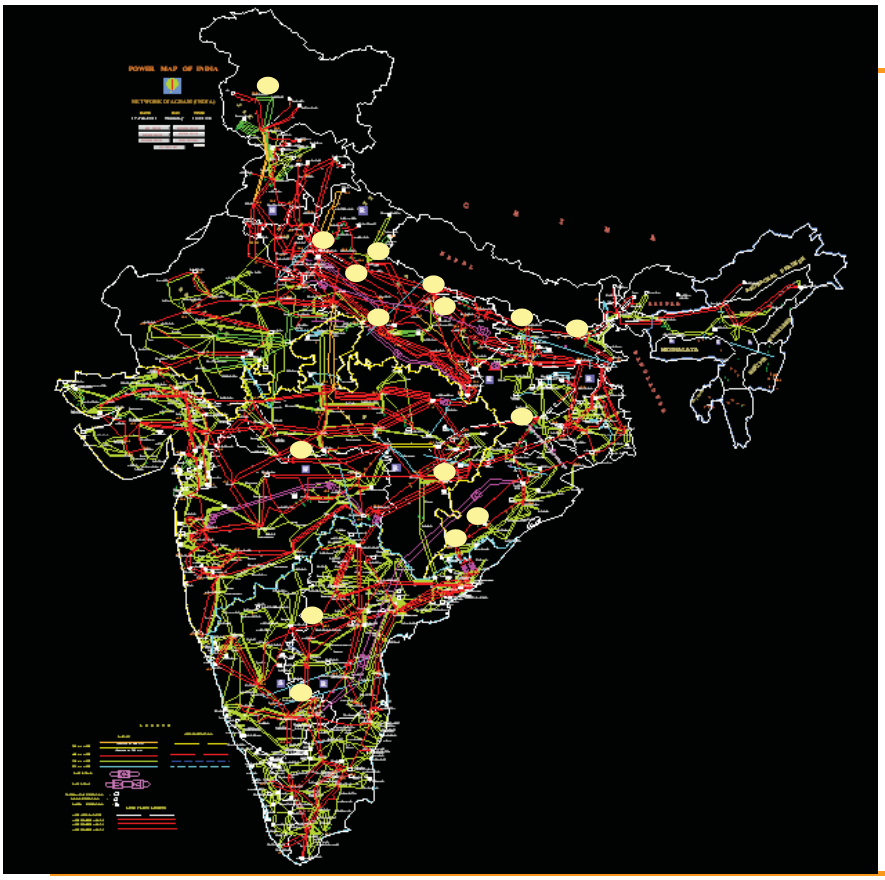
Typical Numbers for Indian Power System…

Demand	:~ 110 GW
Generating Units	:~ 1600
400kV & above Trans. Line	:~ 700
Transformers	:~ 2000
Busses	:~ 5000
Control Areas	:~ 100
Inter-State Metering Points	:~ 3000
Schedule Matrix Elements	:~ 96 X 100 X (~10) ~=100000
Open Access transactions typical daily	:~ 100
Captives participating in market	:~ 125

Typical All India Demand (Monthly Profile)



ALL INDIA NETWORK



HVDC:

BIPOLE - 4

1. Rihand – Dadri
2. Chandrapur – Padge
3. Talcher – Kolar
4. Balia - Bhiwadi

BACK To BACK - 3

1. Vindhyachal
2. Bhadravati
3. Gazuwaka

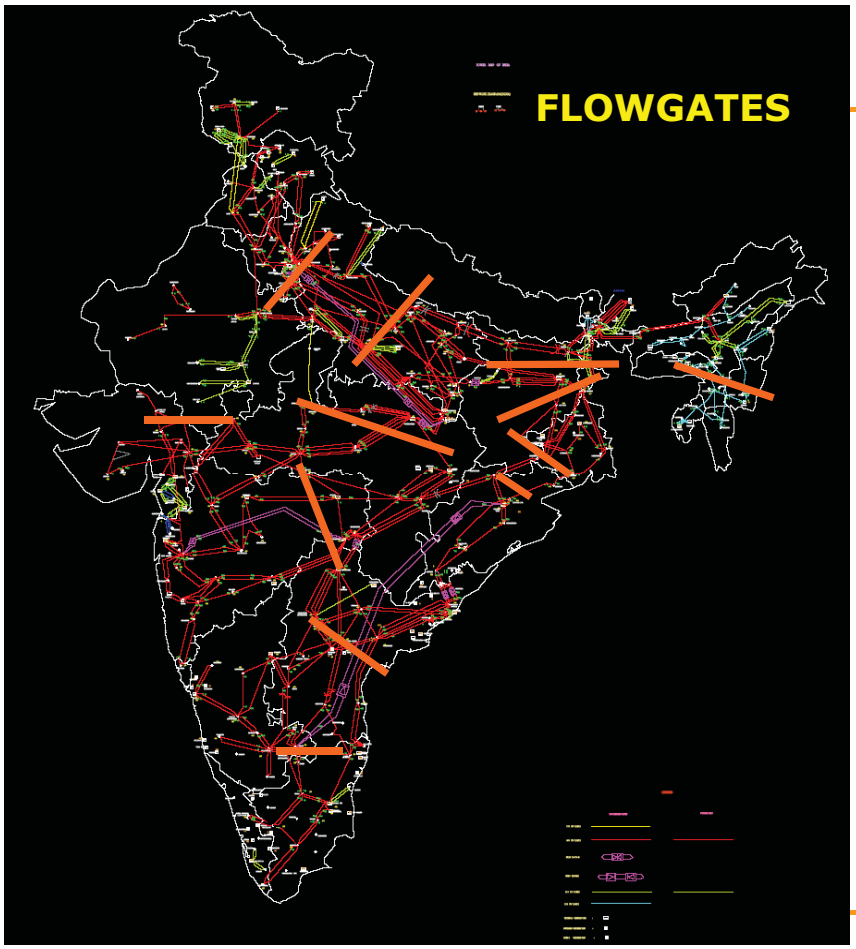
TCSC : - 3

1. Muzaffarpur – Gorakhpur D/C
2. Purnea – Muzzafarpur D/C
3. Raipur – Raigarh D/C

FSC : - 18

1. Muzaffarpur – Gorakhpur D/C
2. Purnea – Muzaffarpur D/C
3. Raipur – Raigarh D/C
4. Gooty – Bangalore 2 * S/C
5. N'sagar – Cuddapah 2 * S/C
6. Kanpur – Ballabgarh S/C
7. Panki – Muradnagar S/C
8. Rengali – Indravati S/C
9. Jeypore – Gazuwaka D/C
10. Meramandali – Jeypore S/C
11. Balia – Lucknow D/C
12. Ranchi – Sipat D/C
13. Seoni – Khandwa D/C
14. Allahabad – Mainpuri D/C
15. Unnao – Bareilly D/C
16. Gorakhpur – Lucknow D/C
17. Bareilly – Mandaula D/C
18. Pampore – Kishenpur 220 kV D/C

Legend: ● **Location of FSC & TCSC**



Pan India Market:
All India Economy & Efficiency

Optimal utilization of resources

Well Meshed Network

400 kV Backbone (~100,000 ckt kms)

765 kV Operations commenced

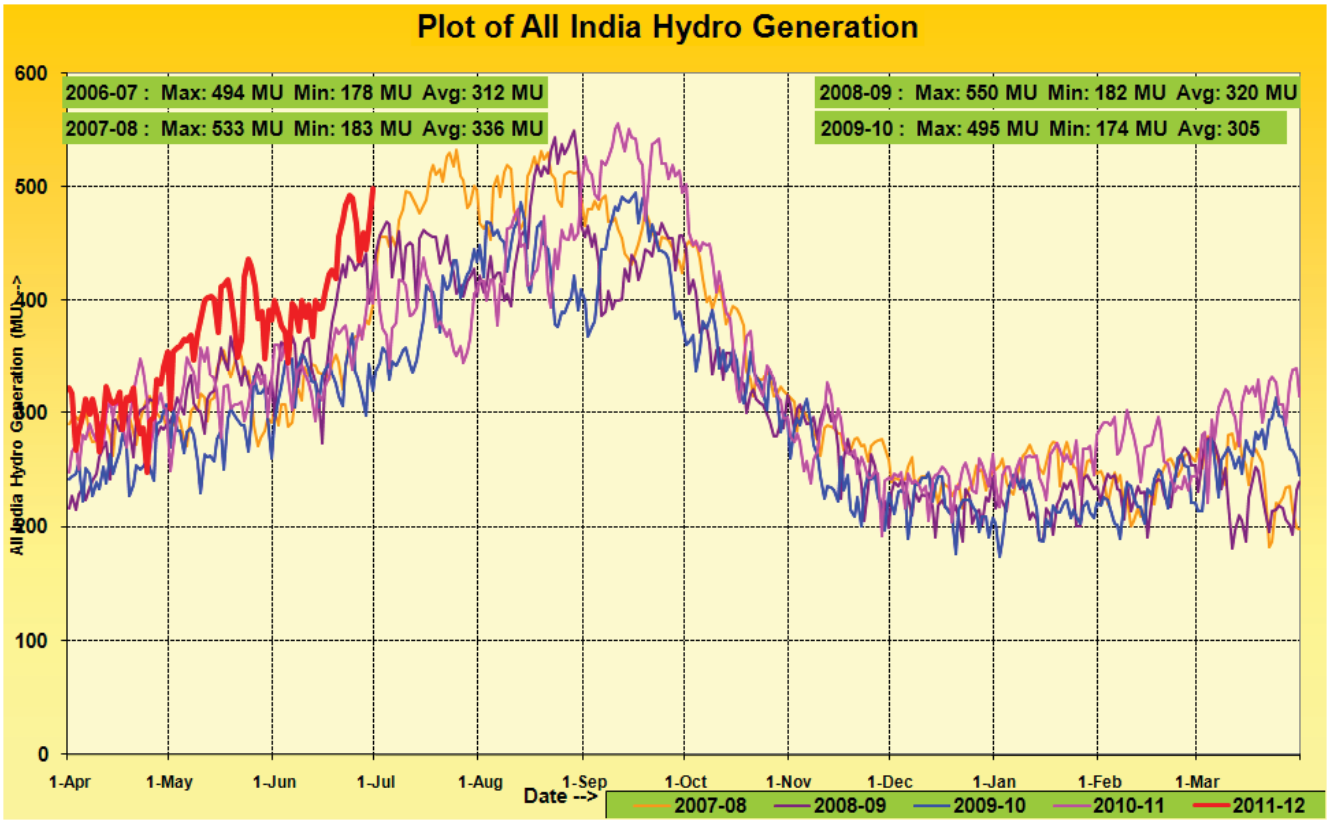
Bulk transfer through HVDCs

High Capacity Corridors under construction

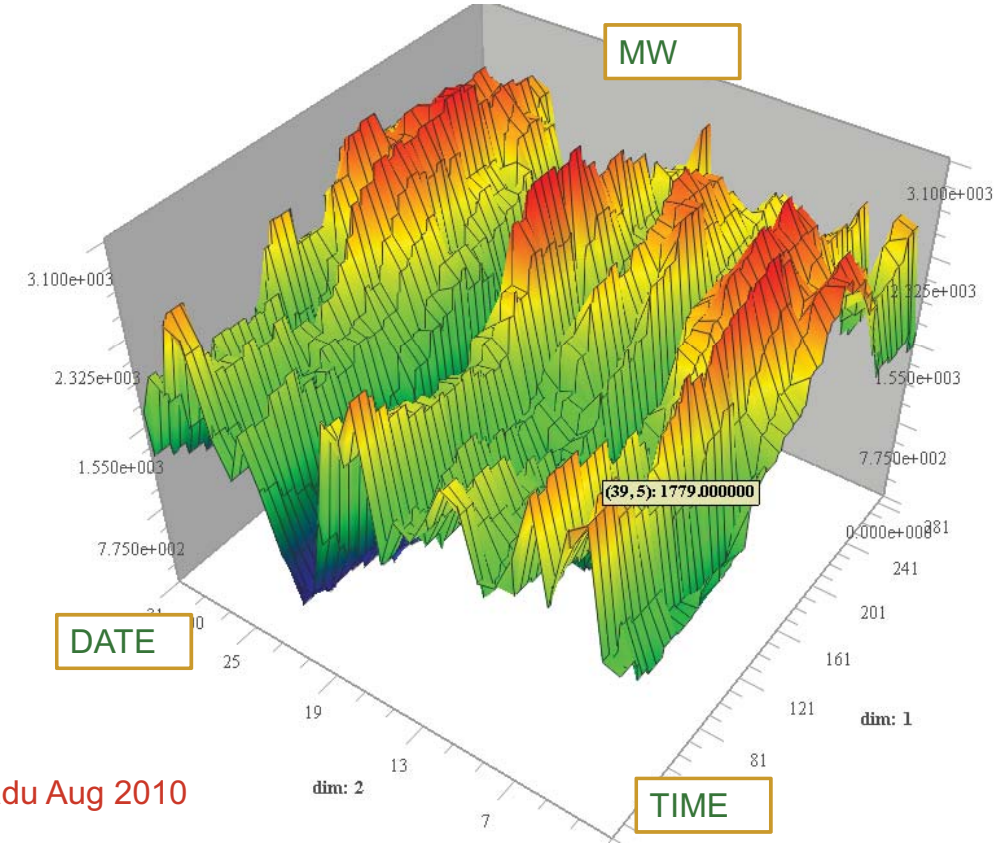
Indian Power System

- **Coordinated and rapidly expanding network**
- **Strong back bone 400 kV system**
- **High capacity interregional links**
- **“Very Large” grid**
- **“Very Large” market**

