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Power Transmission System for High Speed Network

03rd November 2016

Setting the Context

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- High-speed rail (HSR) – Benefits and outlook
  - Power transmission infrastructure for HSR
- Power Transmission – A success story for least cost fast track project delivery
- Sterlite Power – Leveraging technology for fast track project delivery
- Framework for selecting appropriate project procurement method
  - DBFOT procurement framework – Preferred mode of project procurement for fast tracking implementation

High-speed rail

High-speed rail (HSR)

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Background

➢HSR – Rail class with operational speed of 200 km/h or more (up to 350 km/h)

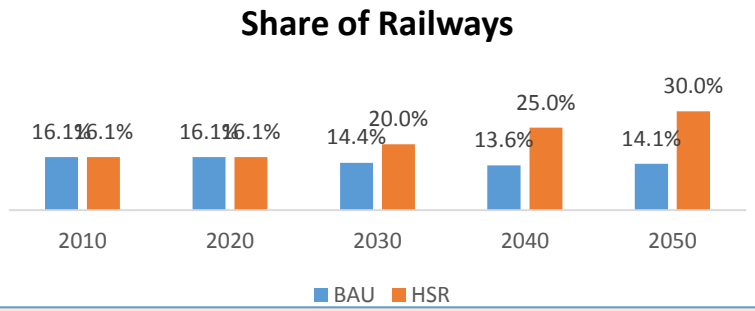
➢Indian Railways' proposed HSR plans – 9 routes identified with cumulative route length 14,771 km

➢HSR benefits –

- Improved connectivity,
- reduction in energy consumption with de-carbonization (electrification),
- 2-5 times more energy-efficient than air and car & socio-economic benefits by improving access to employment, health, education & time savings

Potential & Benefits

Inter-city passenger travel to increase from 6,772 bpkm in 2010 to 25,941 bpkm in 2050



Current Plans & Status

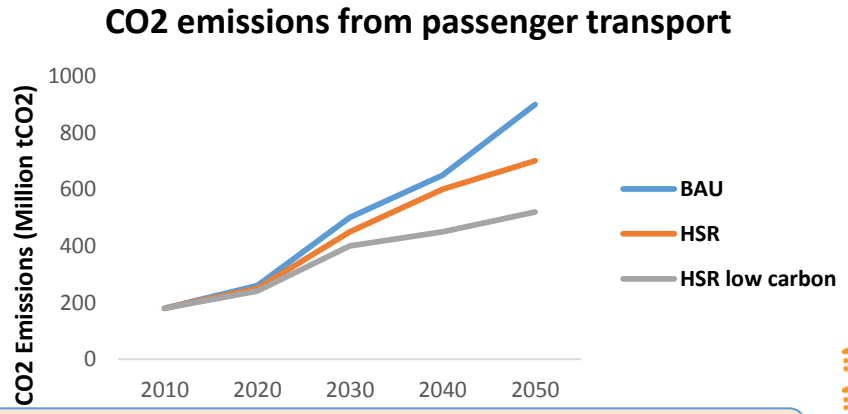
➢Rapid urbanization & increasing personal incomes – intercity travel will increase significantly

➢High Speed Rail Corporation – SPV under Ministry of Railways for dealing with all aspects of HSR in India

➢GoI's Diamond Quadrilateral Project in feasibility stage

- link 4 metro cities of India (high density corridors,
- 135-991 km in length) in feasibility stage

➢HSR between Mumbai – Ahmedabad – Project approved with estimated cost of INR ~ 98,000 crore



*Investment plan of INR 65,000 crore envisaged for high speed rail & elevated corridor for period 2015-19, significant more planned

