5th Annual Conference on

Power Transmission in India

Requirements, Plans, Technologies and Regulation

April 30 – May 1, 2012

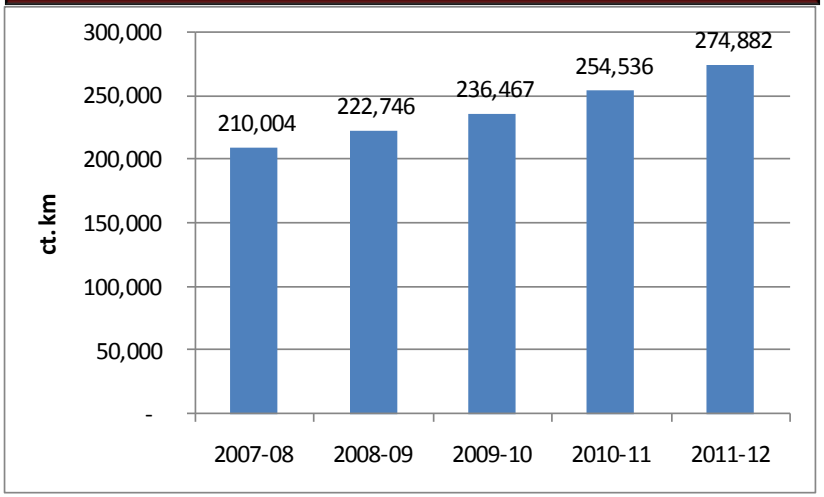
Key Trends and Outlook

Agenda

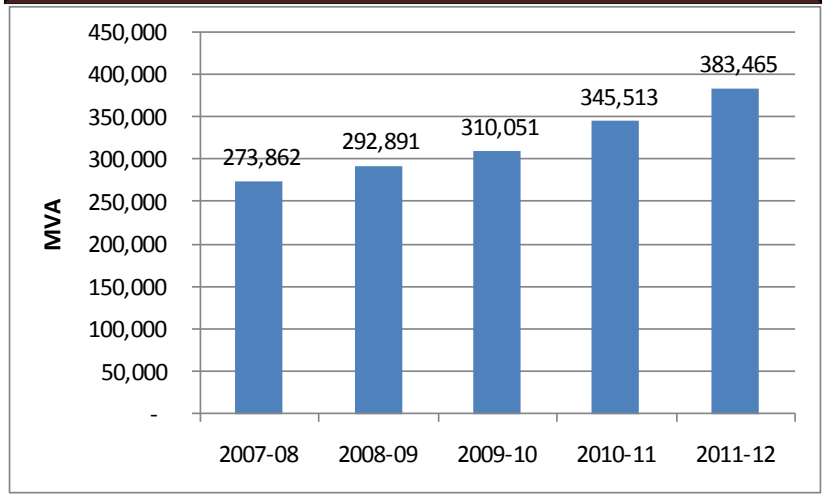
- State of the Sector
- Plans and Achievements
- Market Structure
- Regulations
- Technology Trends
- Issues and Challenges
- Conclusion

Sector Size and Growth

Growth in Line Length



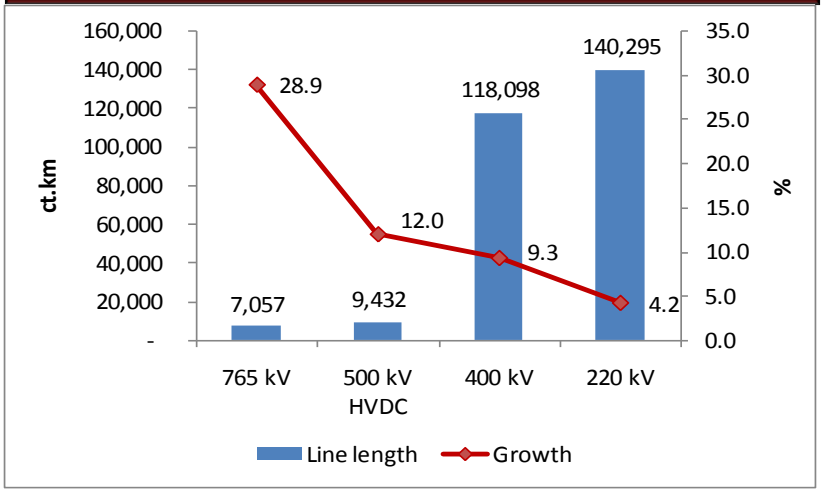
Growth in Substation Capacity



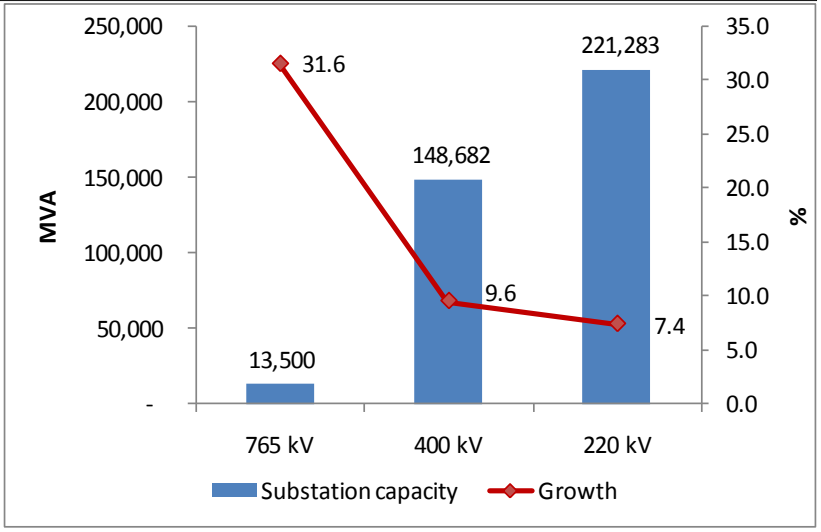
- The transmission line length has been growing at a CAGR of 7% between 2007-08 and 2011-12
  - Growth driven by 400 kV lines
  - 765 kV line length has doubled between 2009-10 and 2011-12
  - While interstate transmission lines have grown at a CAGR of 11%, intrastate has grown at 5% only
- Substation capacity grew at a CAGR of 9% between 2007-08 and 2011-12
  - Interstate transformer capacity grew at a CAGR of 14% while intrastate at a much lower 7%