Seasonal Variation of Hydro Generation



Typical Wind Generation Pattern

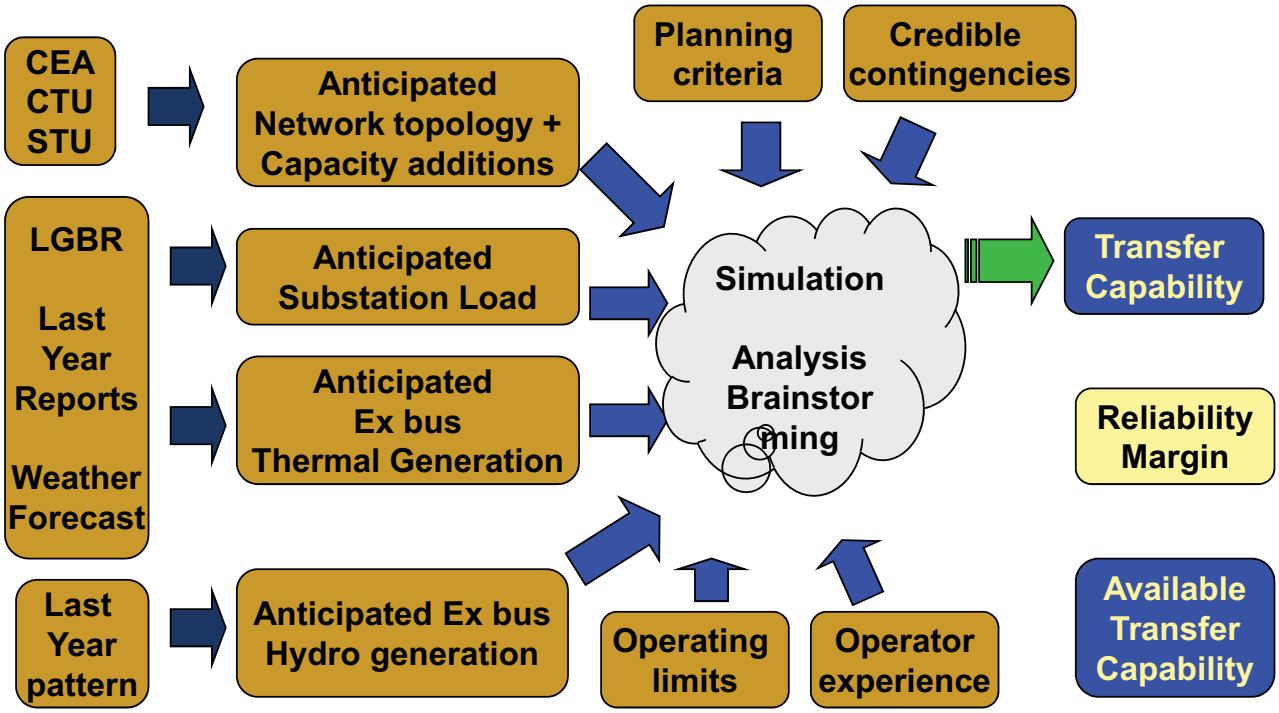


Tamil Nadu Aug 2010

Grid Security : Prime concern in all time horizons

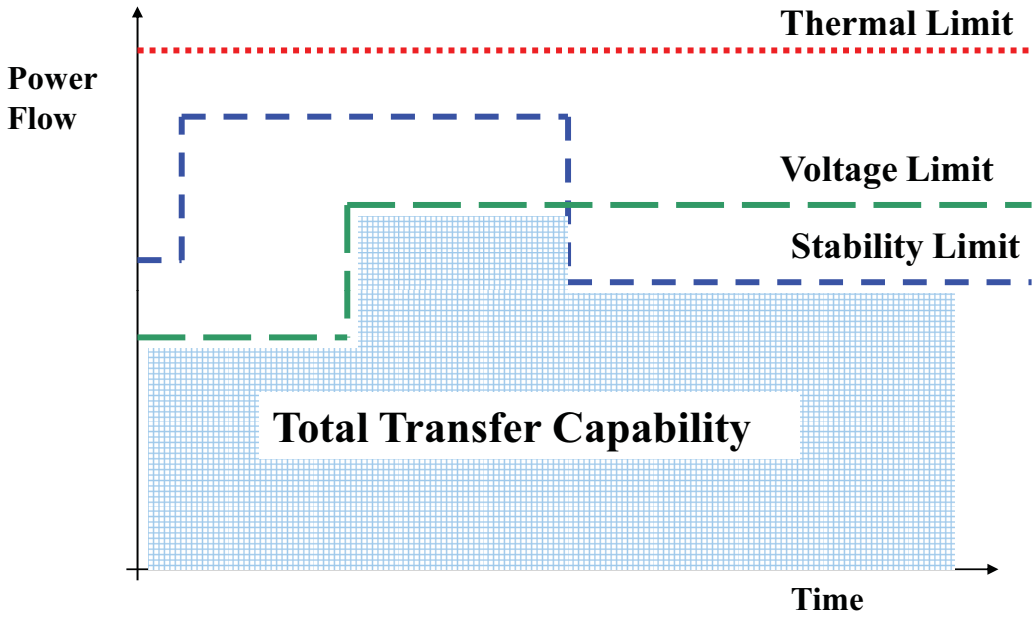
Time Horizon	Handled through
Long-term	Standards and Operating Code Market design Adequacy planning
Medium-term	Maintenance planning (Coordinated at regional level)
Short-term	Resource scheduling (Decentralized)
Real-time	Operating limits Contingency planning

Transfer Capability assessment



Planning Criteria is strictly followed during simulations

Line Loading Limits



Total Transfer Capability is the minimum of the Thermal Limit, Voltage Limit and the Stability Limit

Permissible Line Loading Limits

- **SIL at certain voltage levels modified to account for**
  - Shunt compensation
    - k1 = sqrt (1- degree of shunt compensation)
  - Series compensation
    - k2 = 1 / [sqrt (1-degree of series compensation)
  - Variation in line loadability with line length
    - K3
- **From Sec 4.2 of Transmission Planning Criteria**
  - Thermal loading limits at conductor temperature of 75°
  - Ambient 40° in summer and 10° in winter

Source: Sec 4.1 of Transmission Planning Criteria

Surge Impedance Loading (SIL)

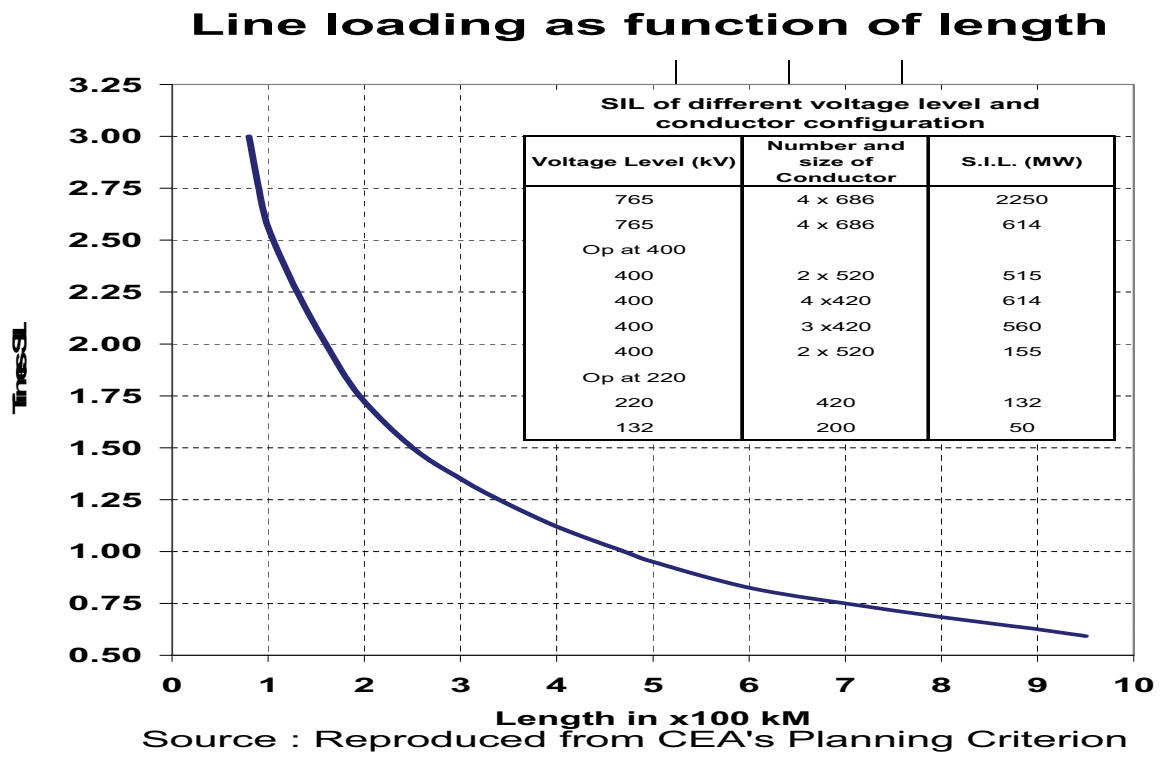
At SIL, Reactive power generated = Reactive power consumed by the line

Sl. No.	Voltage	Conductor	SIL
1	765	Quad Bersimis	2250
2	400	Quad Bersimis	691
	400	Twin Moose	515
	400	Twin AAAC	425
	400	Quad Zebra	647
	400	Quad AAAC	646
	400	Triple Snowbird	605
	400	ACKC(500/26)	556
	400	Twin ACAR	557
3	220	Twin Zebra	175
	220	Single Zebra	132
4	132	Single Panther	50

Effect of Series Compensation on SIL

Effect of Series Compensation on SIL	
At SIL	Series reactance of a series compensated line gets reduced by the % series compensation. So the SIL would increase by a factor of Sqrt [1/(1-%compensation/100)]. For instance in case of Kanpur-Ballabgarh, the SIL without series compensation would be 515 MW. With 35 % compensation, new SIL would be 515/ sqrt(0.65) = 638 MW
$I^2X_L = V^2/X_c$	
$V^2/I^2 = X_L * X_c$	
$Z_c = V/I = Sqrt (X_L*X_c)$	
$Zc = Sqrt (wL/wC)$	
$Zc = Sqrt (L/C)$	
$SIL=V^2/Zc$	

Line Loading as a Function of Length



Source : Reproduced from CEA's Planning Criterion

Computation of Line Operating limits

S No.	From	To	Ckt	Line length	From end shunt reactor	To end shunt reactor	SIL	Power Transfer between adjacent buses at 30 deg angular separation and 5 % voltage regulation P_B	Multiplying factor to take shunt compensation into account = k1	Multiplying factor to take series compensation in account= k2	Multiplying factor from St Clair's curve = k3	Permissible line loading P_L	Thermal limit (MW) at 40° C ambient Pth_sum	Thermal limit (MW) at 10° C ambient Pth_win	Operating limit in summer assuming 40° C ambient	Operating limit in winter assuming 10° C ambient
1	Nalagarh	Kaithal	1	200	0	0	605	1379	1.00	1	2.28	1379	1619	2723	1379	1379
2	Abdullapur	Nathpa	1	180	45.35	0	605	1532	0.79	1	2.53	1212	1619	2723	1212	1212
3	Abdullapur	Nathpa	2	180	45.35	0	605	1532	0.79	1	2.53	1212	1619	2723	1212	1212
4	Hisar	Patiala	1	178	45.35	0	605	1549	0.79	1	2.56	1222	1619	2723	1222	1222
5	Bawana	Abdullapur	1	167	0	0	605	1651	1.00	1	2.73	1651	1619	2723	1619	1651
6	Bawana	Abdullapur	2	167	0	0	605	1651	1.00	1	2.73	1651	1619	2723	1619	1651
7	Nalagarh	Jhakri	1	144	45.35	0	605	1915	0.73	1	3.00	1325	1619	2723	1325	1325
8	Nalagarh	Jhakri	2	144	45.35	0	605	1915	0.73	1	3.00	1325	1619	2723	1325	1325
9	Hisar	Kaithal	1	113	0	0	605	2440	1.00	1	3.00	1815	1619	2723	1619	1815
10	Nalagarh	Patiala	1	94	0	0	605	2933	1.00	1	3.00	1815	1619	2723	1619	1815
11	Jhakri	Baspa	1	35	0	0	605	7878	1.00	1	3.00	1815	1619	2723	1619	1815
12	Jhakri	Baspa	2	35	0	0	605	7878	1.00	1	3.00	1815	1619	2723	1619	1815