Power transmission infrastructure for HSR

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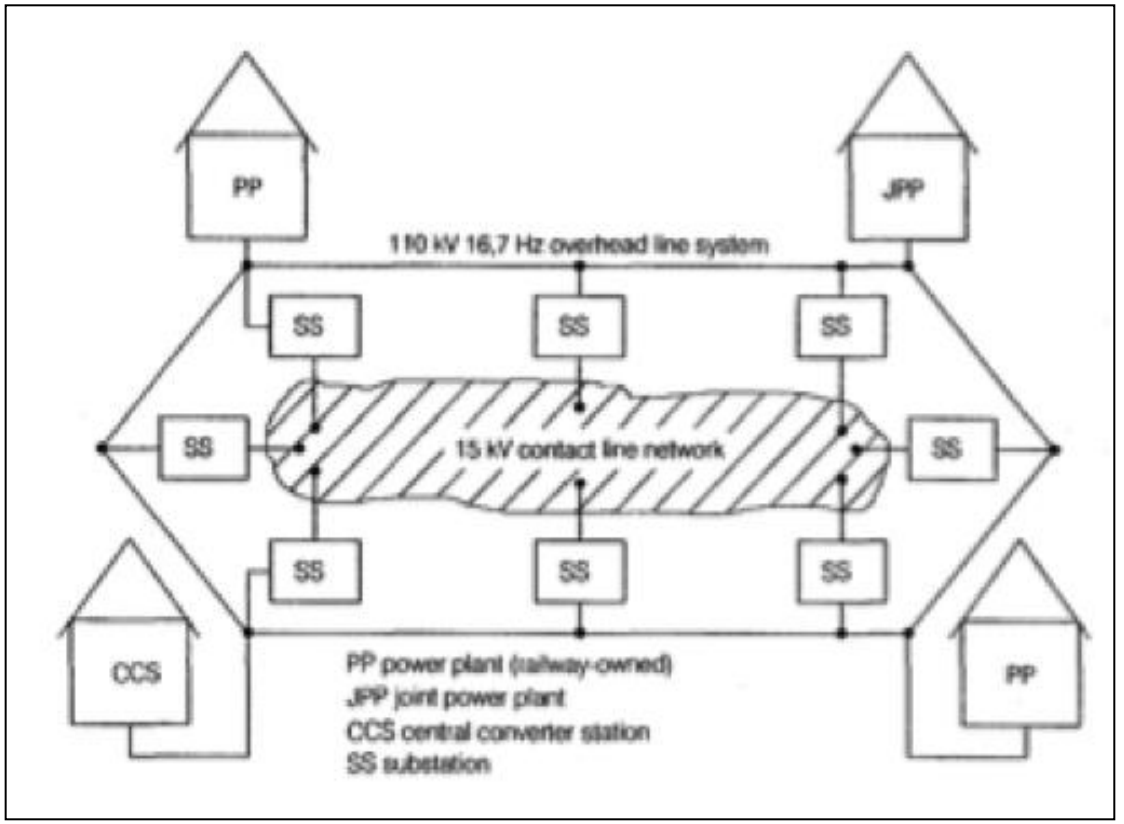
- High-speed rail will involve development of a dedicated HSR infrastructure including elevated tracks, electrification etc.
- Compatibility of HSR infrastructure ensuring
  - High Performance levels
  - Safety
  - Superior Quality
  - Reliable Service
  - Optimum Cost
- Quality of a rail network's electrification directly influences reliability, safety and performance
- Creation of a reliable, cost-efficient electrified infrastructure within a given time framework is essential for development of high-speed rail in India
- Various choices exist for Railway electrification system design; one of such choices for may involve Railway authority owned high voltage (132kV) single phase transmission lines along the route and line side 132/25kV substations for feeding the contact lines. 132kV single phase is derived through converter substations. This type of system design does away with neutral sections in the contact lines, thus improving reliability.

German railway example

- DB's 110kV (1-phase) transmission line internal network for feeding the line side traction substations (the voltage level would be 110kV or 132kV in India)
- Contact line system is 15kV, 16.7Hz in Germany; in India it would be 25kV, 50Hz



