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Formulating Pricing and Loss Allocation Methodology for Inter-State Transmission in India

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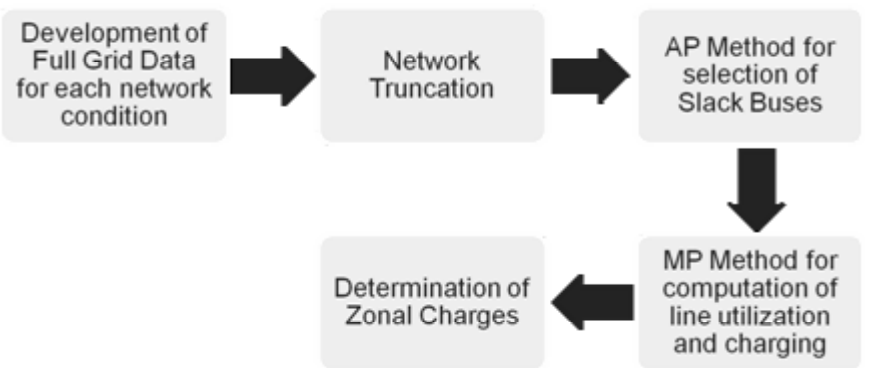
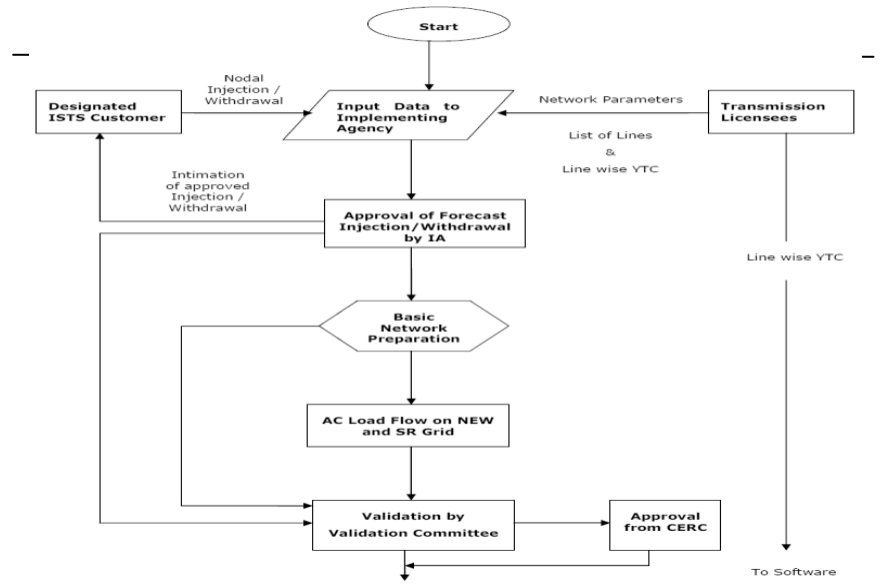
- Methodology in Brief
- Assumptions made in actual implementation
- Results for 2008-09 and 2011-12
- Benefits of the proposed methodology for the principal stakeholders

METHODOLOGY ADOPTED

Hybrid Method



Rationale for each step is explained in the following slides …



Development of the Full Grid for each Network Condition

? The transmission assets are used differently by various transmission customers based on seasons of the year and by time of use

? Utilization by each transmission customer, therefore, must be captured for each season as well as peak and other than peak condition

Network Truncation …(1)

- The mandate was to allocate ARR of the transmission assets owned by ISTS licensees
- Consideration of assets owned only by the ISTS licensees leads to formation of Islands in the network
- Connection of these islands through selected lines for the purposes of load flow convergence has commercial implications for various stakeholders – therefore a need for a consistent policy in this regard. Two options:
  - Consider the entire network
  - Consider the network where most of the assets are owned by ISTS licensees – i.e. consider 765 kV and 400 kV transmission system (except for NER where assets of 132 kV are considered) – because at these voltage levels most of the assets are owned by the ISTS licensees

Network Truncation …(2)

- Per recommendation of CEA, the second option was considered
  - Network was truncated at 400 kV level for the NEW Grid (excluding NER where assets upto 132 kV were considered) and SR Grid
  - **Reason - I**: The ARR of ISTS Licensee – owned assets at 220 kV and below (except NER) is less than Rs. 260 Crores out of the total ARR of Rs. 4959 Crore for 2008-09
  - **Reason – II:** Truncation helps relate local demands with local generation.