Steady State Voltage Limits

Voltage (kV rms)		
Nominal	**Maximum**	**Minimum**
765	800	728
400	420	380
220	245	198
132	145	122

From Section 5 of Transmission Planning Criteria

Transmission Capacity vis-à-vis Transfer Capability

	Transmission Capacity	Transfer Capability
1	Is a physical property in isolation	Is a collective behaviour of a system
2	Depends on design only	Depends on design, topology, system conditions, accuracy of assumptions
3	Deterministic	Probabilistic
4	Constant under a set of conditions	Always varying
5	Time independent	Time dependent
6	Non-directional	Directional
7	Determined directly by design	Estimated indirectly using simulation models
8	Declared by designer/ manufacturer	Declared by the Grid Operator
9	Understood by all	Frequently misunderstood
10	Considered unambiguous & sacrosanct	Subject to close scrutiny by all stakeholders

Credible contingencies

- **From Section 3.5 of IEGC**
  - Outage of a 132 kV D/C line or
  - Outage of a 220 kV D/C line or
  - Outage of a 400 kV S/C line or
  - Outage of a single ICT or
  - Outage of one pole of HVDC bi pole or
  - Outage of 765 kV S/C line

… without necessitating load shedding or rescheduling of generation during steady state operation …

n-1 Contingencies: Examples

- **Outage of Single Pole Rihand-Dadri HVDC Pole**
- **Outage of Single Pole Chadrapur-Phadge HVDC Pole**
- **Outage of 400 kV Singrauli-Lucknow S/C**
- **Outage of 400 kV Singrauli-Kanpur- one ckt**
- **Outage of 400 kV Bareli-Mandola- one ckt**
- **Outage of 400 kV Gwalior-Agra S/C**
- **Outage of 400 kV Farakka-Malda- one ckt**
- **Outage of 400 kV Purnea-Muzaffarpur- one ckt**
- **Outage of 400 kV Talcher-Rourkela- one ckt**
- **Outage of 400 kV Jamshedpur-Rourkela- one ckt**

(n-1): Element or event ?

- **Tower collapse/ lightning stroke on a D/C tower**
- **Failure of opening of 400 kV Line breaker in a two main one transfer scheme**
  - results in multiple loss in elements
  - As per planning criteria- not more than two elements should be affected
- **Coal fired station**
  - Fault in 132kV system- may result in loss of power supply to CW system vis a vis tripping of multiple units
- **Non availability/Outage/Non operation of Bus bar protection**
  - Results in tripping of all lines from remote stations
- **Weather disturbance or floods**
  - Might result in loss of substation/multiple lines in the same corridor
- **Breaker and a half scheme**
  - Outage of combination of breakers may result in tripping of multiple line for a fault in one line

Reliability Margins

- **The beneficiary of this margin is the "larger community" with no single, identifiable group of users as the beneficiary.**
- **The benefits of reliability margin extend over a large geographical area.**
- **They are the result of uncertainties that cannot reasonably be mitigated unilaterally by a single Regional entity**

Peculiarities of Electricity Grids

- **Thomas J,. Overbye says**
  - *"The transmission system's load and its capacity to handle load are in constant flux.*

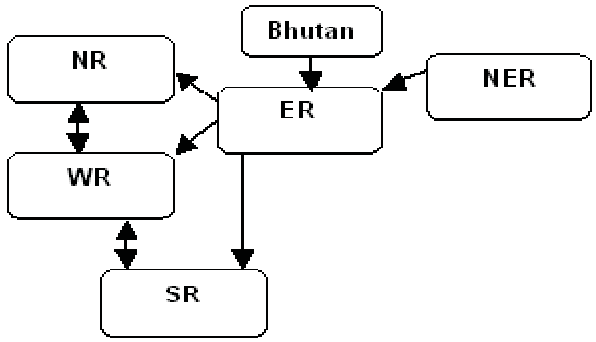
    Electricity product does not check the map to determine the shortest route...

    Electric power flows through the grid as dictated by the impedances of the transmission lines and locations where electric power is injected by the generators and consumed by the loads"

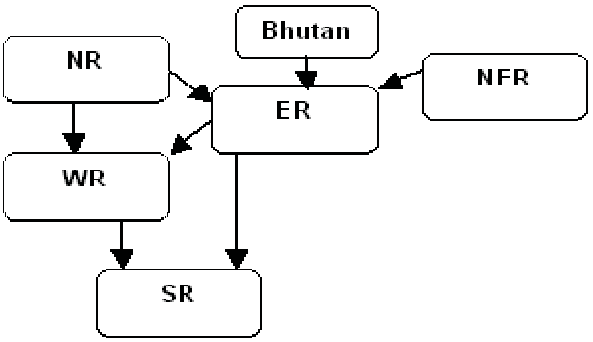
Uncertainties in Indian grids

- **Forecast errors are large**
  - Weather uncertainties
  - Consumer load and its spatial distribution
  - Generation availability
- **Variation in network topology from what was considered**
  - Disparity in project implementation
  - Mid-course changes in project execution
  - Prolonged outages
  - Non-firm maintenance programmes
- **Practical constraints**
  - Reconfiguration of switching arrangement
  - Radial operation
  - Opening of bus couplers
  - Opening of 220 kV loops etc.
- **Other socio-economic, political uncertainties**
  - Changes in long term allocations in Inter State Generating Stations

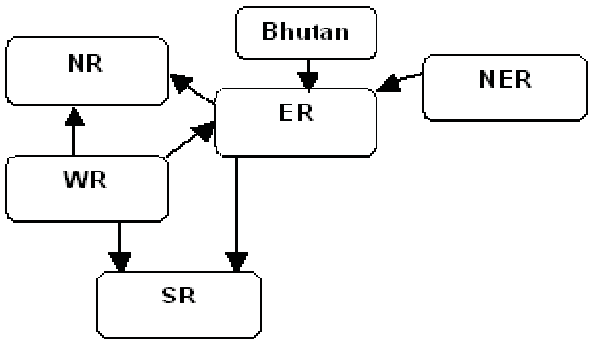
Seasonal Variation in Power Flow Patterns



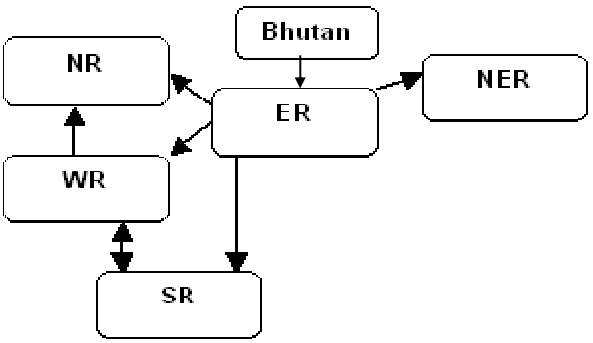
Scenario-1: Normal Monsoon



Scenario-2: Low Load in NR

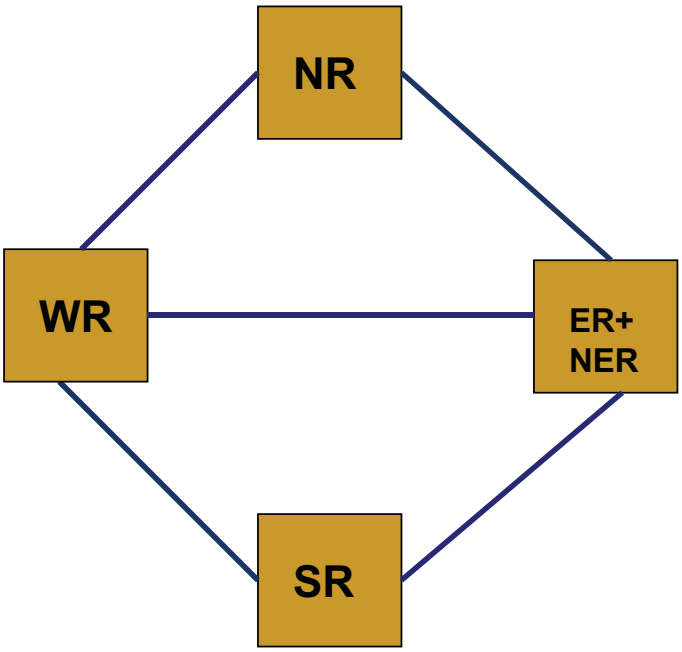


Scenario-3: Low Load in WR



Scenario-4: Peak winter

SKEWED LOAD GENERATION BALANCE



Scenarios:

1. 4D
2. 3D + 1S
3. 2D + 2S
4. 1D + 3S (Congestion)
5. 4S

Types of congestion in Indian context

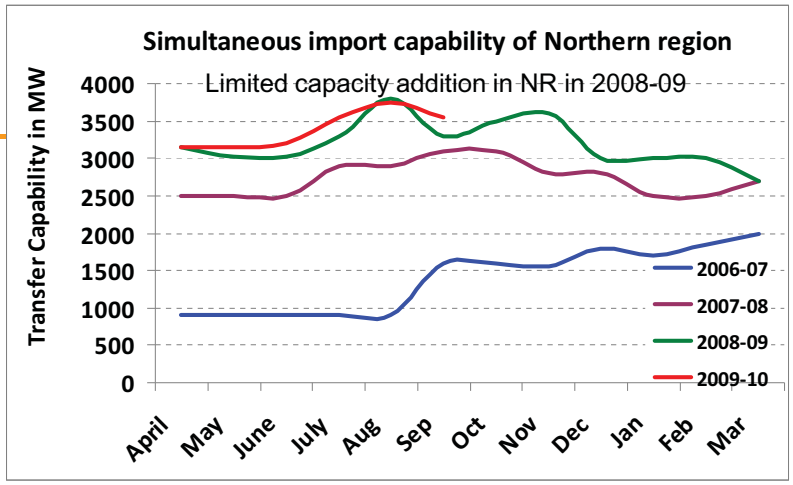
- 3 / 2 / 1 month (s) ahead – advance
- First come first served
- Day ahead PX
- Day ahead bilateral
- Contingency transaction
- Real time

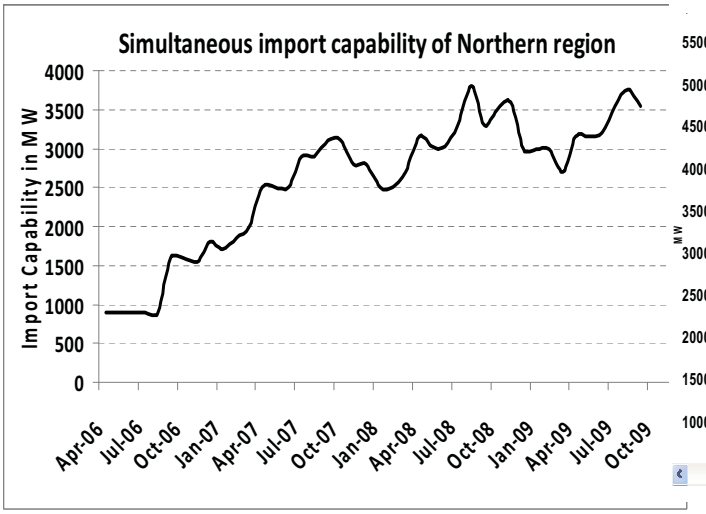
Causes of congestion

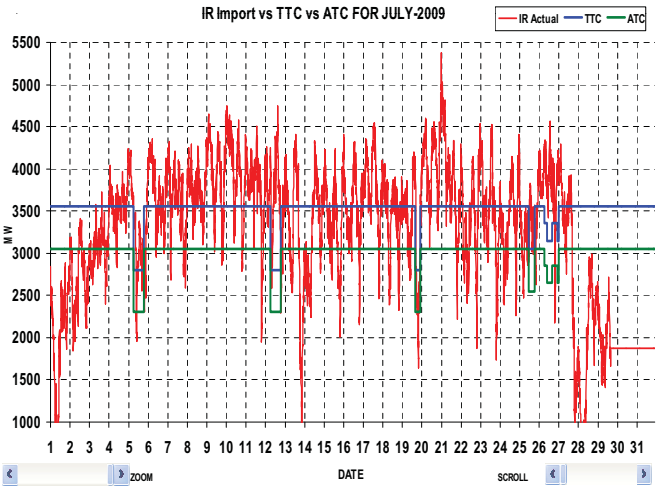
- Inadequate transmission – including outages
- Inadequate reactive support
- Weather diversity, seasonal demand variation
- Skewed generation availability – monsoon, planned / forced outages
- Uneven purchasing power of utilities in a shortage scenario
- Compulsion to meet load at all costs (agriculture, festival, election etc.) – Aggressive buying
- Economy (cheaper generation to replace costlier generation)
- Inflated sale / purchase requirement – Pseudo congestion
- Inter play with UI mechanism – Bids based on anticipated UI price