Evolution of Power transmission

Indian Power Sector- Snapshot

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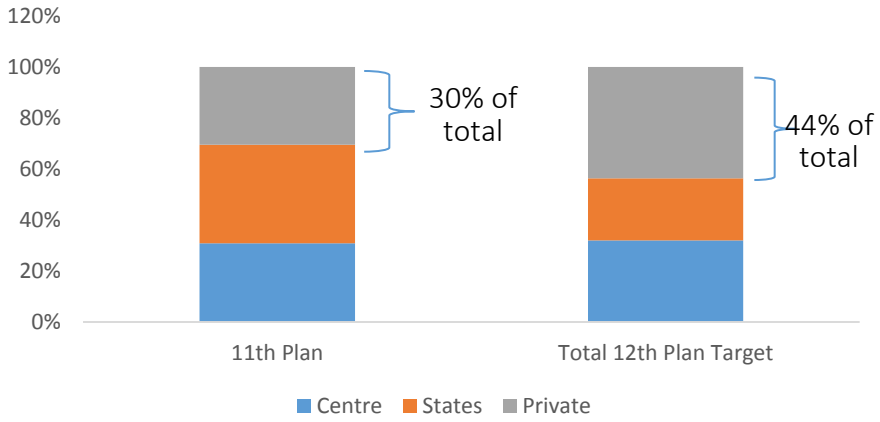
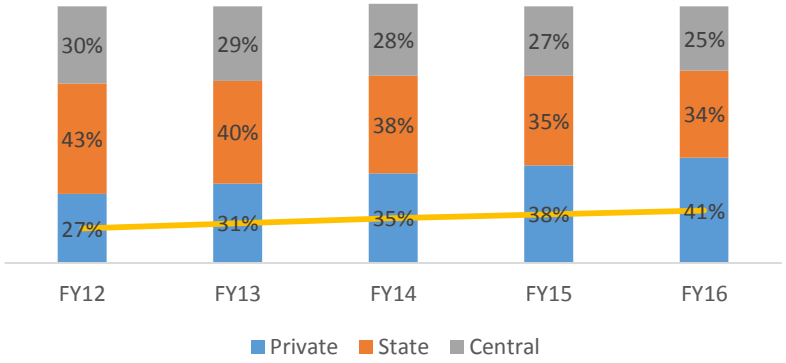
Investment in power sector



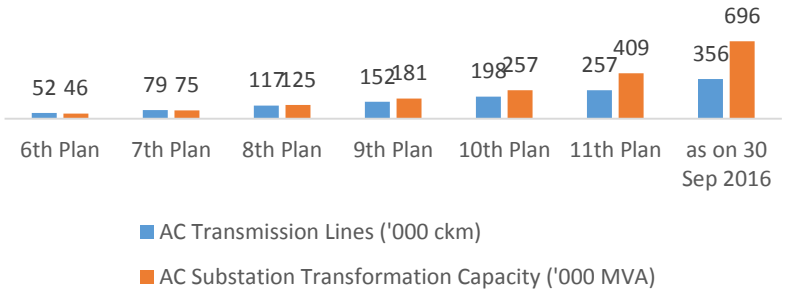
Installed Generation Capacity (GW)



Highlights of Transmission Sector

- 32.7% growth in transmission lines, and 61.1% in AC transformation capacity from FY12 to FY16
- CAPEX of INR 2.6 trillion envisaged in T&D sector during 13th FYP (62,800 ckm of transmission line & 128,000 MVA of transformation capacity
- GoI's push to electrify rural regions - Private sector investments to grow

Growth in Transmission Sector



32 power transmission projects worth INR 45,064 crores awarded under TBCB mode till June'16

Evolution of power transmission sector

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Major milestones in Indian transmission sector

1991

Electricity Laws Amendment Act

- Private participation allowed in generation
- Up to 100% foreign ownership allowed
- Operators and SEBs entered power purchase agreements
- SEBs responsible for transmission and distribution of power

1998

Electricity Laws (Amendment) Act

- Private participation enabled
- CTU and STUs set up
- Electricity Regulatory Commissions Act
- CERC and SERCs formed
- Regulator to protect and promote consumer interest, fair competition, transparency
- Provide a level-playing-field for all players

2003

The Electricity Act

- Replaced earlier laws, aiming to enable reforms and restructure power sector
- Released National Electricity Policy, mandatory creation of SERCs, emphasis on rural electrification, open access in T&D
- Introduced non-discriminatory open access in transmission

2006

National Tariff Policy

- Mandatory competitive bidding of all transmission projects after January 2011
- Framework to determine tariffs and rate of return for projects under Generation, Transmission & Distribution

2011

National Tariff Policy (Amendment)

- Exemption to intra-state transmission sector from mandatory competitive bidding up to 5 January 2013
- Exemption of select works/urgent/compressed time schedule work from tariff based competitive bidding

2016

National Tariff Policy (Amendment)

- Developing transmission projects through competitive bidding process to ensure faster completion at lower cost
- Inter-State transmission charges and losses for renewable power exempted
- Regulators to mandate compulsory purchase of power from micro grid situated in remote areas