Slack Bus Selection – use of the AP method … (1)

- The original MP Method required increase in demand at all the demand nodes in proportion of their base case demand for each 1 MW increase in any generator
- Implications: 1 MW increase in generation at Uri (in J and K) would be counterbalanced by increase in demand in Kerala. Though the line usage at distant locations is still minimal (a reason why this method is also called the "area of influence" method), the rationale was not acceptable and "intuitive" to most stakeholders
- CEA suggested selection of slack buses each generator / demand such that:
  - The generators in deficit regions serve demand in their immediate "vicinity", and
  - The generators in surplus regions serve demand in their vicinity and other deficit regions, and
  - Likewise for the demand nodes

Slack Bus Selection – use of the AP method … (2)

- AP Method selects sink buses for each generator based on the principle of proportionate tracing, e.g. for TAPS (in Maharashtra, which is a net importing state, but this plant also supplies to Gujarat), the slack buses are
  - VAPI, KALWA, KHARGAR (3% weight), LONI, KARAD (0.5% weight), BABLESHWAR, PADGHE, KOLHAPUR, AURANGABAD, MAPUSA (0.2% weight), BOISAR (44.5%), NAGOTHANE
  - These sub-stations can be correlated with the physical network for better appreciation

Slack Bus Selection – use of the AP method … (3)

- Similarly, for Generators such as Singrauli (NTPC), the slack buses for **Summer Peak** are spread far and wide,
  - e.g., FATEHABAD, DEHAR,BHIWANI, HISAR, KISHENPUR, MOGA, PANIPAT, BAWANA, BAMNOLI, MERTA, KANKROLI,HERAPURA, JODHPUR, AGRAUP, UNNAO, BARELI, RISHIKESH, GORAKHPUR, LUCKNOW, MURADABAD, MUZAFARNAGAR, MURADNAGAR, KASHIPUR, ANPARA, OBRA, SARNATH, AZAMGARH, SULTANPUR, MAU, WAGORA, ABDULAPUR, NALAGARH, KAITHAL, MEERUT, AMRITSAR, LUDHIANA, JALANDHAR, BALABGARH, BHIWADI, MALERKOTLA, MAHARANIBAGH, BASSI, BAHADURGARH, MANDOLA, GNOIDA, PATIALA, MANPURI,ALAHABAD
- It may be appreciated that the slack buses for Singrauli in **Monsoon Peak** Condition do not extend to Abdullapur, Nalagarh, Dehar etc. because in this season, Himachal Pradesh is a surplus and exporting state

MP Method for line utilization and charging …(1)

- Why not AP Method for line Utilization and Charging also?
  - AP Method traces power from source to sink. However when power is injected at a node, lines (other than those on the tracing path) also get affected – which are not captured by the AP method
  - The MP method closely mirrors the laws of physics. According to ETSO:
    - *The AP method is based on an arbitrary assumption that contradicts the laws of physics. AP is based on the arbitrary assumption that the power flow arriving at one node must be shared between the local load and the exiting flows in the other lines at that node. Moreover, AP assumes that the sharing is in proportion of local loads and exiting flows. This assumption is not physical: many other solutions are possible and would lead to different responsibilities of generators and loads and to different compensations.* ***In particular, according to physical laws, an increment in the flow in a line entering one node would be distributed among all other lines at that node and not only those with exiting flows.***
  - MP has been implemented in various countries, experience with AP is significantly lesser

MP Method for line utilization and charging …(2)

- AP Method allocates transmission charges to either generators or demand nodes – allocation between generators and demands is decided exogenously and is hence arbitrary and distorts locational signal
- The only significant criticism of the MP method – regarding selection of slack bus – is taken care of by exploiting the strength of the AP method