RLDCs have to ensure integrated operation of the grid and schedule in accordance with contracts

Declaration of transfer capability in advance is only a transparent mechanism for executing the mandate



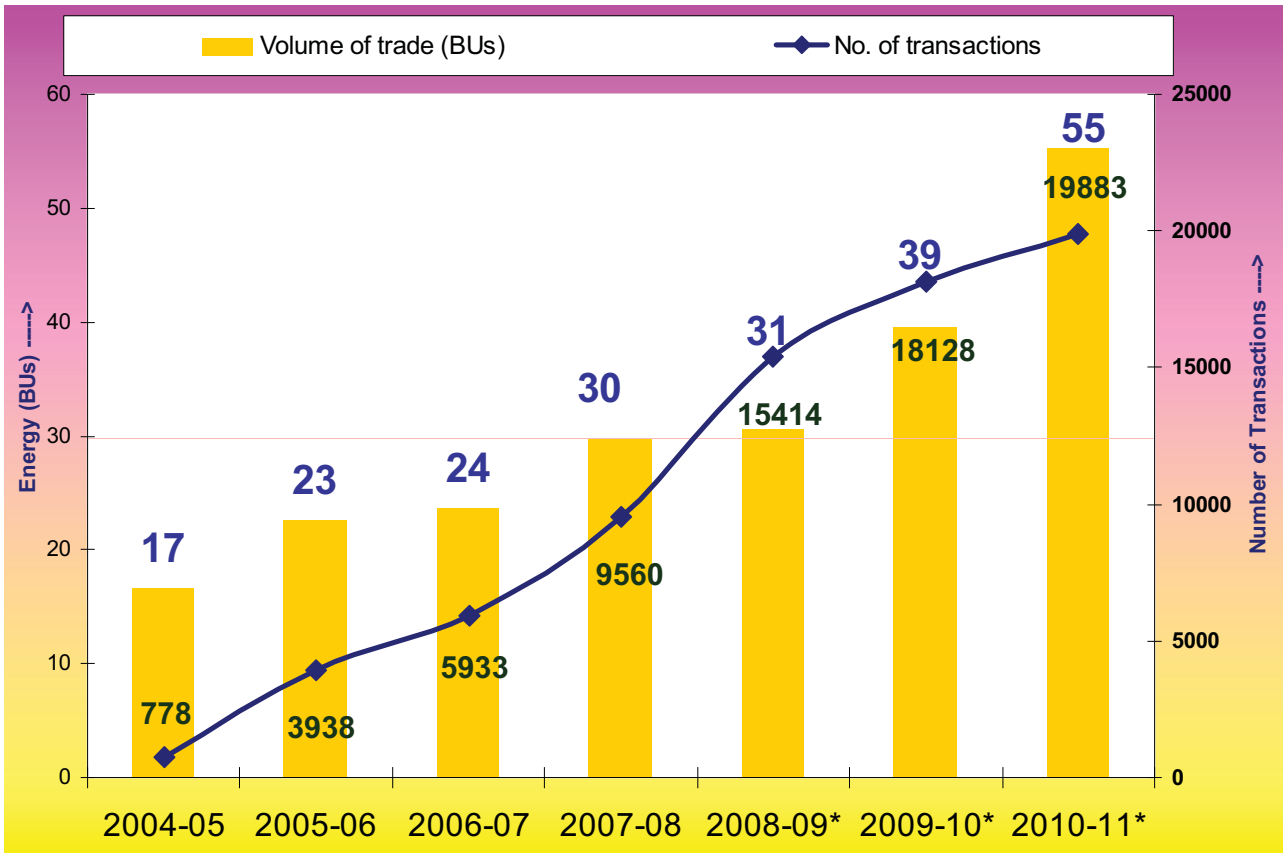




Transparency - Information Sharing

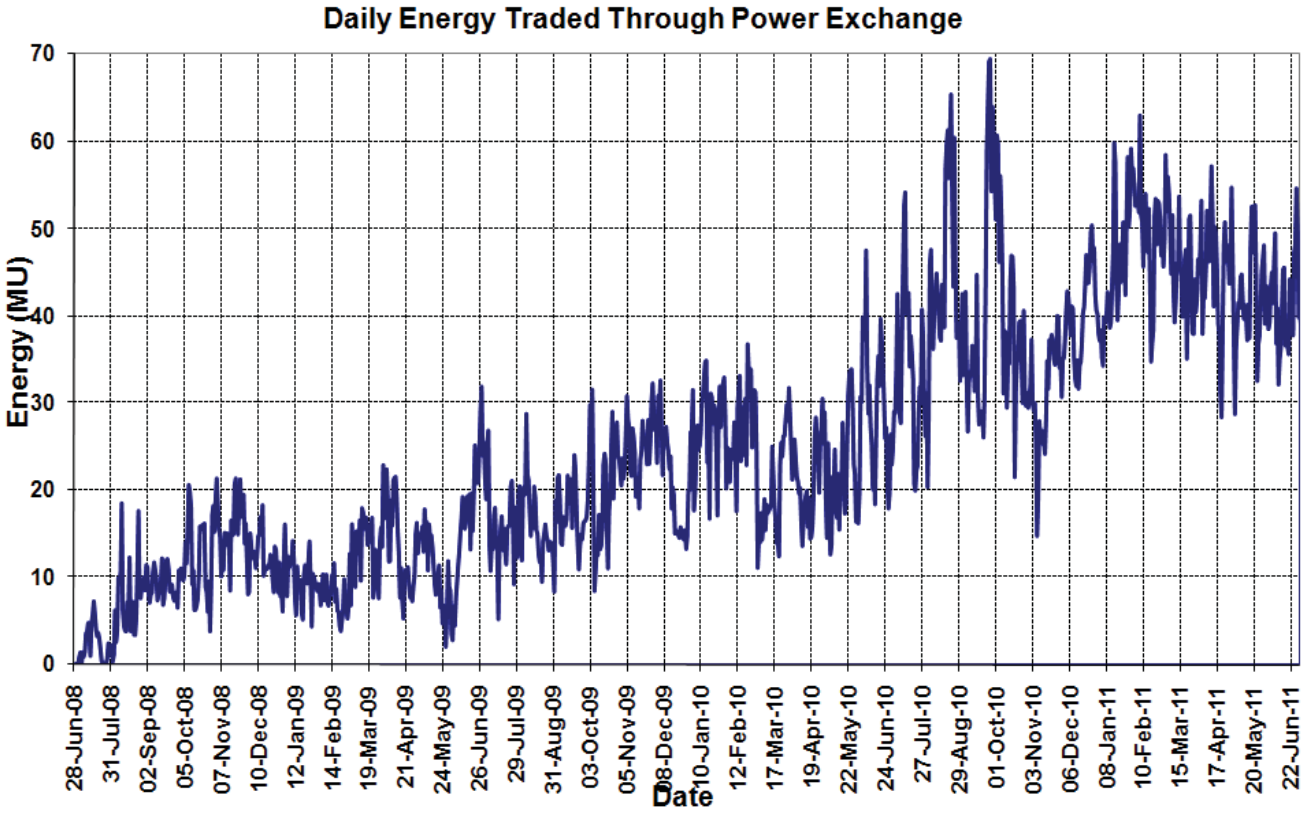
- Available Transfer Capacity (ATC) -3 months ahead
- Past & Current Transactions
- Injection & Drawal Schedules
- Frequency Trend
- Urgent market information – unit tripping, load crash, contingencies
- 52 week ISTS pooled losses
- Procedures ……much more on RLDCs websites