Voltage-wise Break-up of Transmission Network

Line Length



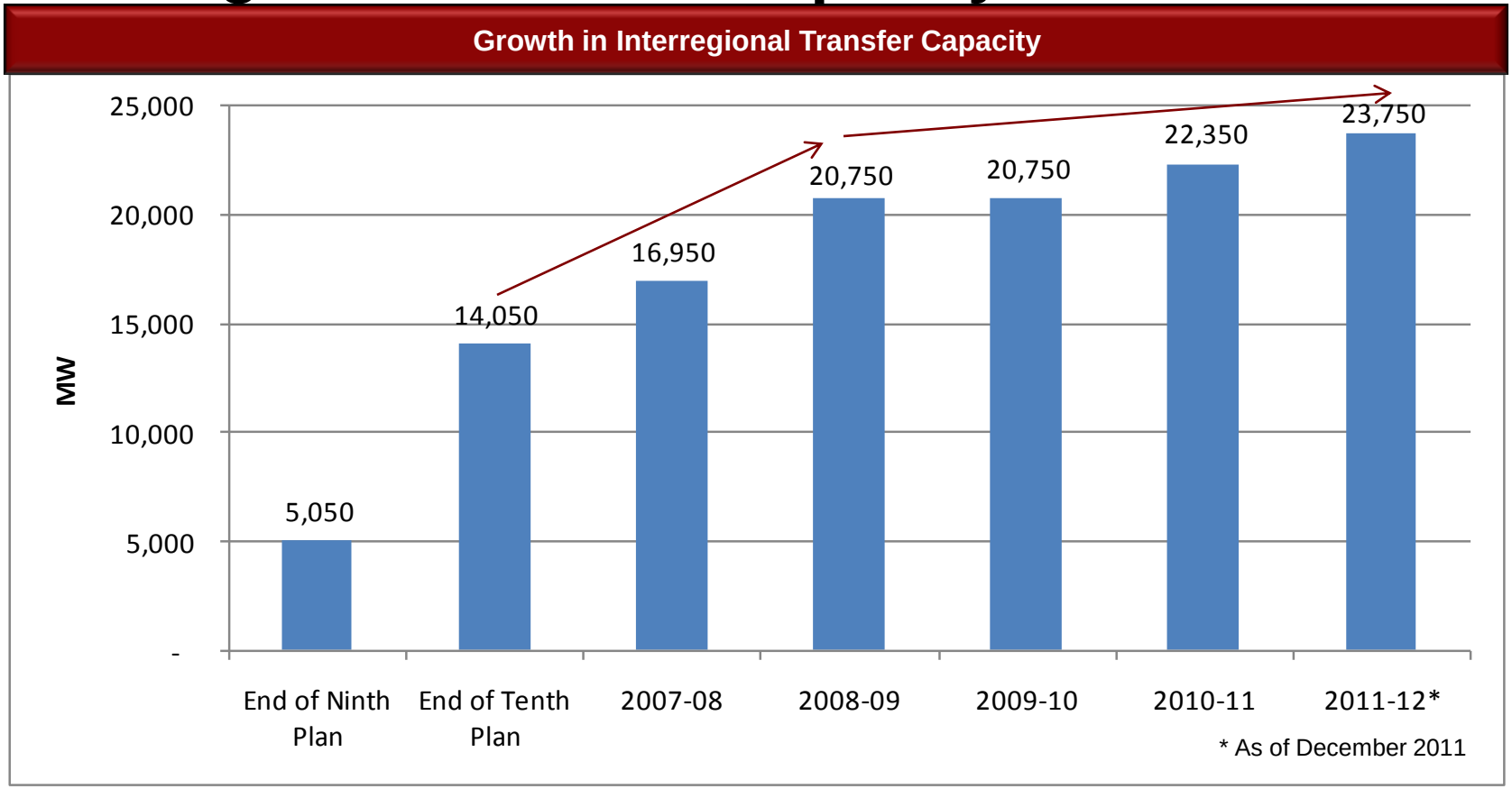
Substation Capacity



- The transmission network is dominated by 220 kV lines, followed by 400 kV
- However, the trend has been a movement towards higher voltage levels
  - 765 kV lines have grown at a CAGR of 29% between 2007-08 and 2011-12
  - Powergrid is setting up the first 800 kV HVDC line (Biswanath-Chariyali-Agra Bipole)
  - 400 kV level has witnessed a higher growth than 220 kV level
- Similar trends are visible for the substation capacity as well

– Aurangabad-Wardha 400 kV Quad D/C line has been designed such that it can be converted to 1,200 kV S/C line

Interregional Transfer Capacity



- The inter-regional transmission capacity stood at 23,750 MW as of December 2011
  - Growth has been slow over the past 3-4 years
- Considering a capacity addition of 76,000 MW in the 12th Plan, interregional links of about 38,000 MW capacity are planned to be added during this Plan period