Creation of Zones

- The nodal allocators have been “zoned” in consultation with CEA for 2008-09. Criteria used:
  - Geographical contiguity
  - State Boundaries for large states (charges for small states have been aggregated or combined with neighbouring states)
  - Electrical contiguity
- For the current network, NEW Grid and SR charges have been computed separately
- Costs and losses apportioned separately
- For the 2011-12 network the results have been derived in conjunction with the CTU

Assumptions made in Actual Implementation

Data used for Basic Network

? The average of annual energy injection of DICs in the last four years (2007-08, 2008-09, 2009-10 and 2010-11 till February 2011) ***has been used for arriving at the average MW injection for the year 2011-12***.
Generating units which are to be commissioned by 30th June 2011 have also been considered

- Networks are constructed/augmented to support LTOA – with adequate security margins – using past averages cause following errors
  - Impact of past Short Term transactions and UI on transmission utilization is also built into these charges
  - For current short term transactions / UI there are separate charges
  - Generation by new generators is imposed the network with past injection by existing generators – will lead to gross deviation in actual utilization / even planned utilization

Data used for Basic Network

? The growth rate of annual energy consumption of DICs in the last four years (2007-08, 2008-09, 2009-10 and 2010-11 till February 2011) was computed to obtain the forecasted energy consumption in 2011-12.

- The forecasts include average Long Term, Medium Term and Short Term and UI withdrawals
- Flows caused by Demand during peak hours differs those during off peak hours
- Himachal Pradesh / Uttarakhand – which are net exporters during Monsoons and importers during winters – average yearly demand fails to capture network utilization

Computation of Transmission Charges

These rates are prior to the application of slab rates

SR Grid Zonal PoC Rate

Zone	Generation PoC (Rs/MW)	Load PoC (Rs/MW)	Generation	Load	LTA (Generation)	LTA (Demand)	Modified Generation PoC (Rs/MW)	Modified Load PoC (Rs/MW)
Andhra Pradesh	37401	23425	4383	5382	350	1744	468368	72304
Tamil Nadu	113886	82215	1385	2625	2204	2349	71565	91883
Kerala	0	95988	0	600		1053		54672
Karnataka	29815	59440	2437	4267	798	1476	91038	171871
Pondicherry	0	19206	0	74		364		3904
Goa-SR	0	31236						31236
Ramagundam	33381	0	2231	0	2537		29353	
Injection from Talcher	20132	0	2000	0	1767		22785	

Computation of PoC Charges - Implications

- For LTOA, Generators in Andhra Pradesh pay what they should have paid for LTOA+UI+STOA combined
- For STOA / UI / deviation, they pay a higher rate per MW
- The LTOA for demand in AP is less - 1744 MW, average withdrawal considered for computation of PoC charges are 5382 MW – therefore the DISCOMs of Andhra are charged for LTOA what they should have paid for LTOA+STOA+UI combined, per MW rates for withdrawal during short term are correspondingly high
- Though slabs have been created – these are based on the modified POC charges computed above
- Consideration distortion is caused for 2011-12, albeit this may be removed from the next year if CERC order on removal of difficulties is amended

Computation of 50% usage for declaration of state lines being used for ISTS

- ISTS is defined as per EA 2003 as

inter-State transmission system" includes -

(i) any system for the conveyance of electricity by means of main transmission line from the territory of one State to another State;

(ii) the conveyance of electricity across the territory of an intervening State as well as conveyance within the State which is incidental to such inter-State transmission of electricity;

(iii) the transmission of electricity within the territory of a State on a system built, owned, operated, maintained or controlled by Central Transmission Utility.

- Why 50%? Incidental flows cannot be 50%???

RESULTS OF 2008-09 and 2011-12

Results of the Hybrid Method for 2008-09 and 2011-12 – Generation Access Charges – NEW Grid

	2011-12		2008-09	
Zones	Rs Lakh / MW / Annum	Ps/kWh	Rs Lakh / MW / Annum	Ps/kWh
Bhutan	10.31	11.77	12.56	14.34
Bihar-KH	9.84	11.23	13.06	14.91
CHTIS-KOR	7.64	8.72	10.15	11.59
CHTIS-OTHER	10.41	11.88	12.97	14.81
Delhi, HR, Raj, UP-W	2.09	2.38	2.98	3.40
GUJ	3.63	4.15	4.25	4.85
HP-CHM	5.06	5.78	10.77	12.30
HP-DH	4.49	5.12	4.89	5.58
HP-NJB	8.51	9.72	13.87	15.83
JandK	4.78	5.46	6.88	7.85