Current policy framework

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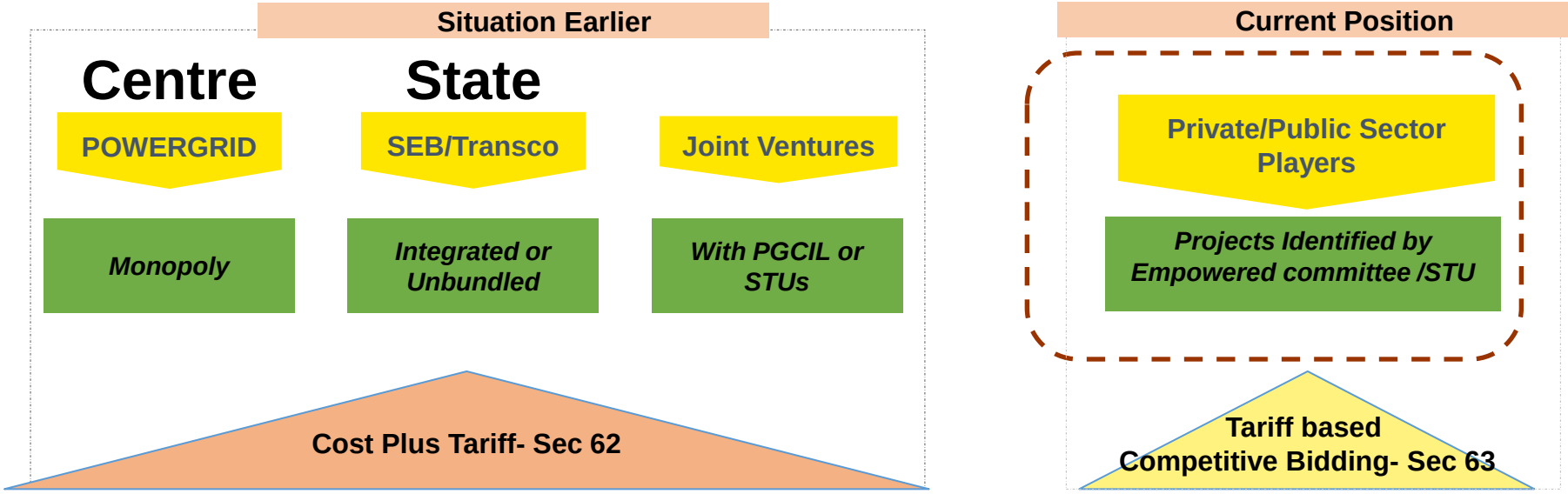


Inter-state

- Guidelines in 2006 mandated competitive bidding for all new projects post 5th Jan '11
- PGCIL also to bid for projects
- Exemptions for 1200 kV HVDC experimental works and for lines to be taken up on compressed schedule on a case to case basis

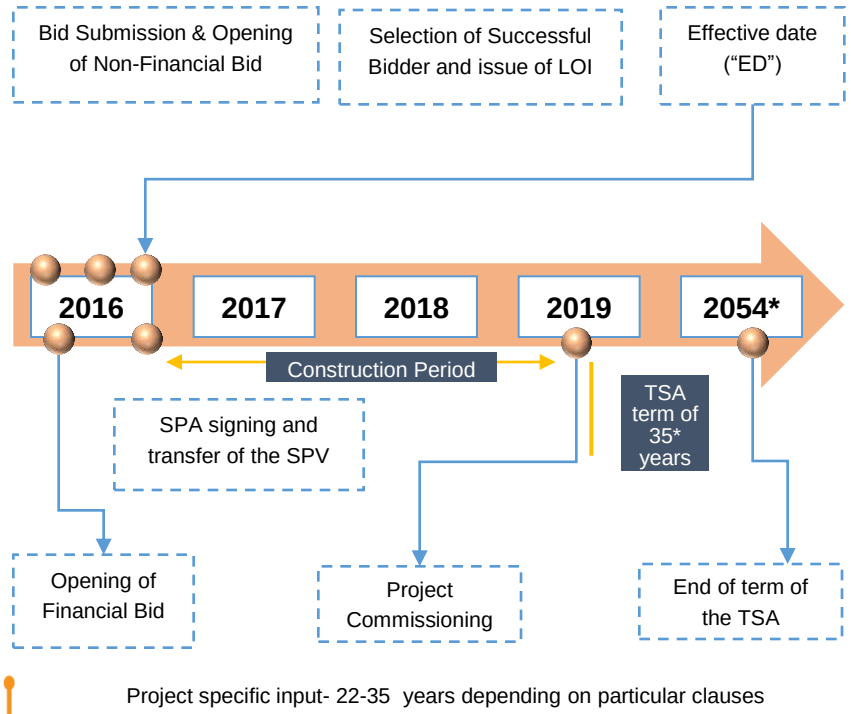
Intra-state

- Competitive Bidding became mandatory from Jan '13
- VGF based model also used in some projects (4 till date - one each in Haryana, MP and 2 in Rajasthan)