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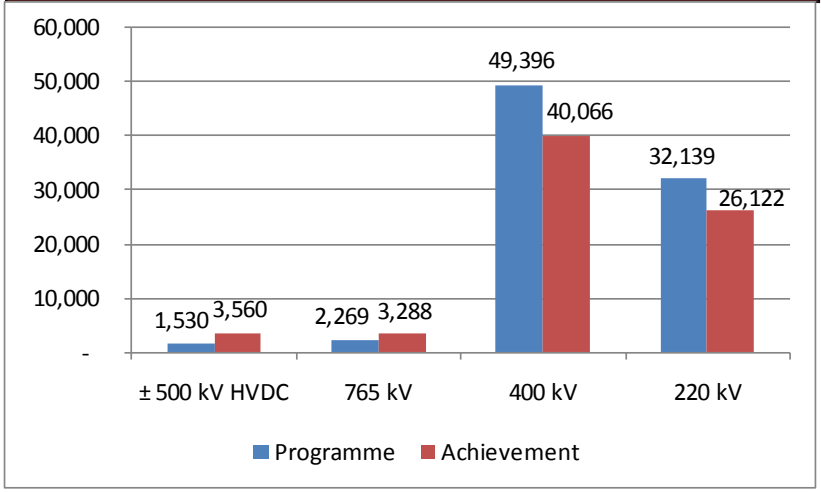
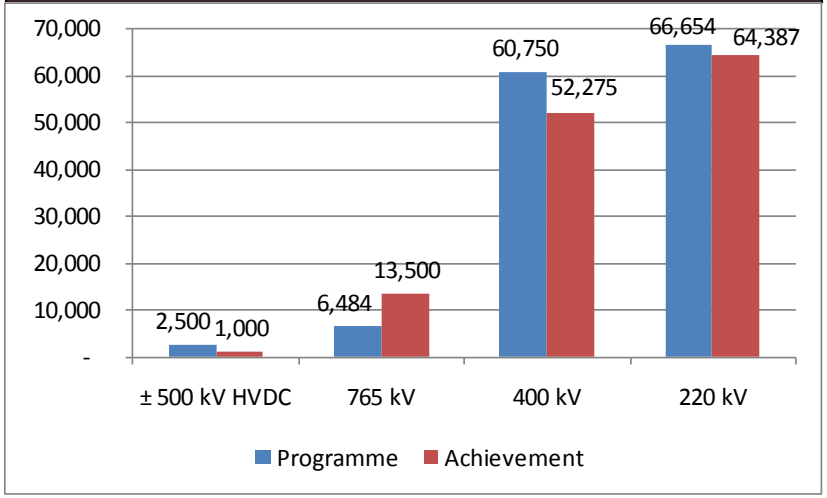
Eleventh Plan Targets and Achievements

Transmission Line Length (ct. km)

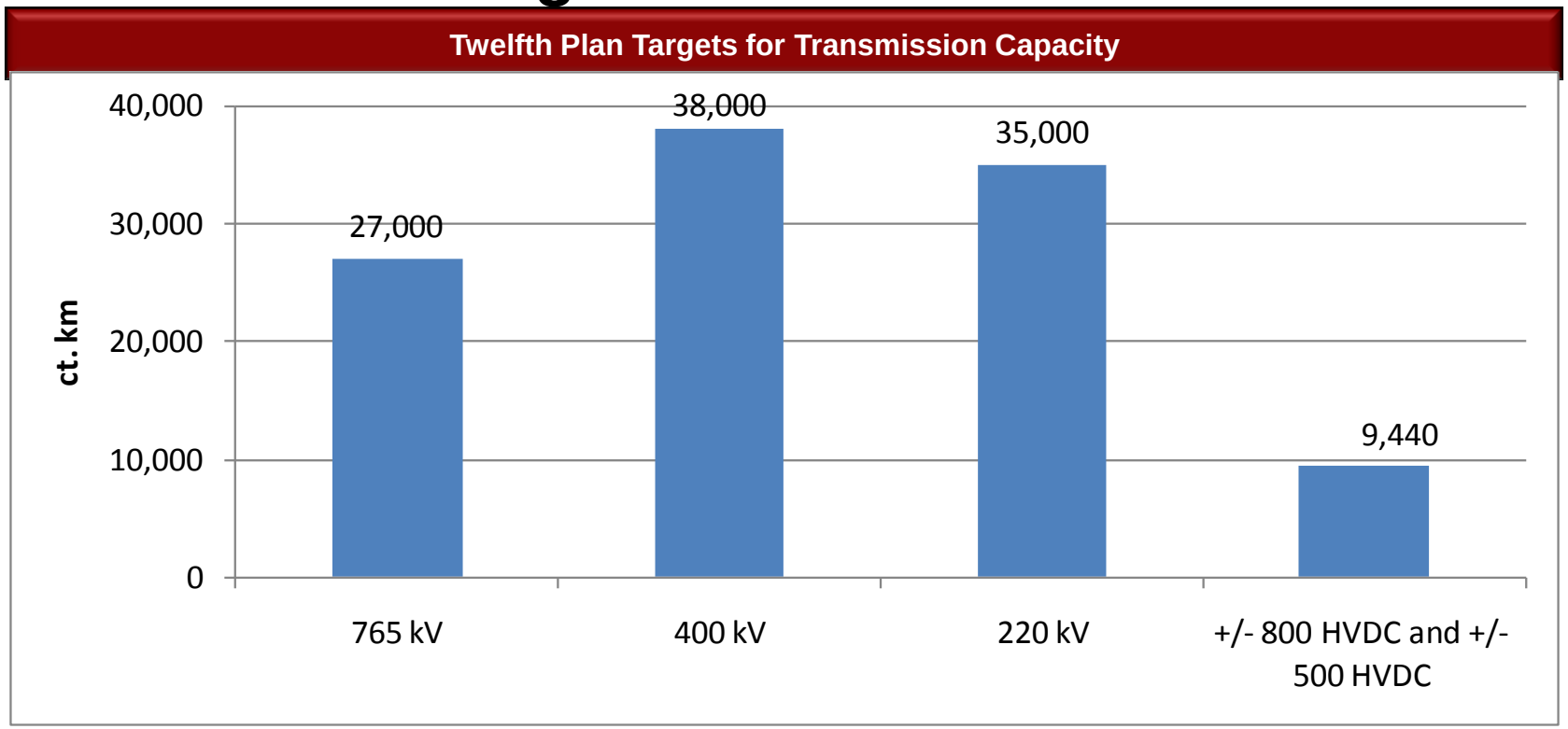


Substation Capacity (MVA)



- The total programme for the Eleventh Plan was around 84,000 ct. km line length and 134,000 MVA substation capacity
- More than 69,000 ct. km line length has been added implying 82% achievement
- Around 130,000 MVA substation capacity has been added implying 97% achievement
- Private sector (through JVs) has contributed 3,700 ct. km and 2,197 MVA
- 765 kV and ± 500 kV HVDC levels have seen good growth during the Plan period

Twelfth Plan Targets



- Investment required for 12th Plan estimated at Rs 1,800 billion – Rs 1,000 billion by central sector, Rs 550 billion by state sector and Rs 250 billion by private sector
- Total substation capacity addition during 12th Plan expected to be 270,000 MVA taking total capacity at end of 12th Plan to more than 640,000 MVA
- HVDC capacity of 13,000 MW expected to be added during the 12th Plan period
- Around 38,000 MW of inter-regional capacity is expected to be added during the 12th Plan
- Huge growth in 765 kV transmission lines and substations planned for evacuation of bulk power