Results of the Hybrid Method for 2008-09 and 2011-12 – Generation Access Charges – NEW Grid

	2011-12		2008-09	
Zones	Rs Lakh / MW / Annum	Ps/kWh	Rs Lakh / MW / Annum	Ps/kWh
Jharkhand	8.66	9.88	15.51	17.70
Maha	2.65	3.02	2.90	3.32
MP	7.70	8.79	9.45	10.79
NER	7.18	8.19	8.25	9.42
Orissa-STR	9.01	10.29		
ORISSA	3.74	4.27	4.85	5.54
Sikkim	15.14	17.28	17.75	20.27
UK	4.78	5.46	5.92	6.76
UP-E&C	6.72	7.67	8.71	9.95
UP-W	1.67	1.91	2.98	3.40
WB-BFP	6.71	7.66	8.72	9.95

Results of the Hybrid Method for 2008-09 and 2011-12 – Generation Access Charges – SR Grid

	2011-12		2008-09	
	Rs Lakh / MW / Annum	Ps / kWh	Rs Lakh / MW / Annum	Ps / kWh
AP - OTHER Total	1.69	1.93	2.80	3.20
AP E&C Total	3.43	3.91	7.93	9.05
KAR - OTHER Total	3.76	4.29	4.40	5.03
KAR-KTB Total	3.76	4.29	7.27	8.30
TN-N Total	1.43	1.64	3.79	4.32
TN-S Total	4.54	5.19	10.84	12.38
Kerala	2.99	3.41	7.32	8.35

Results of the Hybrid Method for 2008-09 and 2011-12 – Demand Access Charges – NEW Grid

	2011-12		2008-09	
Zone	Rs Lakh / MW / Annum	Ps / kWh	Rs Lakh / MW	Ps/kWh
Bihar	6.63	7.57	8.84	10.09
Chattisgarh	3.50	4.00	4.39	5.01
Delhi	5.87	6.70	10.20	11.65
Goa	10.50	11.98	8.37	9.56
Gujarat	5.60	6.39	6.98	7.97
Haryana	5.75	6.56	11.80	13.47
Himachal Pradesh	4.41	5.03	8.13	9.28
JandK	5.46	6.23	13.75	15.70
Jharkhand	4.23	4.83	7.69	8.77

Results of the Hybrid Method for 2008-09 and 2011-12 – Demand Access Charges – NEW Grid

	2011-12		2008-09	
Zone	Rs Lakh / MW / Annum	Ps / kWh	Rs Lakh / MW	Ps/kWh
Maharashtra	4.87	5.56	6.75	7.71
Madhya Pradesh	8.47	9.67	11.55	13.19
NER	14.36	16.39	12.85	14.67
Orissa	5.16	5.89	3.78	4.32
Punjab	11.06	12.62	16.81	19.19
Rajasthan	9.98	11.39	9.65	11.02
Uttarakhand	5.98	6.83	7.39	8.43
Uttar Pradesh	5.63	6.42	7.43	8.49
West Bengal	2.19	2.51	3.24	3.69

Results of the Hybrid Method for 2008-09 and 2011-12 – Demand Access Charges – SR Grid

	2011-12		2008-09	
	Rs Lakh / MW / Annum	Ps / kWh	Rs Lakh / MW / Annum	Ps / kWh
Andhra Pradesh	4.81	5.49	8.54	9.75
Karnataka	5.67	6.47	8.23	9.4
Kerala	7.89	9.00	15.78	18.02
Tamil Nadu	4.33	4.94	13.15	15.01

ZONAL LOSSES – Generation – NEW Grid – 2008-09

Zones	Scaled up Loss as % of Energy
Bhutan	2.27%
Bihar	3.71%
CHTIS - KORBA	3.76%
CHTIS - Other	3.73%
GUJARAT and Rajasthan South	0.42%
HP-Chamera Area	0.91%
HP-Dehar Area	0.37%
HP-Natpha Jhakri Area	1.37%
J&K	0.55%
Jharkhand	3.87%
Maharashtra	0.84%
MP	3.43%
NER	2.84%
Orissa	0.52%
Sikkim	3.10%
UK	0.37%
UP-E&C	3.47%
UP-W, Haryana, Punjab, Rajasthan-North & Delhi	0.39%
WB	1.20%