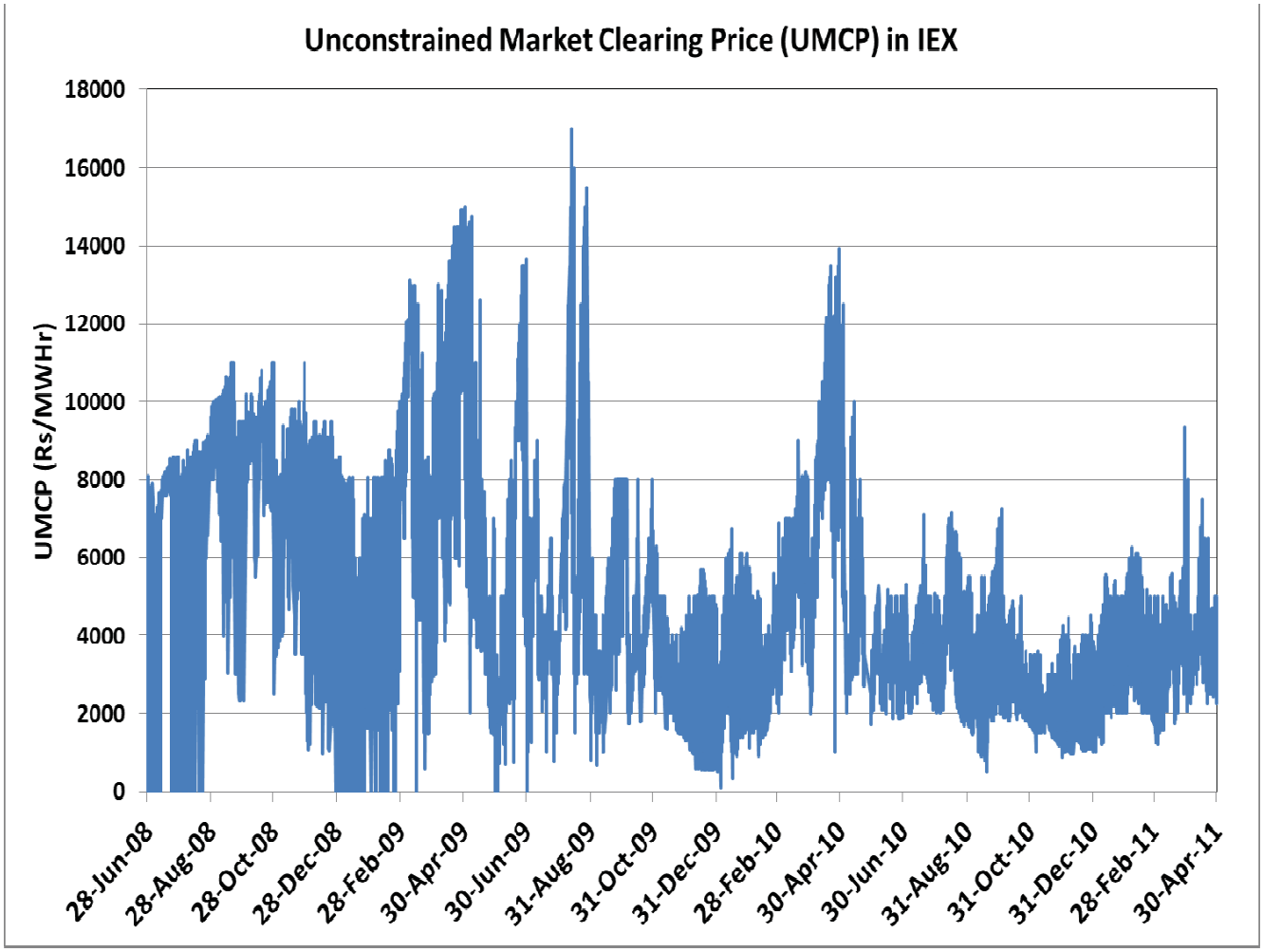
Trade under Short-Term Open Access



*Includes Bilateral + Collective transactions

Daily Energy Traded through Power Exchanges




Unconstrained Market Clearing Price (UMCP) in IEX
UMCP (Rs/MWHr)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
28-Jun-08
28-Aug-08
28-Oct-08
28-Dec-08
28-Feb-09
30-Apr-09
30-Jun-09
31-Aug-09
31-Oct-09
31-Dec-09
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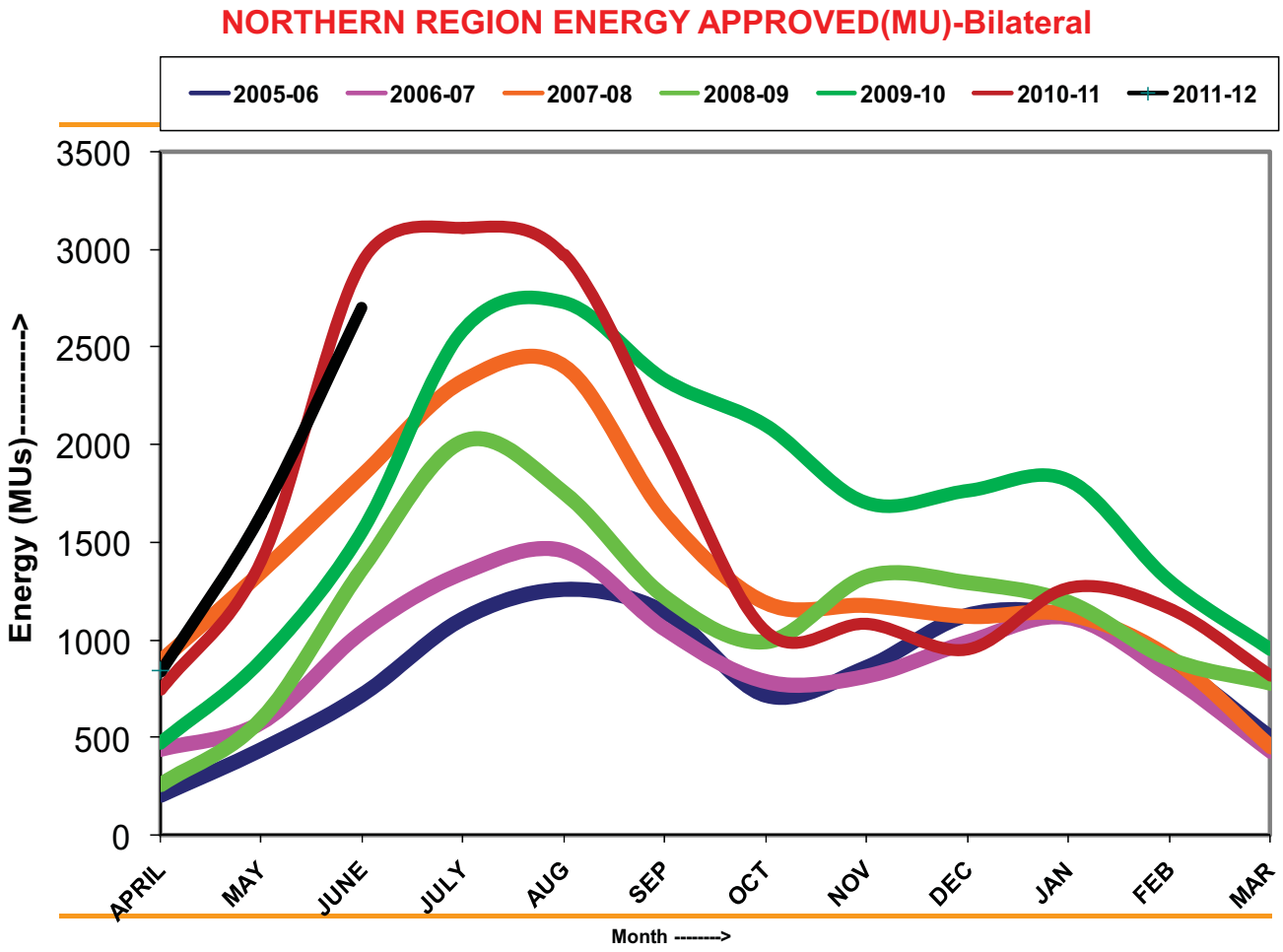
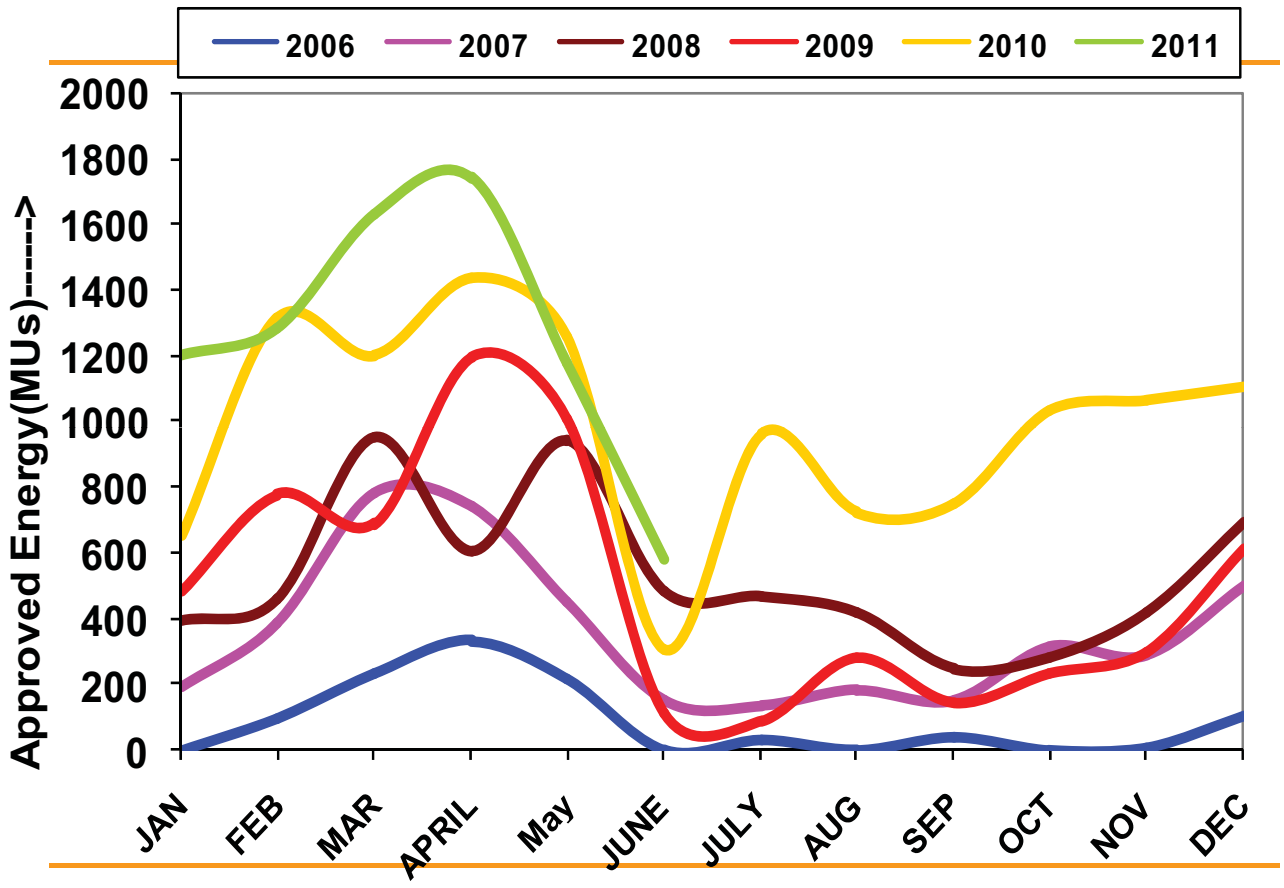
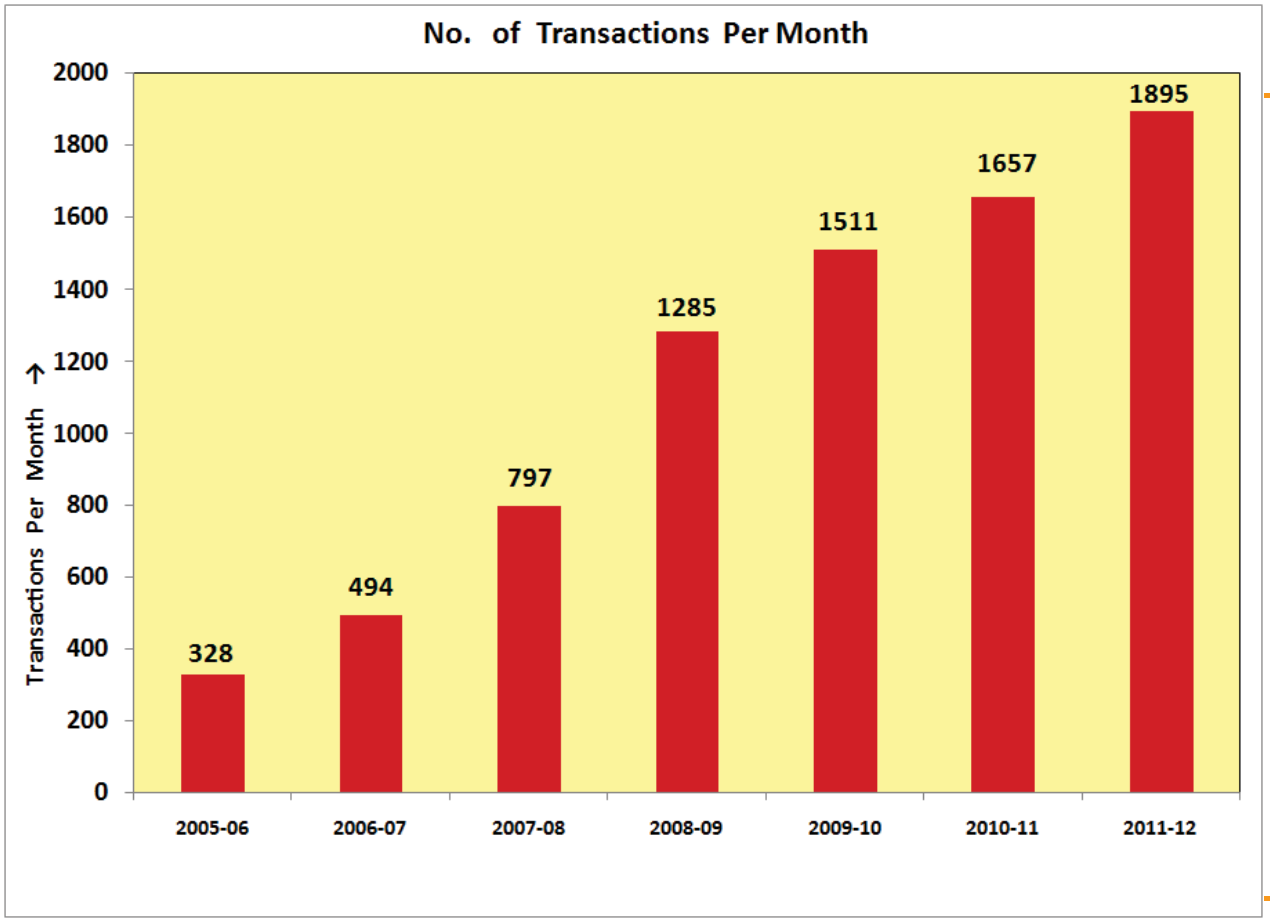
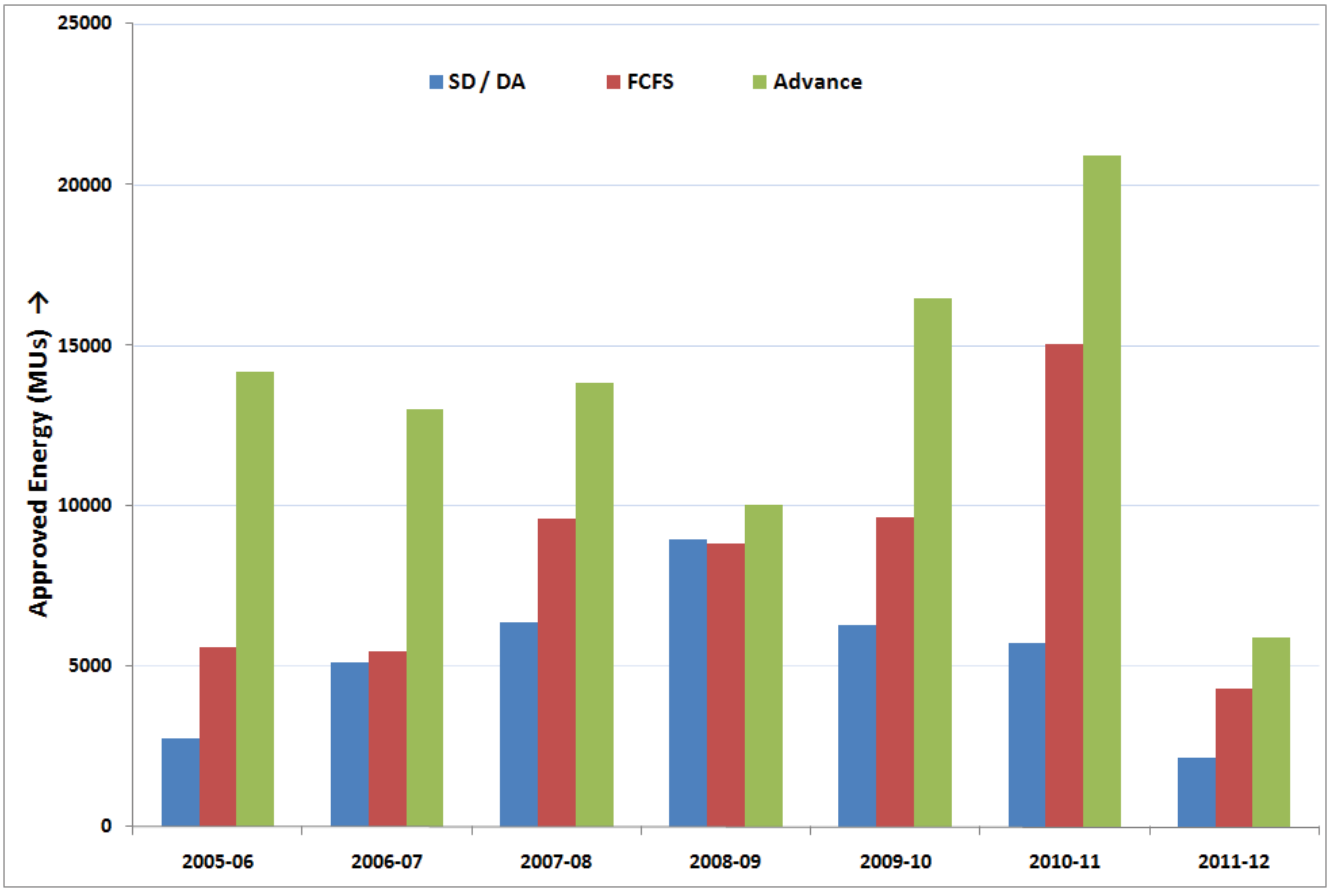
31-Aug-10
31-Oct-10
31-Dec-10
28-Feb-11
30-Apr-11