Current bidding framework

- Projects across two or more states (interstate projects) tendered by the Central Government (through PFC and REC)
  - Standard Bid Document (SBD) used by PFC and REC for tendering inter-state transmission projects on BOOT basis
- State specific projects tendered through the States' Transmission Utilities / Bid Process Coordinators (BPCs) appointed
- BPCs of states are primarily following the VGF based model i.e. DBFOT

Timeline of a typical transmission project



Project specific input- 22-35 years depending on particular clauses

Key bidding terms (IPTC model of MoP)

Technical Qualification Criteria	▶ Experience of undertaking development of projects with cumulative capex above a certain threshold (linked to expected cost of project being tendered)
Bidding Parameter	▶ Levelised Transmission charges calculated by discounting the Quoted Transmission Charges to Scheduled CoD
Key responsibilities of BPC	▶ To obtain approval for laying transmission lines under Sec 68 of EA ▶ To initiate acquisition of land for location specific substations etc. ▶ To initiate process of seeking forest clearance if required
Minimum shareholding	▶ 51% of issued and paid up equity for 2 years from CoD and 26% of issued and paid up equity for 3 years thereafter

Tariff Based Competitive Bidding – Benefits

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Faster execution

- Reduced timeline with private involvement in project development - Commissioning before SCOD permissible under current norms the motivating factor for developer
- Decentralization of forest and environment clearances and reduction in project award time from 250 days to 145 days
- Introduction of technology and mechanized construction for fastening transmission sector growth & reducing overburdening of projects with PSUs

Lower tariffs

- Introduction of competition has reduced the tariff by almost 30-35% in many cases.
- Private developers have brought in innovations in financing, design, implementation, contractual framework with EPC etc. to reduce the costs.
- In addition, projects with lower tariffs have been successfully completed and are operational.

Innovative technology

- TBCB has enabled the micro-management of specifications
- Free hand to developers for using innovative technology in the development of a transmission line in key areas including survey, tower design, selection of conductor and mechanized construction methods
- Savings in project cost courtesy effective and optimal use of technology – green tower designs, LiDAR survey and high performance conductors

Less burden on Govt. finances

- Pre 2011, projects were awarded on cost plus basis to PGCIL/state transcos with significant impact on government finances which was brought in as equity/budgetary support
- With the advent of TBCB, financing the project comes under the purview of private developer, thereby ensuring availability of govt. finances for other schemes.

Comparative - Annual levelized transmission charges

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Name of ITPE	Levelized Tariff (INR Million/Annum)		
	As per TBCB	As per CERC	(%) Change
Transmission scheme for enabling import of NER/ER surplus power by NR	1187.9	2061	(-) 42%
System Strengthening common for WR and NR	1421.3	2133.8	(-) 32%
System Strengthening for WR	1995.3	3531.8	(-) 43%
Transmission System associated with IPPs of Nagapattinam/ Cuddalore Area – Package A	987	1321.8	(-) 25%
Transmission System Associated with Patran 400kV S/S	274	385.4	(-) 29%
Eastern Region System Strengthening Scheme – VII	589	520.6	(+) 13%
Eastern Region System Strengthening Scheme – VI	1173.7	1174.3	At par
Part ATS of RAPP U – 7 & 8 in Rajasthan	365	436.1	(-) 16%

Case Study: MP Power Transmission

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Project Situation

- MP expected to commence generation of electricity from 2x250mw plant by December 2013
- Transmission line required at the earliest possible time for power evacuation
- Time and cost overrun by MPPTCL historically at 5 years and ~200%