ZONAL LOSSES – Generation – SR Grid – 2008-09

Zones	Scaled up Loss as a % of Energy
AP E&C	1.49%
AP - OTHER	0.79%
KAR-KTB	1.47%
KAR - OTHER	1.03%
TN - N	0.74%
TN -S	0.69%
Kerala	0.72%

ZONAL LOSSES - Demand – NEW Grid – 2008-09

States	Loss as a % of energy
Bhutan	0.28%
Bihar	1.68%
Chattisgarh	1.56%
Delhi	4.11%
Goa	1.03%
Guj	1.60%
Haryana	3.71%
HP	1.16%
JandK	2.62%
Jharkhand	1.34%
Maha	2.00%
MP	3.53%
NER	2.72%
Orissa	0.63%
Punjab	4.15%
Rajasthan	3.12%
UK	5.47%
UP	3.19%
West Bengal and Sikkim	0.46%

ZONAL LOSSES – Demand – SR Grid – 2008-09`

Zones	Loss as a % of Energy
Andhra Pradesh	2.04%
Karnataka	1.33%
Kerala	6.81%
Tamil Nadu	5.30%

Generation Access Charges – NEW Grid – Some Specific Observations

- Transmission System associated with Naptha Jhakri gets utilized better because of New Generation at Karcham Wangto – results in lower charges per MW in that Zone
- Transmission Charges in J and K decline because of better utilization of the ATS of Uri, where Uri-II is added
- More than 2000 MW is added in Jharkhand at Maithan and Kodarma – which results is lower transmission charges
- A new zone for Sterlite power plant had to be created in 2011-12 because this plant is expected to supply outside through the ATS being constructed for it. The charge is therefore higher at this node as compared to the other nodes in Orissa.
- Generation access charges in Sikkim decline because of capacity additions expected on the Tista
- Transmission access charges in UP-W decline because of further capacity addition at Dadri (Ext. U 5,6)

Demand Access Charges - NEW Grid – Some Specific Observations

? Most of the states where demand access charges are declining – e.g., Delhi (because of Bawana (1500 MW)), Haryana and Punjab (Jhajjar (1500 MW), Hisar TPS(1200 MW)), Himachal Pradesh (Karcham Wangto, Parbati, Budhil, Allain Duhangan, Malana II) are states with more generation expected

Generation Access Charges – SR Grid – Some Specific Observations

? AP E&C: New generation at Gautami, Konaseema, Kothagudem, Kondapalli have been added over and above 2008-09 scenario. This brings in extra generation (summer peak: 6295 MW in 2011-12 against 2383.6 MW in summer peak of 2008-09). Since these stations are close to existing pooling points, corresponding transmission capacity addition is less and the existing gets utilized well. This causes a decrease in the charge.

? Tamil Nadu - North: In 2011-12 new power plants at Vallur, North Chennai, and Mettur have been added. Generation increases from 1182.86 MW in summer peak in 2008-09 to 4270 MW in 2011-12. These power plants are close to load centres, the corresponding transmission investment is less and the per unit transmission charges decline.

? Tamil Nadu - South: New generators are added at Kudankulam. This leads to increase in generation to 2090 MW in summer peak in 2011-12 from 473 MW 2008-09.

Demand Access Charges – SR Grid – Some Specifc Observations

? Kerala: Three more demand nodes are connected by 400 kV lines in 2011-12: Kozhikode, Cochin and Chulliar. The total demand at the 400 kV nodes increases to 1588 MW in 2011-12 from 805 MW in 2008-09. Further, the existing node at Trivandrum is being fed from Tirunelveli (in TN), which is being fed by new generation at Kudankulam. Thus there is new generation close to demand nodes here also

? Tamil Nadu: The decline in rates is due to increase in generation - as indicated above in Tamil Nadu- North and Tamil Nadu – South.