Planned Transmission Corridors

Cluster	Number of IPPs	Installed capacity (MW)	LTOA granted (MW)	Corridor cost (Rs million)
Orissa	7	10,090	6,080	87,520
Jharkhand	5	4,540	4,084	57,090
Sikkim	9	2,358	2,358	13,040
Bilaspur and Madhya Pradesh	6	4,370	4,160	12,430
Chhattisgarh	13	15,485	15,185	288,240
Krishnapatnam	4	4,600	3,072	20,650
Tuticorin	2	2.600	2,045	23,570
Srikakulam	2	3,960	3,760	29,860
Cuddalore/Nagapattinam	3	3,570	2,987	NA
Vemagiri	4	5,400	5,150	NA
IPPs in Southern Region	-	11,526	9,227	48,210
Total	55	56,973	48,881	580,610

- Powergrid is constructing 11 high capacity transmission corridors, at an estimated cost of Rs 580 billion to facilitate power transfer from various upcoming IPP generation projects
- Planned transmission lines: 23,000 ct. km – more than 70% will be 765 kV lines
- Planned substations - 29 nos. of more than 60,000 MVA capacity
- Four HVDC terminals of 7,000 MW capacity also planned

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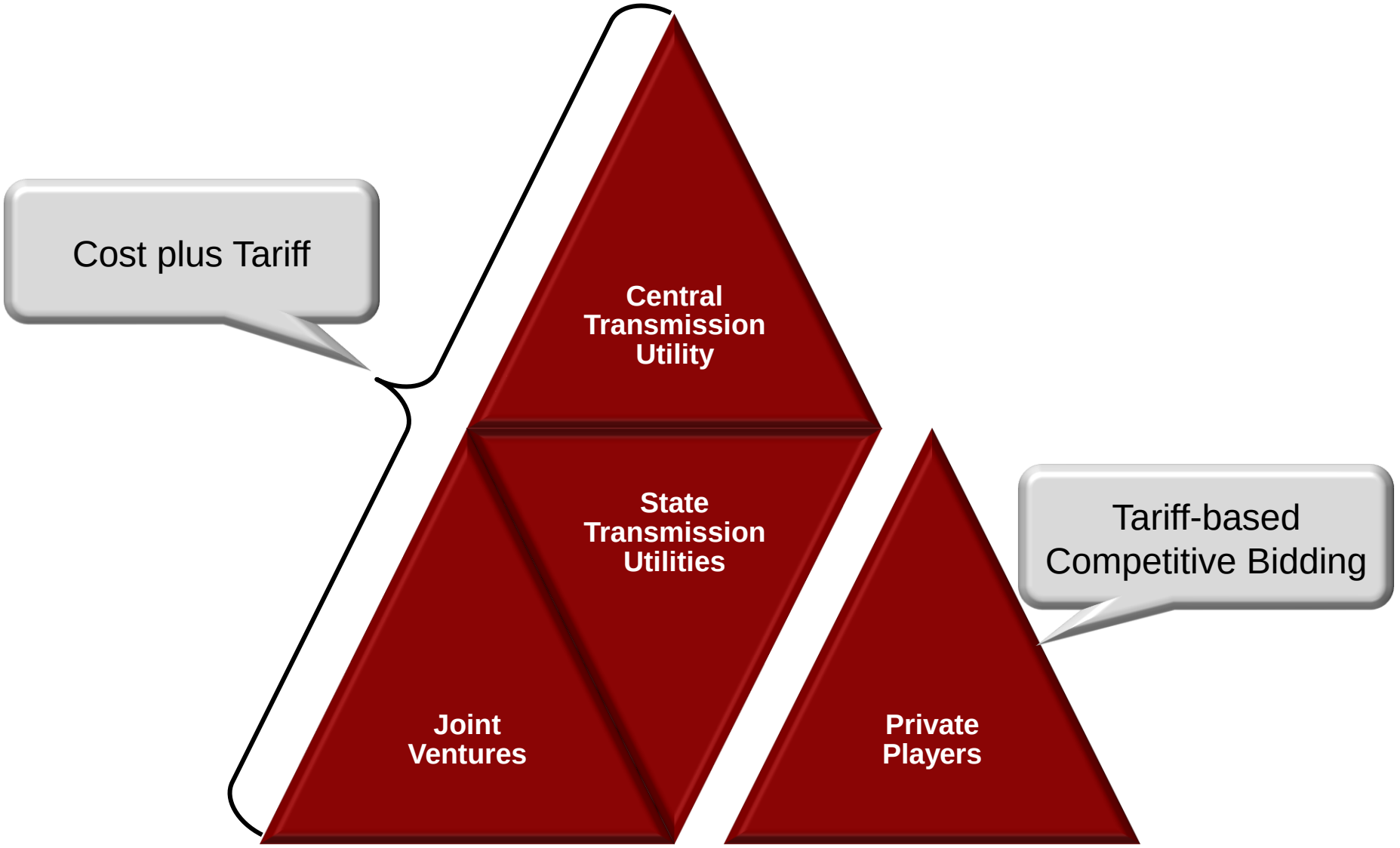
Market Structure



Private Sector Participation

Interstate Transmission Projects

- Seven Independent Power Transmission Companies
  - RPTL: 3 projects
  - STL: 3 projects
  - Patel Engineering- BS TransComm and Simplex Infrastructure Consortium: 1 project
- Five projects in pipeline

- Six Joint Ventures with Powergrid
  - Tata Power, Reliance, Torrent, Jaiprakash Hydro, Teesta Urja, and ONGC Tripura Power Company