Key challenges

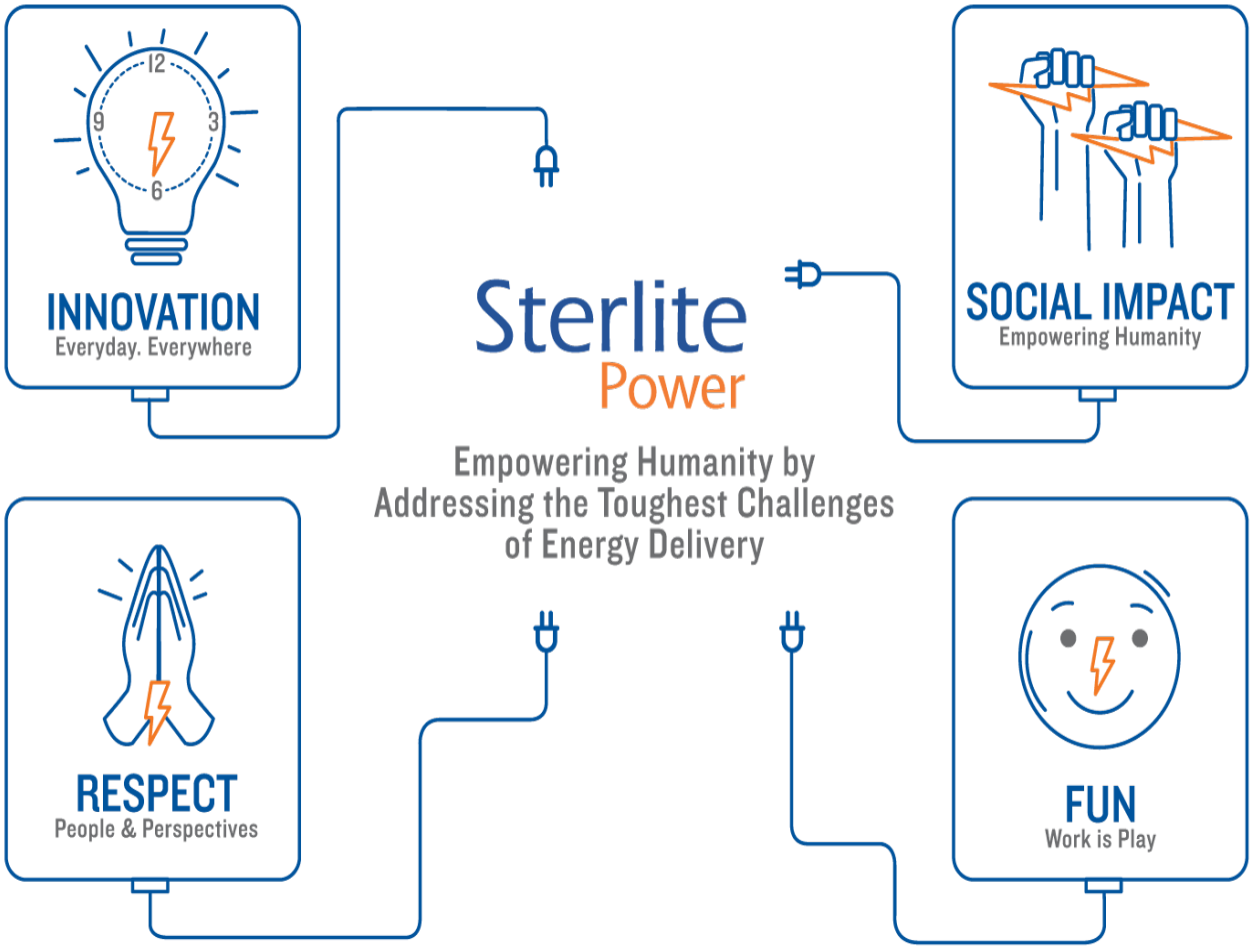
- Shorter period of project development to ensure smooth evacuation of power
- Obtaining the most competitive tariff through transparent bidding
- Obtaining Viability Gap Funding (VGF) support from Centre Govt.
- Ensure cost efficiency
- Obtaining regulatory approvals for unitary charge

Key learnings/findings

- Project completed in 8 months from financial closure whereas MPPTCL would have taken 60 months
- Allocation of risk to the party best situated to control the risk i.e. risks related to demand and power availability to be allocated to state govt.
- Transmission tariffs were lowered by about 12%

Sterlite Power – Leveraging technology for fast track execution

Sterlite Power - Core Purpose and Values



Company overview

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Sterlite Power presence in the entire value chain of the Power Transmission business through its three business lines — Products, Solutions and Power Transmission Infrastructure development.