Transition to the POC Charge Methodology

? Charges
- 50% of the ATC of the ISTS Licensees will be recovered based on the POC charges and the balance 50% will be recovered based on the Uniform Charges (separate postage stamp rates for NEW and SR Grid)
- For medium term / short term transactions the POC charges will be applicable in full

? Losses
- Total losses in the NEW grid and SR grid will be computed as per the existing methodology
- 50% of the losses will be allocated to beneficiary states based on the POC loss allocators computed using the Hybrid Method and the balance 50% losses will be allocated uniformly according to the existing methodology
- For the medium term / short term transactions the POC loss allocators will be applied

BENEFITS OF THE PROPOSED METHODOLOGY

Benefits of the proposed POC methodology

? The charges are therefore indicated to provide a signal:

- If demand charges are high in a zone – it would be advantageous to add generation there (after considering the trade-off between cost of fuel transportation and transmission of electricity)
- If the generation charges are high in a particular region and there is adequate transmission capability, adding generation there will reduce transmission charges
- If the generation charges are high in a particular region and transmission system is operating close to capability, adding generation there may increase transmission charges
- Demand access charges in the vicinity of a generation hub are low (provided the demand nodes are connected directly with the generation hubs)
- A commercial contract which is against the direction of physical flow of power will invite lower transmission charges – e.g. commercial contract between a plant in UP-West / Delhi and Maharashtra – such a contract will be against the direction of flow

Benefits of the proposed POC methodology …(2)

- At present the transmission investments are faced with the uncertainty in generation and also the cumbersome process of getting the BPTAs signed by all the expected beneficiaries of the transmission system
- Under the proposed mechanism all the Designated ISTS Customers (DICs) are default signatories to the Connection and Use of System Agreement (CUSA), which also requires these DICs to pay the point of connection charge
- This commercial arrangement is also expected to facilitate financial closure of transmission investments
- *Efficient network development will lead to the greater network efficiencies and hence lesser costs on the aggregate for the users*

Benefits of the proposed POC methodology …(3)

- Facilitates integration of electricity markets, enhances open access and competition by obviating the need for pancaking of transmission charges
- The need for arbitrary distinction and determination of charges for Long term, Medium term and Short Term open access is obviated by the new transmission pricing mechanism.
- The National Electricity Policy requires the transmission charges to reflect network utilization. The Point of Connection tariffs are based on load flow analysis and capture utilization of each network element by all the customers.
- The distinction between generation and demand customers provides siting signals to generators. The current decision of generators is based on just the fuel transportation costs.

Benefits of the proposed POC methodology …(4)

? The proposed framework will greatly facilitate fair and transparent competition for case-1 bids. Under the current methodology, the case-1 bid processes are severely distorted because of pancaking, and this results in pit head / hydro plants not being competitive for inter-regional bids. The impact of pancaking is further amplified in such bid processes because of application of escalation factors to transmission charges over a 25 year period. The proposed methodology will remove such difficulty

A few practical transactions (2008-09 costs)

From State	To State	Proposed Method	Existing Method
Chattisgarh	Punjab	34	39
Madhya Pradesh	Punjab	30	39
Gujarat	Haryana	18	39
Jharkhand	Haryana	31	41
Orissa	Haryana	19	41
Tripura	Kerala	28	70

Inter-Regional Transactions are expected to be cheaper, and the charges shown above further decline in 2011-12. Intra-Regional transactions in certain cases would become costlier under the new mechanism. Increasingly, however, now more states are opting for Inter-regional purchases (eg. UMPP)

Application of Loss Allocation Factors

- LAF are computed for each node as – Loss as a percentage of Total System Losses in Base Case
- This is converted to Loss as a percentage of injection / withdrawal at each bus (% POC Loss)
- Actual losses are then computed for each region (L)
- Moderated PoC Loss % = (% PoC loss on Injection / Drawal) (A_{act} /A_s)
  - Where A_{act} = Actual Regional Lossses in %
  - And A_s = Regional Percentage Loss as per study
- Applicable on a weekly basis
- Demand schedules will be adjusted for LT customers
- Both the Supply and Demand Schedules are adjusted in the case of ST transactions – bilateral and collective transactions