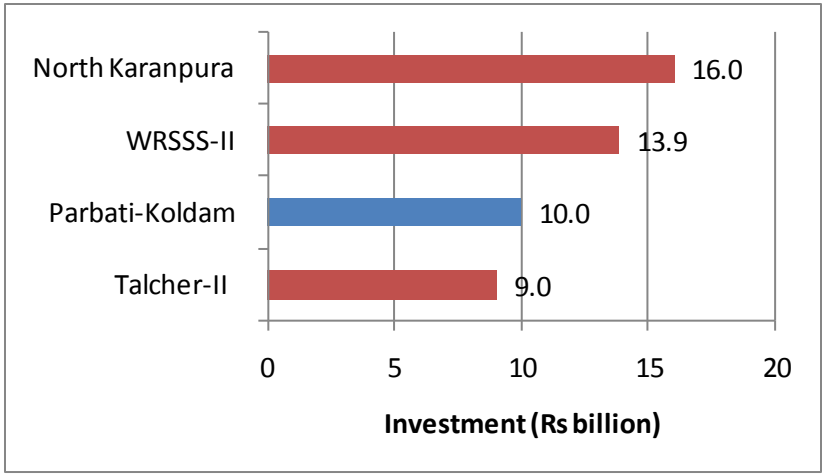
Intra-state Transmission Projects

- 3 Joint Ventures with State Transmission Company (Mahatransco)
  - JSW Energy
  - Adani Power
  - Indiabulls

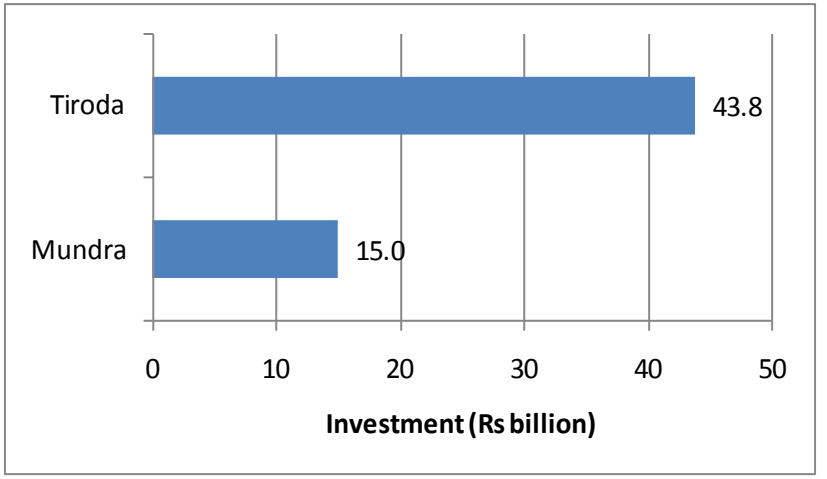
- Eight projects awarded through bidding route
  - Haryana: 1 project
  - Rajasthan: 5 projects
  - Uttar Pradesh: 2 projects