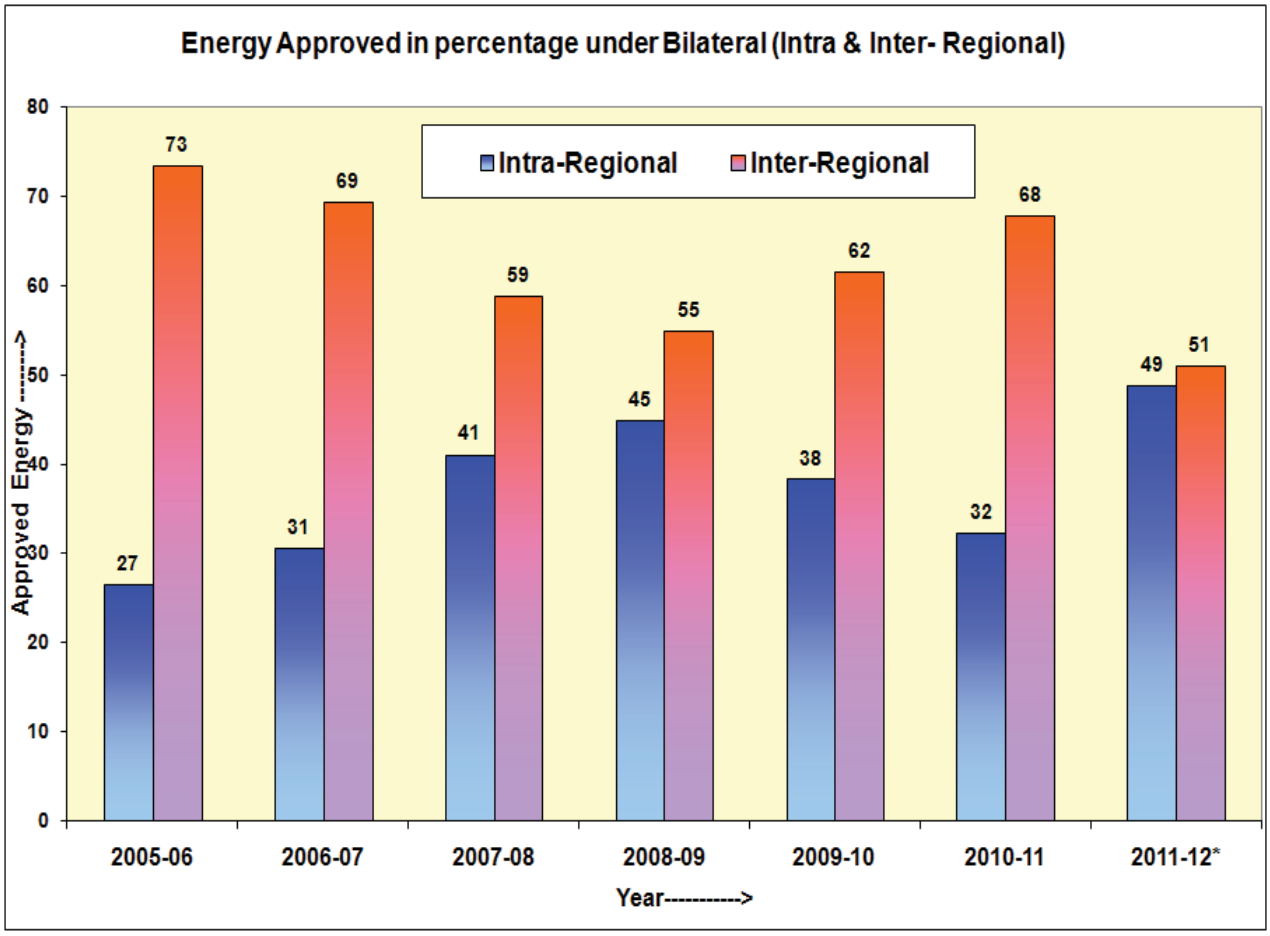

NORTHERN REGION ENERGY APPROVED(MU)-Bilateral
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
Energy (MUs)---------->
3500
3000
2500
2000
1500
1000
500
0
APRIL
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
Month ------->

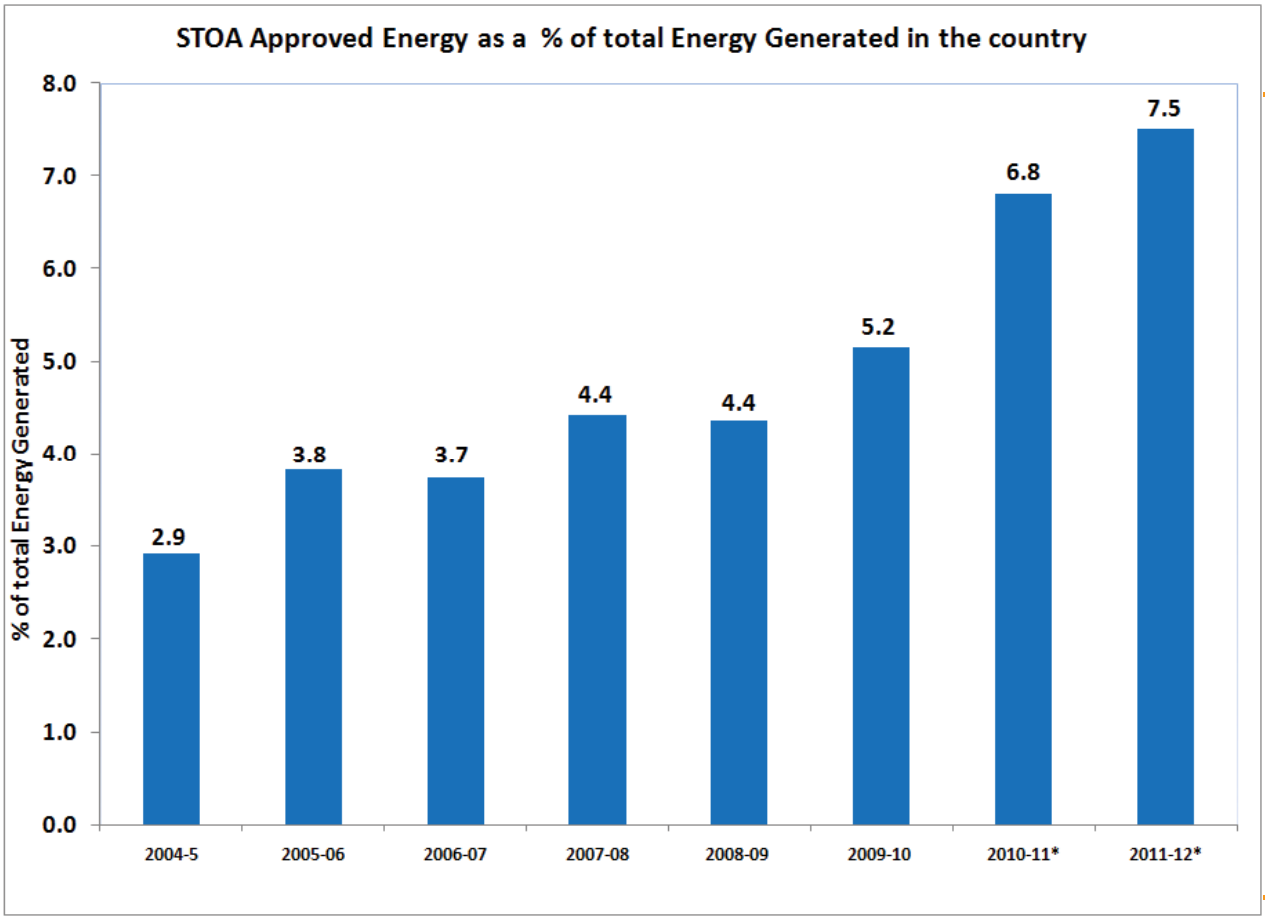
SOUTHERN REGION ENERGY APPROVED(MU)-Bilateral