- Overhead Transmission conductors
- Underground HV/EHV Cables
- OPGW
- Hardware & Fittings

- Uprating/uprating capacity
- Integrated O/H & U/G T&D network with communication capability
- T&D Loss reduction

- Transmission Infrastructure development ~ 35 years BOOM Projects
- ~$2 Bn. Capital Commitment

Power infrastructure ~ Journey So Far

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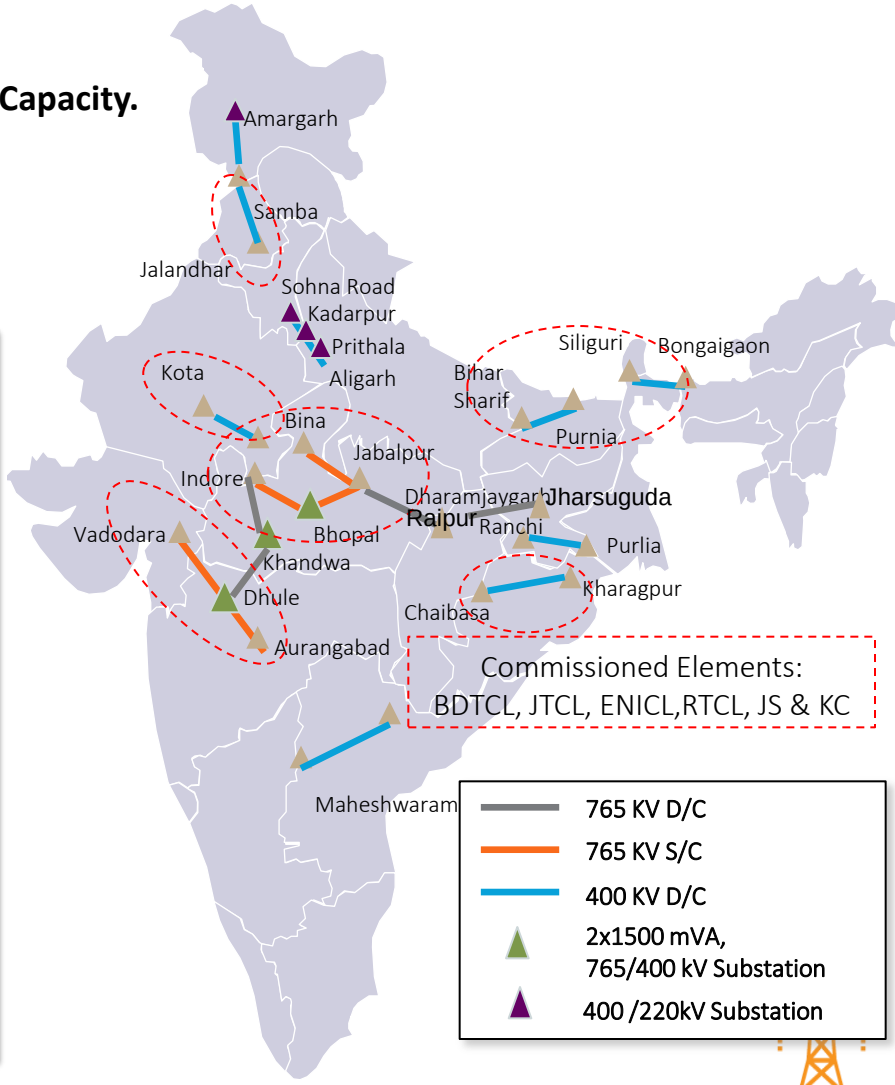
India's largest private power transmission portfolio

- 10 projects~7000 Ckms and 12750 MVA of Transformation Capacity.
- Presence across 15 states – operational assets in 10 states
- ~ $ 2 billion of capital outlay.

Projects	Elements
BDTCL (commissioned)	4 x 765kV Single Circuit + 2 x 400 kV Double Circuit transmission lines (~1000 kms)+ 2 X 3000 MVA, 765/ 400kV Substations
JTCL (commissioned)	India's first 765 kV Double Circuit + 765kV Single Circuit lines (740 Ckt Km + 240 Km)
ENICL (commissioned)	Two 400kV Double Circuit Transmission Lines (550 Kms)
RTCL (commissioned)	400 kV x D/C transmission line from RAPP (Rajasthan) to Madhya Pradesh (201kms)
PKTCL	400 kV D/C transmission lines from Purulia to Ranchi + Kharagpur to Chaibasa under Eastern Region System Strengthening Scheme 7 to enable power trade among states (560 Ckt Km)
NRSS29	2x400 kV trans. lines (~440 Kms.)+ GIS Substation at Amargarh (400kV/ 220kV GIS Substation) connecting J&K to Northern Region
MTL	2x 400 KV transmission lines(238 kms)
OPGC	1x765 kV (291kms)+ 1x 400 kV (52 kms) transmission lines
GPTL	4x 400 kV trans. Lines (~144 kms)+ 3x 400/220 kV s/s
KTL	2x 765 kV d/c (258 km) + 2 x 400 kV d/c (32 kms) +765/400 kV S/S