Private Sector Participation

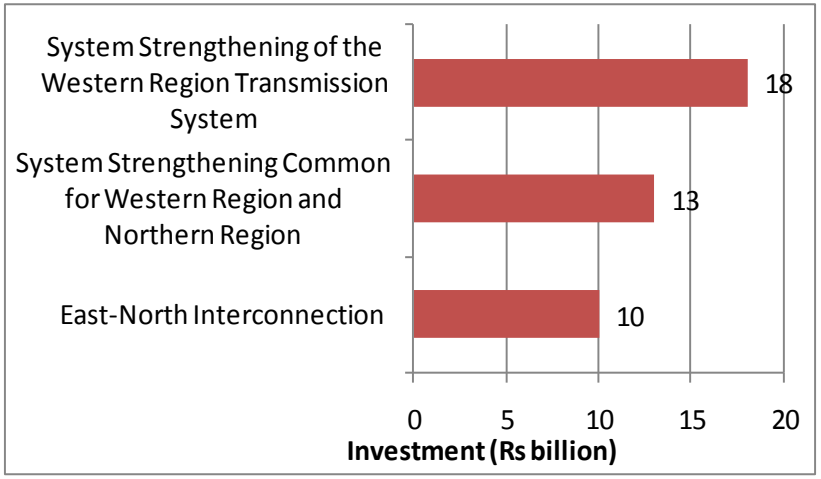
RPTL's Transmission Projects



Adani Power's Transmission Projects



Sterlite Technologies' Transmission Projects

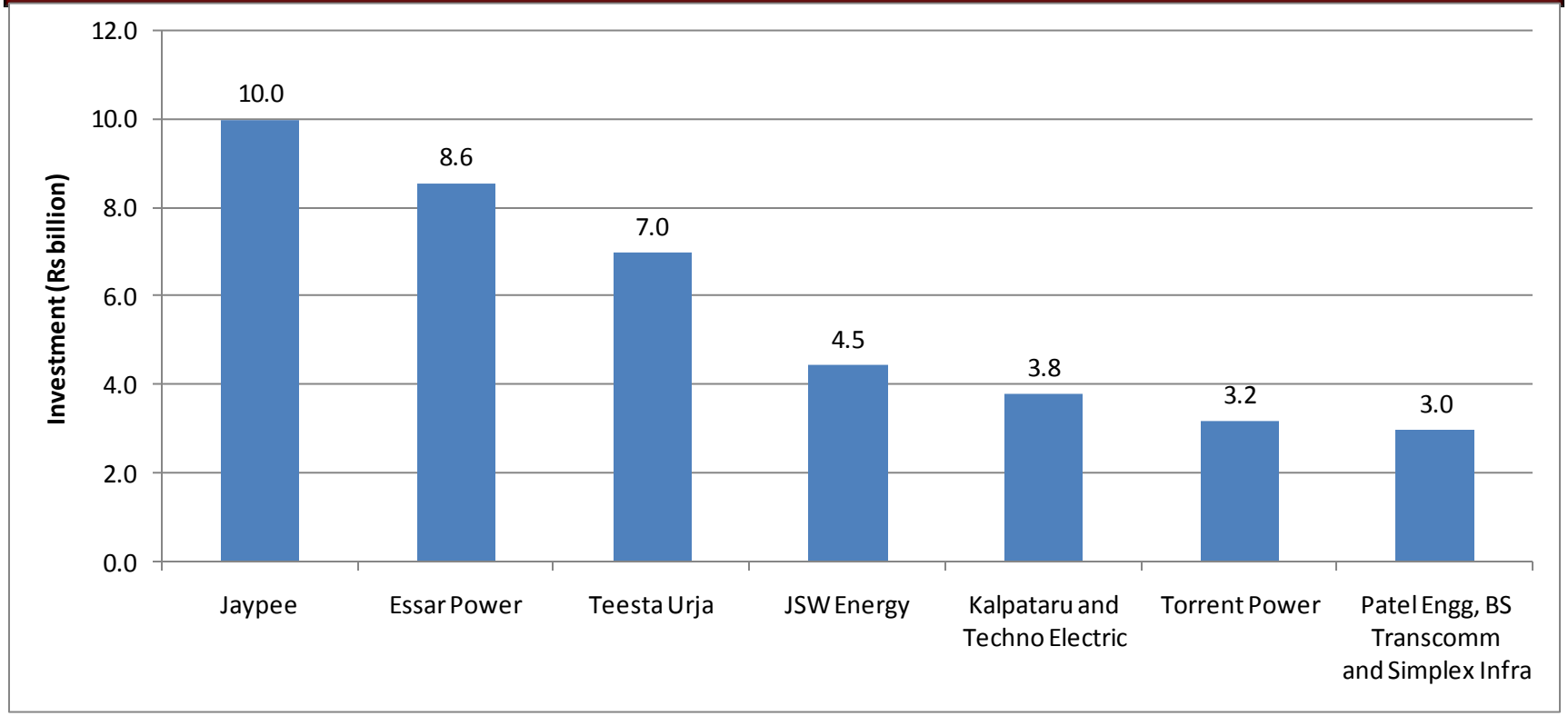


- Seven interstate transmission projects awarded under competitive bidding so far
- WRSSS-II project of RPTL has seen the commissioning of 5 lines (500 km) – entire project expected to be commissioned in 2012
- Five more projects worth Rs 65 billion identified for competitive bidding
  - Powergrid has emerged the lowest bidder for two of these (Vemagiri and Nagapattinam Cuddalore)

Independent Power Transmission Project JV Project

Private Sector Participation

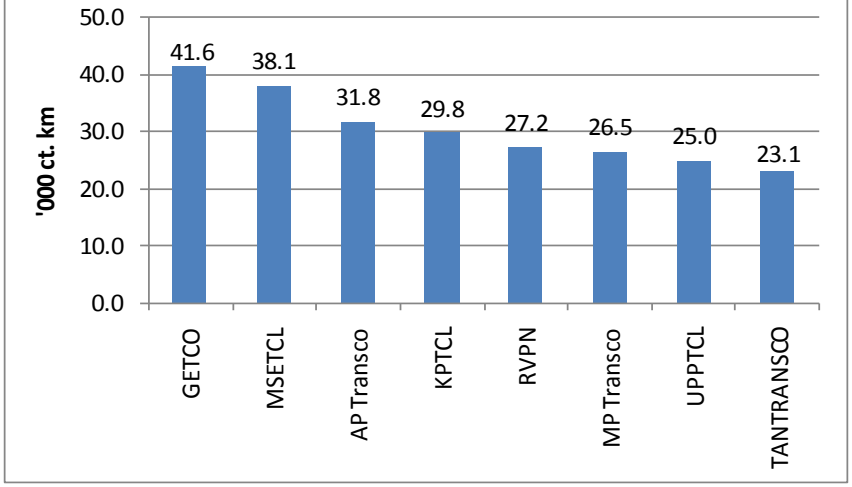
Transmission Projects of other Players



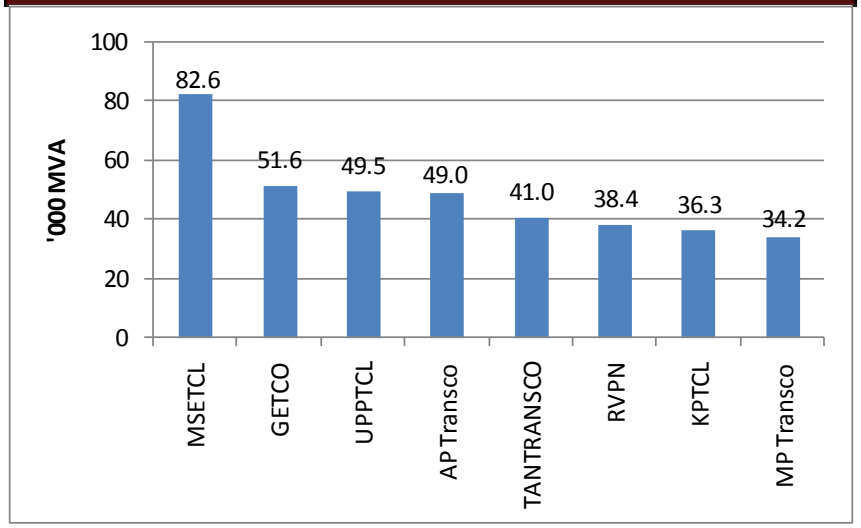
- Almost a dozen transmission systems associated with private generation projects being developed by private players either independently or in JV with the CTU or STUs
- Maharashtra, Haryana, Rajasthan and Uttar Pradesh have implemented PPP in state level transmission projects involving over 4,300 km of lines at investment of over Rs 25 billion
  - Three projects in Maharashtra (one is operational) being executed in JV with the STU
  - Projects in the remaining states have/will be awarded through the bidding route

State Transmission Utilities

Line Length of State Transcos



Substation Capacity of State Transcos



- STUs accounted for 323,641 ct. km of transmission lines and over 483,234 MVA of transformer capacity as of March 2012
- Maharashtra, Gujarat, UP, AP and TN account for more than 50% of the total intra-state transformer capacity
  - Maharashtra and Chhattisgarh have HVDC transformer capacity
- Gujarat, Maharashtra, AP, Karnataka and Rajasthan account for around half of the total intra-state line length
- While intra-state transformer capacity grew at a CAGR of 7.3%, line length grew at 4.7% (2007-08 to 2011-12)
- Mahatransco incurred the highest capital expenditure at Rs 29.4 billion during 2010-11 followed by RRVPNL at Rs 20 bilion, and Tantransco and KPTCL at Rs 17 billion

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Key Regulations and their Impact