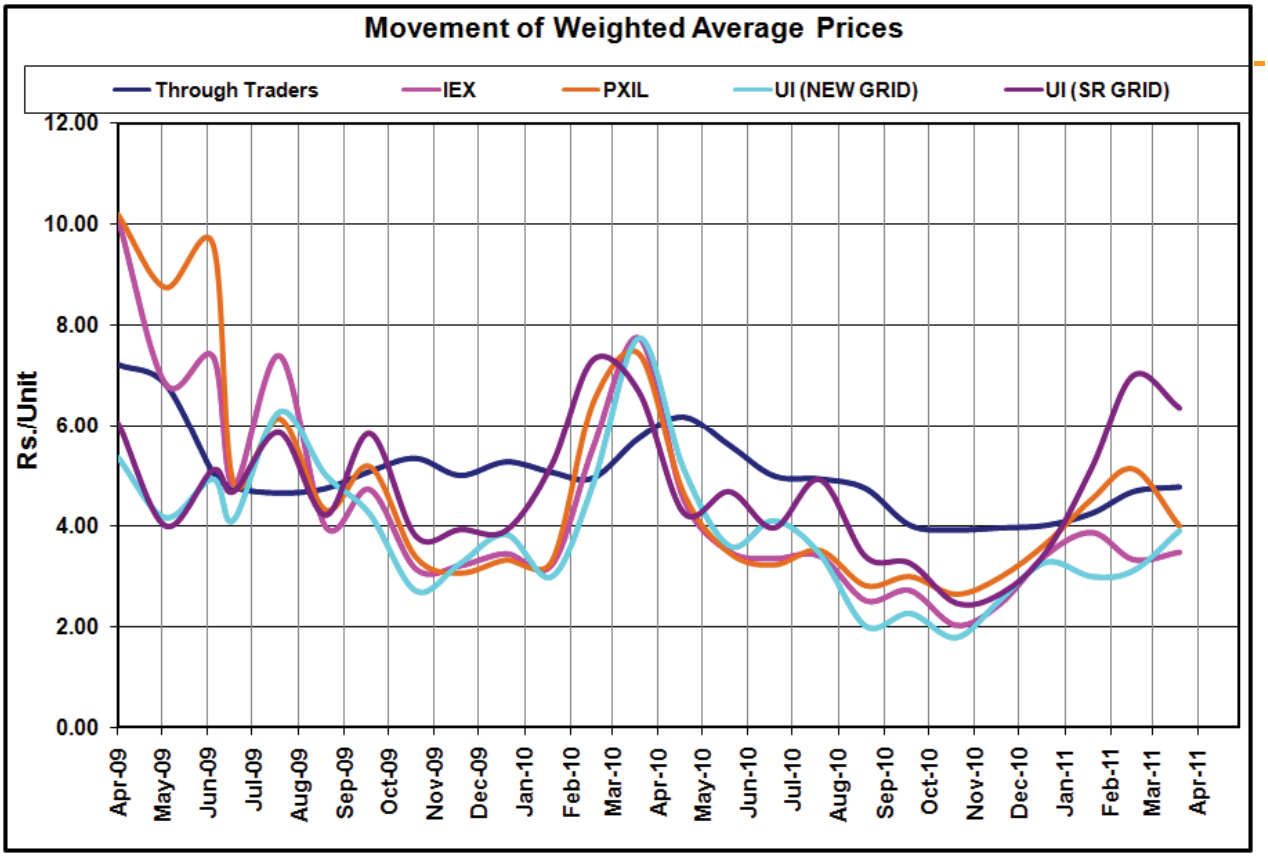


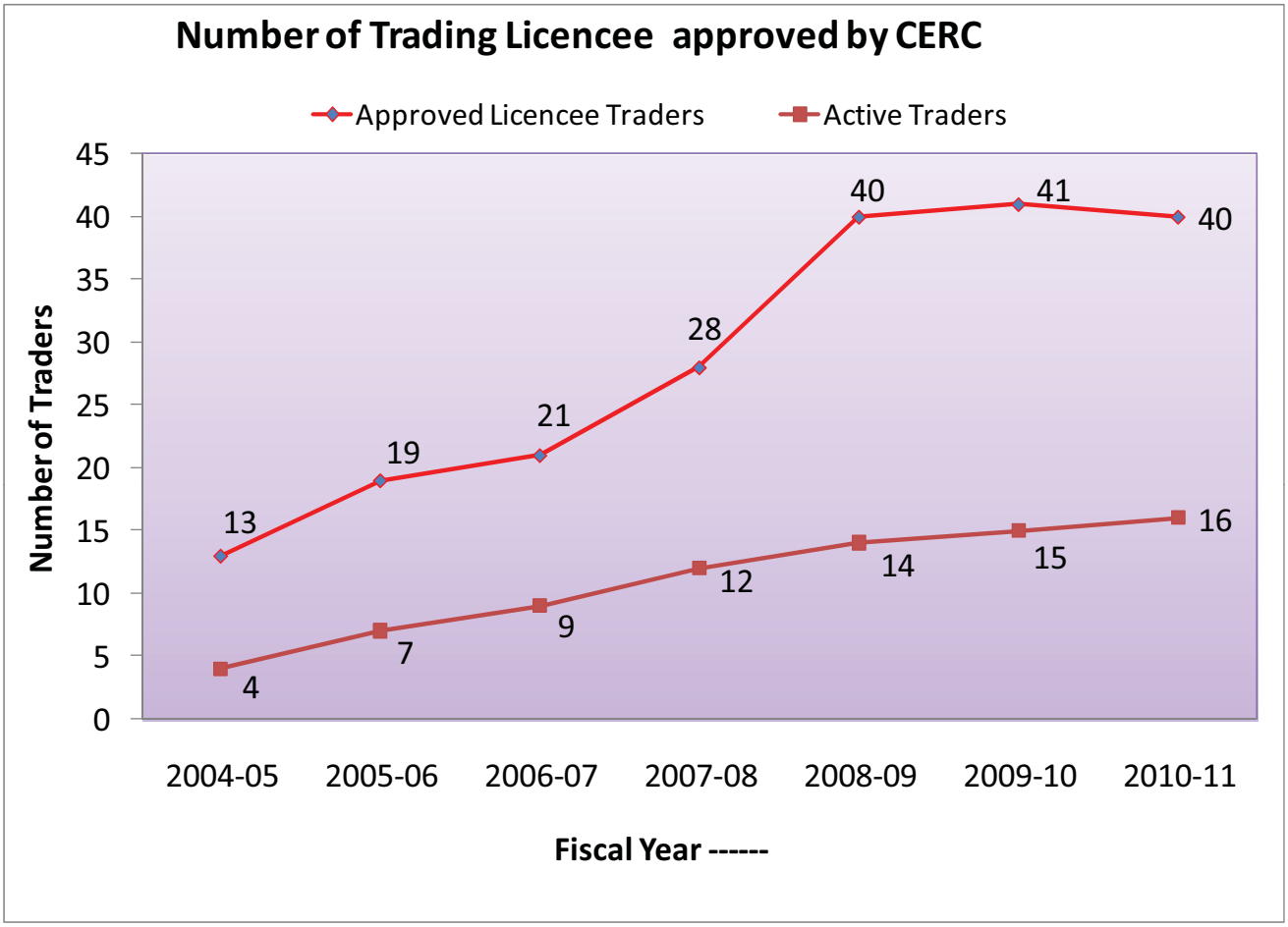

SD / DA
FCFS
Advance
Approved Energy (MUs) →
25000
20000
15000
10000
5000
0
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12


Energy Approved in percentage under Bilateral (Intra & Inter- Regional)
Intra-Regional
Inter-Regional
Approved Energy ------->
80
70
60
50
40
30
20
10
0
73
69
59
55
62
68
51
27
31
41
45
38
32
49
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12*
Year---------->
Energy Approved in percentage under Bilateral (Intra & Inter- Regional)



*Includes Bilateral + Collective transactions



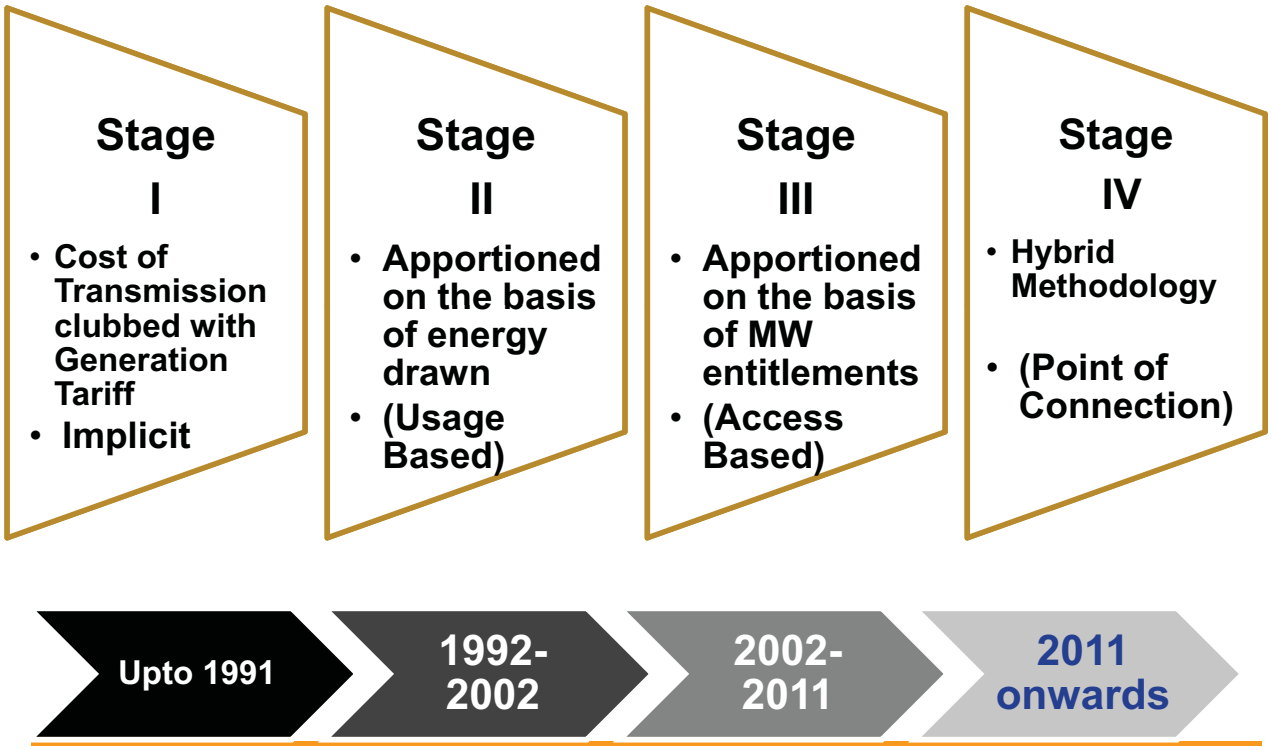


As on 31.03.2011

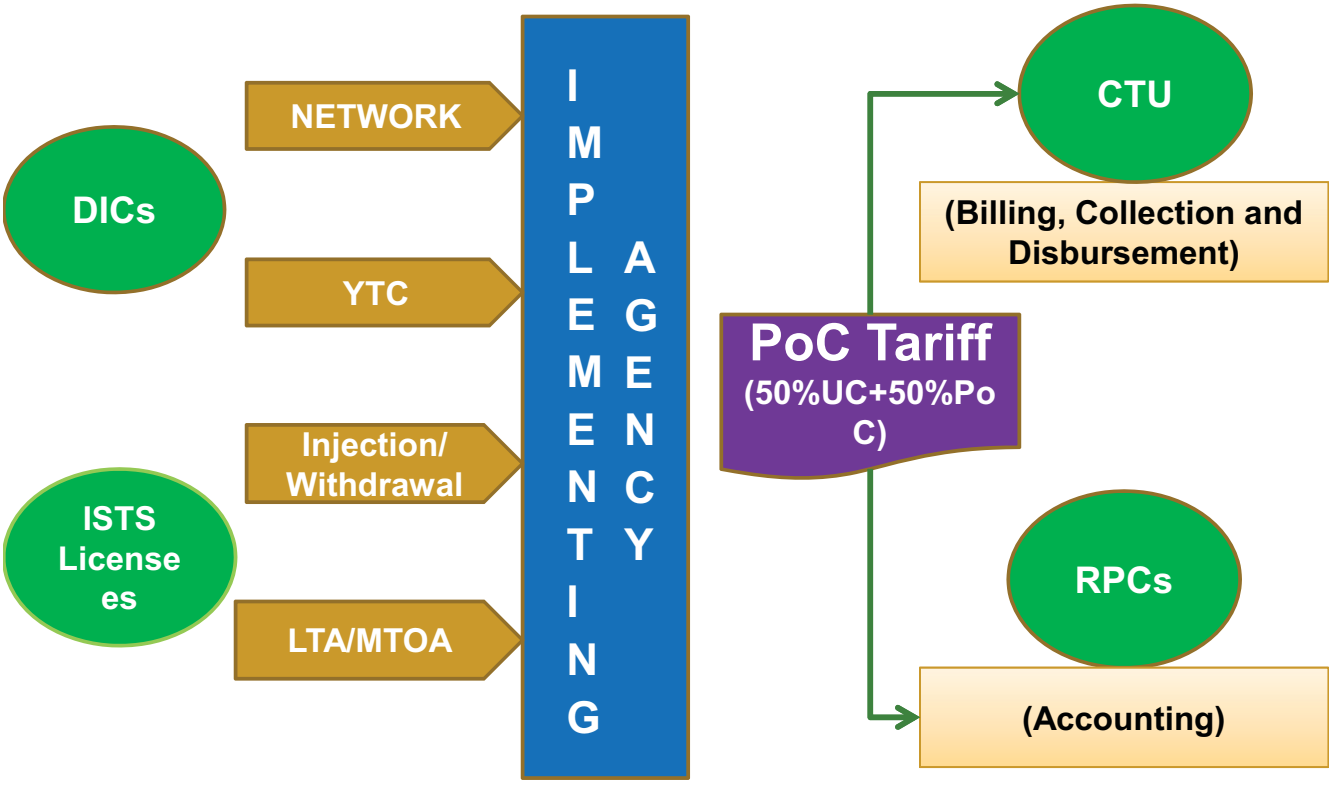
Short-Term Open Access: Key Success Factors

- Control area demarcation & boundary metering
- Robust transmission system
- Assessment of Transfer Capability
- Balancing mechanism
- Methodology for transmission charge sharing
- Treatment of transmission losses
- Streamlined scheduling and settlement mechanism
- Transparency and non-discriminatory implementation
- Compliance
- Dispute redressal mechanism
- Congestion management