Transmission Tariff

- Point of Connection method for sharing the cost of and losses in the interstate transmission system (ISTS) implemented from July 1, 2011
- New pricing framework sensitive to distance, direction and quantum of power flow
- PoC tariffs based on load flow analysis and capture utilisation of each network element by the customers
- All designated ISTS customers are default signatories of TSA, ensuring payment of PoC charge for use of the network
- As per amendment introduced in March 2012, there will be 3 slab rates for injection and demand PoC charges till 2013-14
- The implementing agency will aggregate PoC charges for geographically and electrically contiguous nodes on the ISTS to create zones within the state boundary and arrive at a uniform zonal rate
- Any interstate generating station directly connected to the 400 kV ISTS will be treated as a separate zone and not clubbed with other generator nodes

Connectivity and Open Access

- Generation stations granted connectivity to the grid allowed to inject infirm power into the grid during testing upto 6 months after first synchronisation
- The CTU or transmission licensee to take up construction of dedicated transmission line in phases after ensuring that advance payment for main plant equipment orders have been made (for 500 MW and above thermal plants and 250 MW and above hydro plants)

Key Regulations and their Impact

IEGC

- The recent amendment has tightening of the operational frequency band from '50.2 to 49.5 Hz' to '50.2 to 49.7 Hz' aimed at ensuring better operational performance of the grid
- In the case of forced outages of generating units, the schedule of all beneficiaries will be reduced on a pro-rata basis
- For new wind energy plants, all fluctuations within ±30% of the schedule will be borne by all users of the interstate grid
- For solar power, there is no such band and all fluctuations for new solar power plants have to be borne by users of the interstate grid
- Allows new wind energy generators to fine tune their schedules, based on forecasting, as close as three hours before actual generation

UI Charges Amendment

- High UI charges as deterrent for overdrawl from the grid
  - UI charges specified in the frequency band of 50.2 to 49.5 Hz
  - A maximum UI charge of Rs 9.0 per unit is applicable at grid frequencies below 49.7 Hz
  - Additional UI charges: 49.7-49.5 Hz – 20% of the maximum UI charge; 49.5-49.2 Hz – 40% of maximum UI charge; below 49.2 Hz – 100% of maximum UI charge

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Technology Trends

Move to higher voltage levels

- Necessitated by the need to increase the MW flow per metre of RoW
- First line (Biswanath Chariyali - Agra bi-pole line) at 800 kV HVDC level expected to be completed by August 2013
- Powergrid engaged in developing the 1,200 kV transmission system – UHV AC test station is under development at Bina, Madhya Pradesh

Conductor configurations and materials

- Increasing the thermal capacity of the conductors and use of high temperature low sag (HTLS) conductors to increase transmission capacity
- High Surge Impedance Loading (HSIL) technology to increase the load of the lines
- Low resistance conductors (AL59 alloy conductors) and dull surface finish conductors are some of the upcoming kinds of conductors.

Others

- Tower design improvements
  - Compact/pole type towers for to tackle RoW issues
  - Multicircuit towers
- Substation automation
- Compact substations - gas insulated switchgear

Smart Grid Initiatives in Transmission

Key Initiatives by CTU

- Key smart-grid technologies deployed in transmission:
  - Synchronized Phasor Measurements using Wide Area Monitoring Systems like PMUs
  - Self Healing Power Systems
  - Adaptive Islanding Systems
- Remote operations of substation – 27 unmanned substations as of today
  - Setting up of National Transmission Monitoring Centre (NTMC) by 2013
  - Remote monitoring and operation of 192 Substations
- Powergrid has commissioned 8 PMUs in the northern grid under the first WAMS pilot project
  - Pilot projects being implemented in other regions: Western Region (25 PMUs), Eastern Region (25 PMUs), Southern Region (6 PMUs), North Eastern Region (6 PMU)
  - Power grid plans to cover all 400 kV and above substations by installing around 1,000 PMUs by 2015

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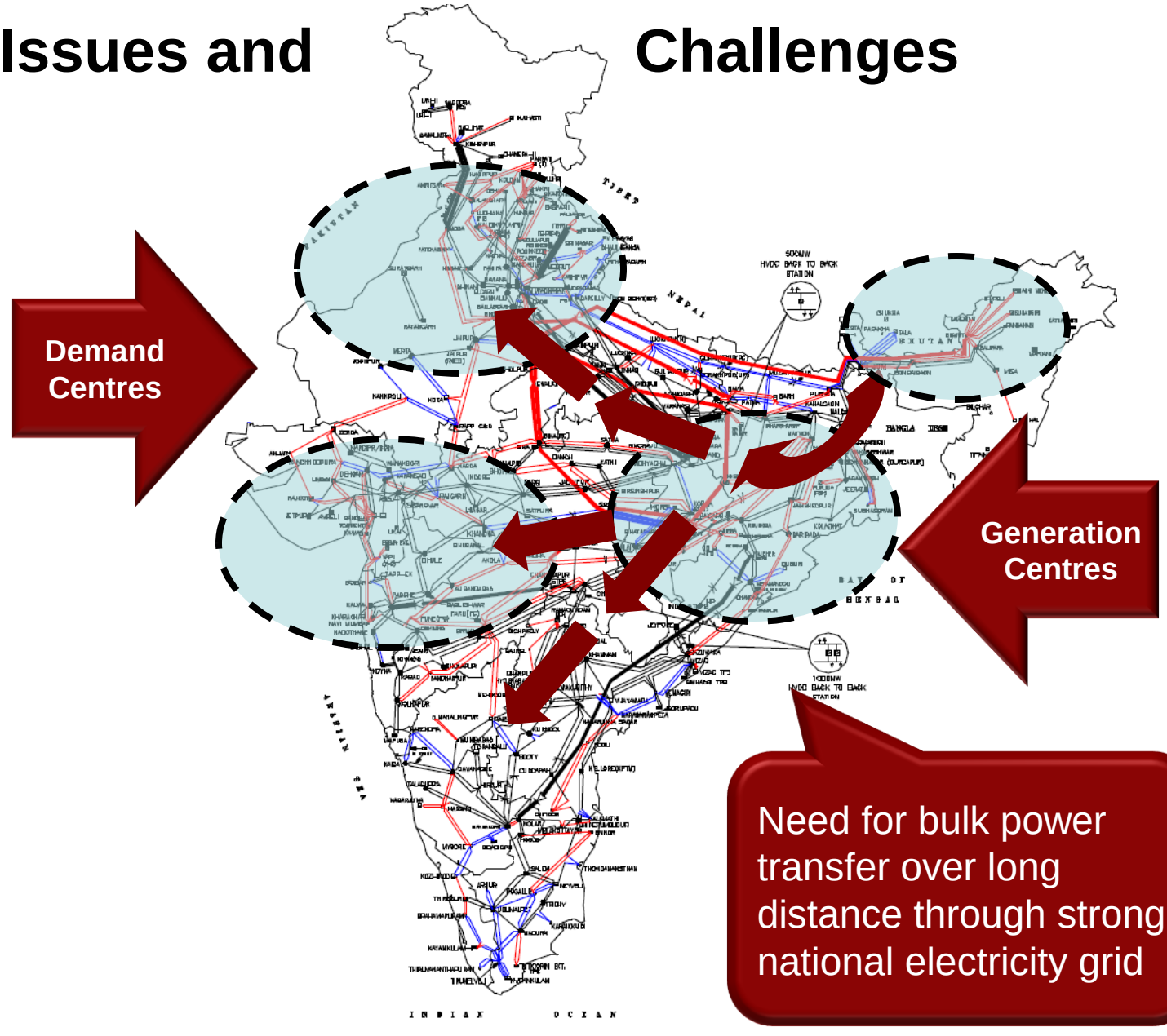
Issues and Challenges