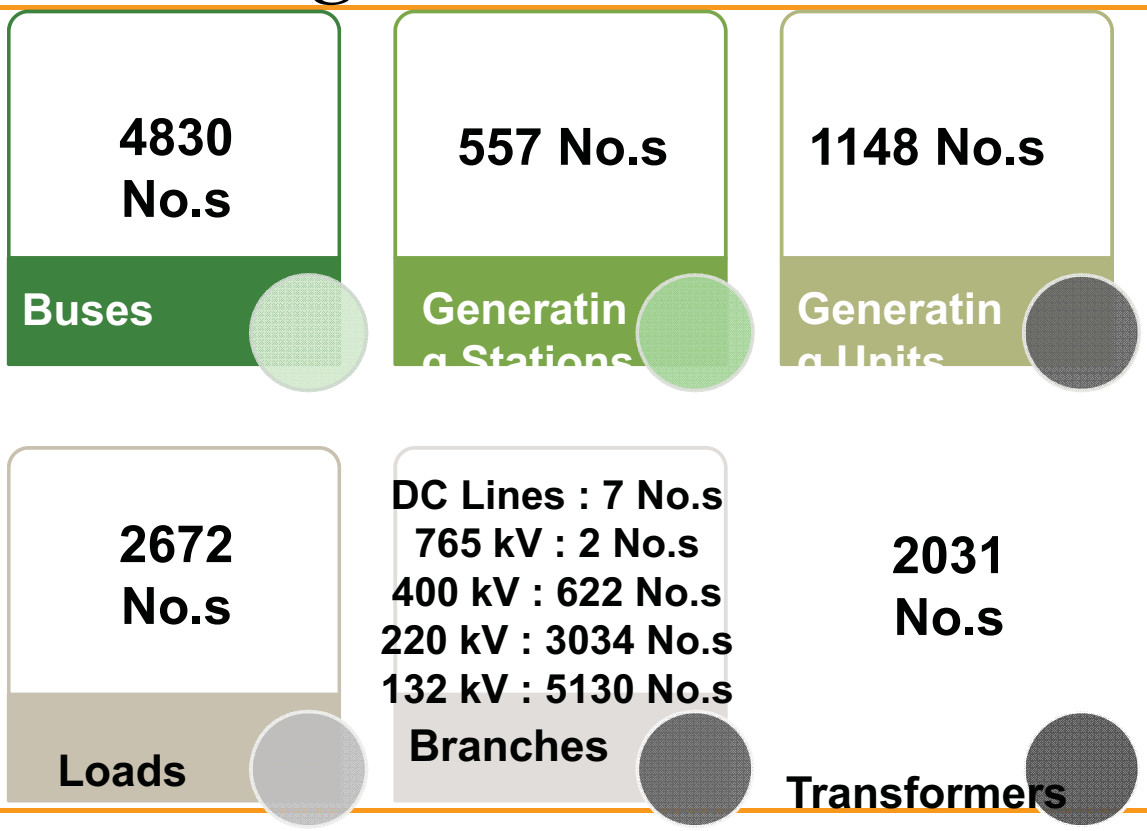
Transmission Pricing Reforms



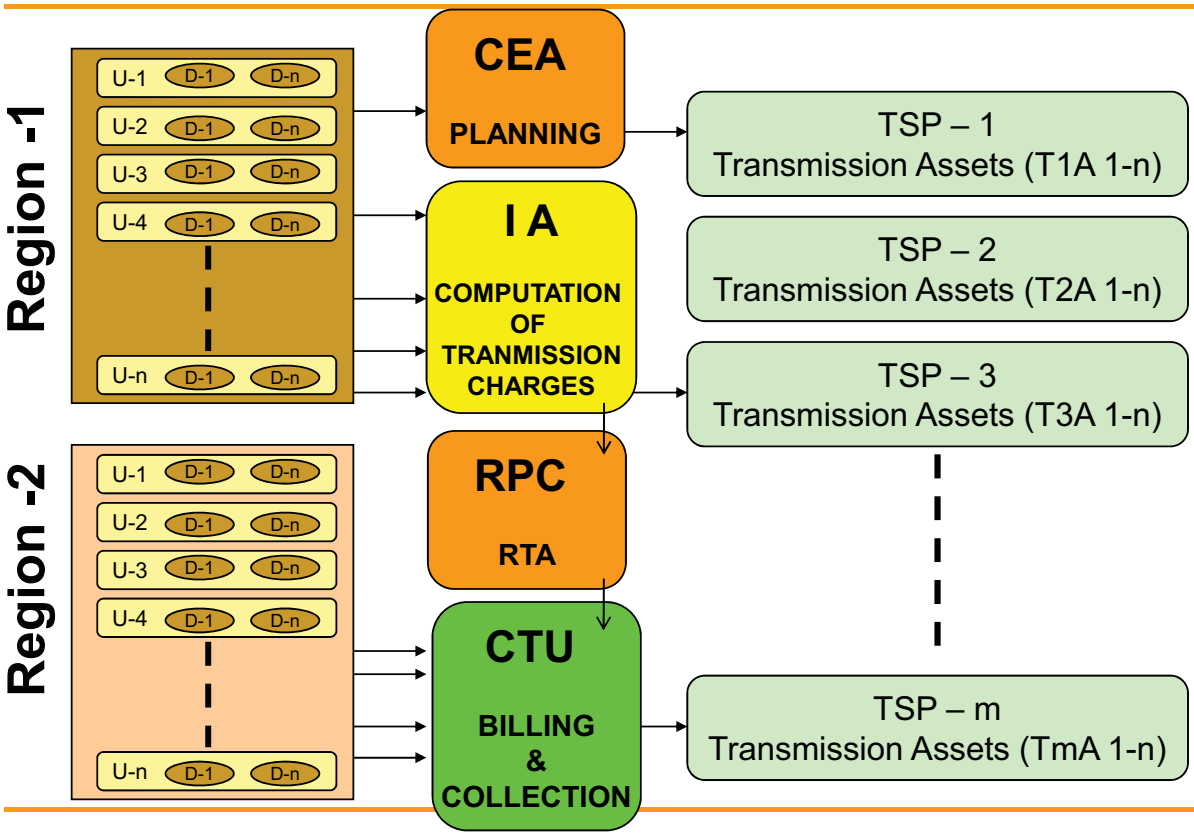
The New Framework



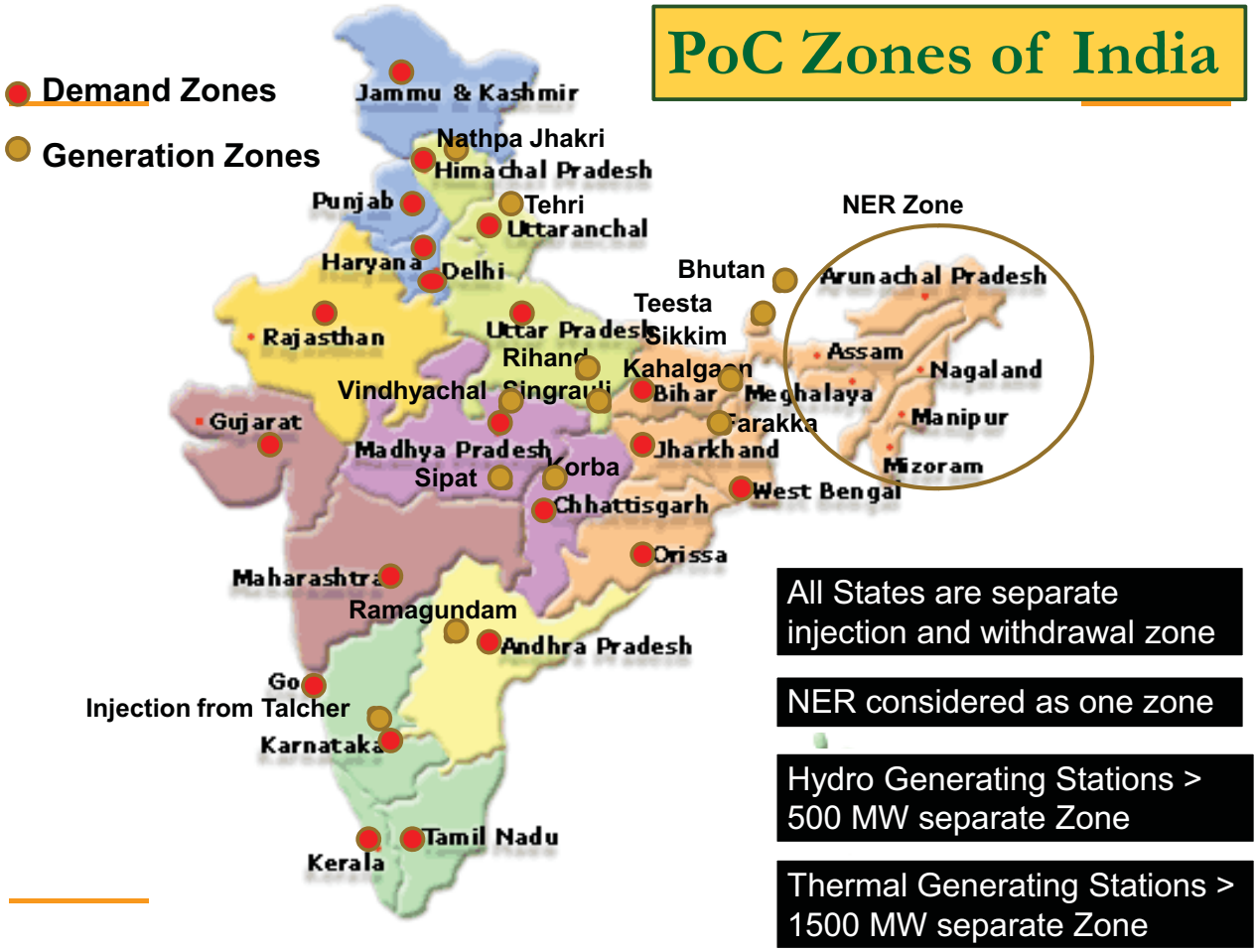
Handling Bulk Data



Model as Implemented

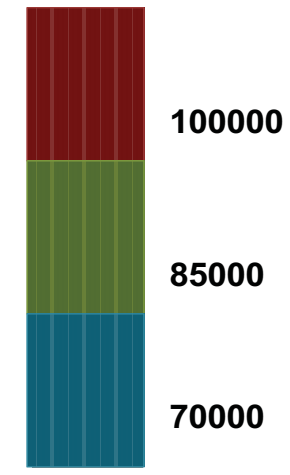


PoC Zones of India

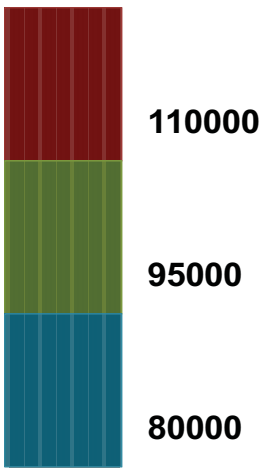


PoC Slab Rates

- Slab for PoC rates approved by CERC

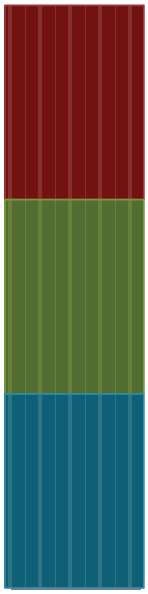


NEW Grid



SR Grid

PoC Losses



Average Loss + 0.3%

Average Loss
(Based on previous week SEM Data)

Average Loss - 0.3%

CIGRE 2010:
Study Committee C5 on Electricity Markets

- **Preferential Subject 1:**
  - Challenges of national or state regulations of transmission and system operators in regional markets, L. A. Dale
  - 8 Papers
- **Preferential Subject 2:**
  - Impact of intermittent Resources or Demand Response on Market Designs; Andrew L. Ott
  - 10 Papers
- **Preferential Subject 3:**
  - Interactions of environmental incentives and markets (e.g. carbon) with electricity markets, Charles F. Zimmermann
  - 4 Papers

Attempt to Harmonize in Europe (C5-102)

- definitions,
- products to be auctioned,
- participation requirements,
- financial guarantees,
- firmness of both allocated capacities and nominated programs,
- definition of force majeure,
- bids format,
- time schedule of the auctions,
- compensation/reimbursement in case of reduction,
- payment modalities,
- secondary market principles (”use it or sell it”),
- responsibility of parties,
- the suspension/termination of contract conditions.

Thank you !!

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