Issues and Challenges

Procedural delays	• Delays in land acquisition, obtaining right of way (ROW), environmental and related statutory clearances • Equipment deployment, use and repair, particularly in hostile terrains • Bidding process takes a long time which adds to the transaction costs of prospective developers
Lack of coordination	• Coordination with generation projects, so that the transmission system comes up in tandem with the generation capacity • Transmission networks can be better planned when the allocation of generation projects is decided in a holistic manner • Merchant capacities and renewable power pose their own challenges
Limited private sector participation	• Unlike generation, private participation in transmission has been limited • Private sector players have concerns regarding a level playing field • Steps like standard bidding documents, PoC tariffs, payment security mechanism etc. will provide confidence
Inadequate investments	• Investments in intra-state transmission networks have been inadequate • Due to network constraints, power cannot be fully transported from surplus to deficit areas, and open access transactions cannot be effectively facilitated • PoC tariffs if implemented at the state level could make transmission investments self sustaining

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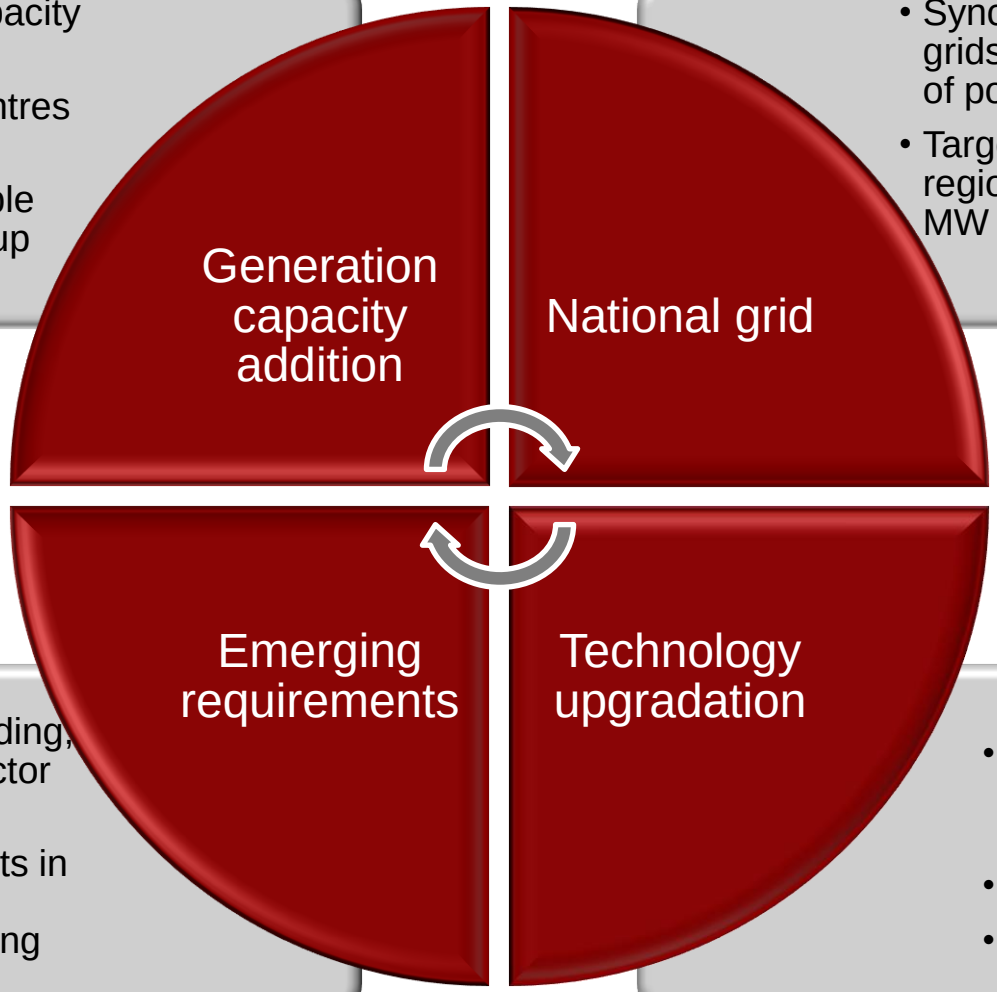
Summing Up

- 76,000 MW planned capacity addition in 12th Plan
- Generation and load centres dispersed
- High amount of renewable power capacity coming up



- Synchronisation of all regional grids to ensure seamless flow of power
- Targeted increase in inter-regional capacity to 75,000 MW by 2017

- Open access, power trading, ABT regime are new sector challenges
- Transmission investments in increasing system redundancies and a strong grid

- Move to higher voltages including 765 kV, 800 kV HVDC and 1,200 kV
- Smart grid projects
- GIS substations, SCADA, ERP

Thank You