Firsts by SPTL

- First private company in India to **commission 765 KV double circuit transmission line**
- First private company to win **MoP award for early completion** of 765/400 kV/1500MVA Dhule S/S.
- First transmission company **to complete an element 12 months ahead of schedule.**
- **First company to use Aerial Technologies (LiDAR, Heli-erection/stringing, UAVs) to design, construct and maintain transmission projects in India.**
- **First company in India to deliver Smart line (HPC+OPGW+ Communication Equipment) in Goa**
- **World's first on-shore application of laying 3-Core 66 kV Cable.**

Leveraging technology for early project delivery

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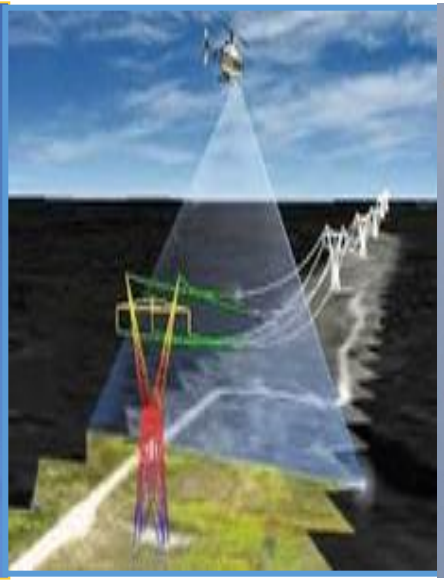
Use of Aerial Technologies for construction of Transmission Lines

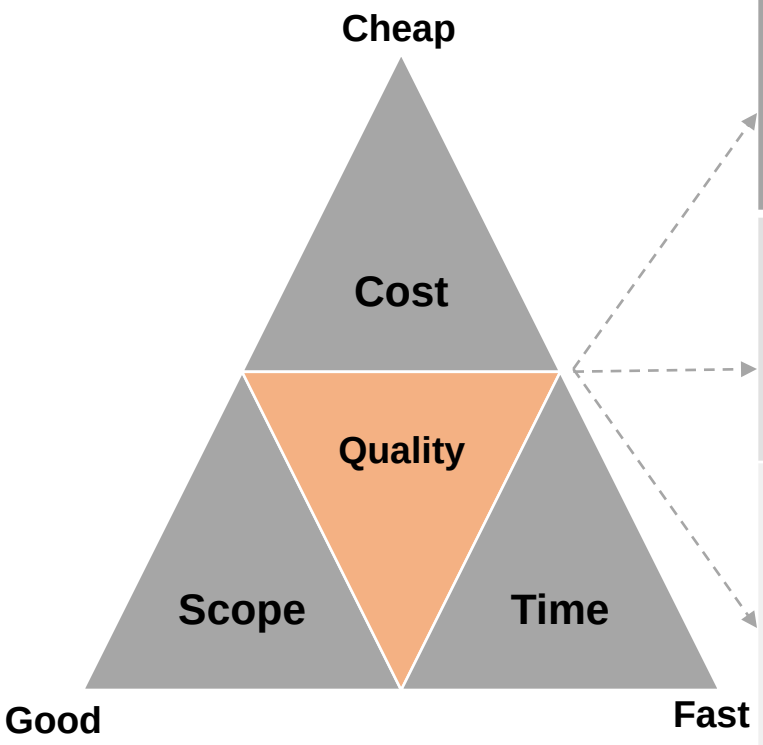
- **Use of Helicopter for Stringing of Conductor and OPGW.**
- **Use of Helicrane for Tower Erection.**
- **LiDAR for Survey, Design and Engineering.**
- **UAV(Drone) for Operation and Maintenance**






Procurement framework – Selection of suitable framework for projects

Project execution – Critical aspects



Cost	➢ Cost overrun – Controlling cost in infra projects a major hurdle ➢ Projects have finite budget, increase in costs may increase chances of compromise in quality
Time	➢ Time is ‘money’ ➢ Delays in time inadvertently lead to cost overruns ➢ Incentivizing early completion essential
Scope	➢ Needs to be fully defined or understood from beginning ➢ Unclear risk allocations/responsibilities lead to delays and make project prone to litigations ➢ Scope clarity essential for avoiding disputes/claims

Balancing cost, time and scope constraints are critical to ensure project success. Higher availability and reliability of a system maximizes benefits for all the stakeholders

Evaluation – Procurement methods

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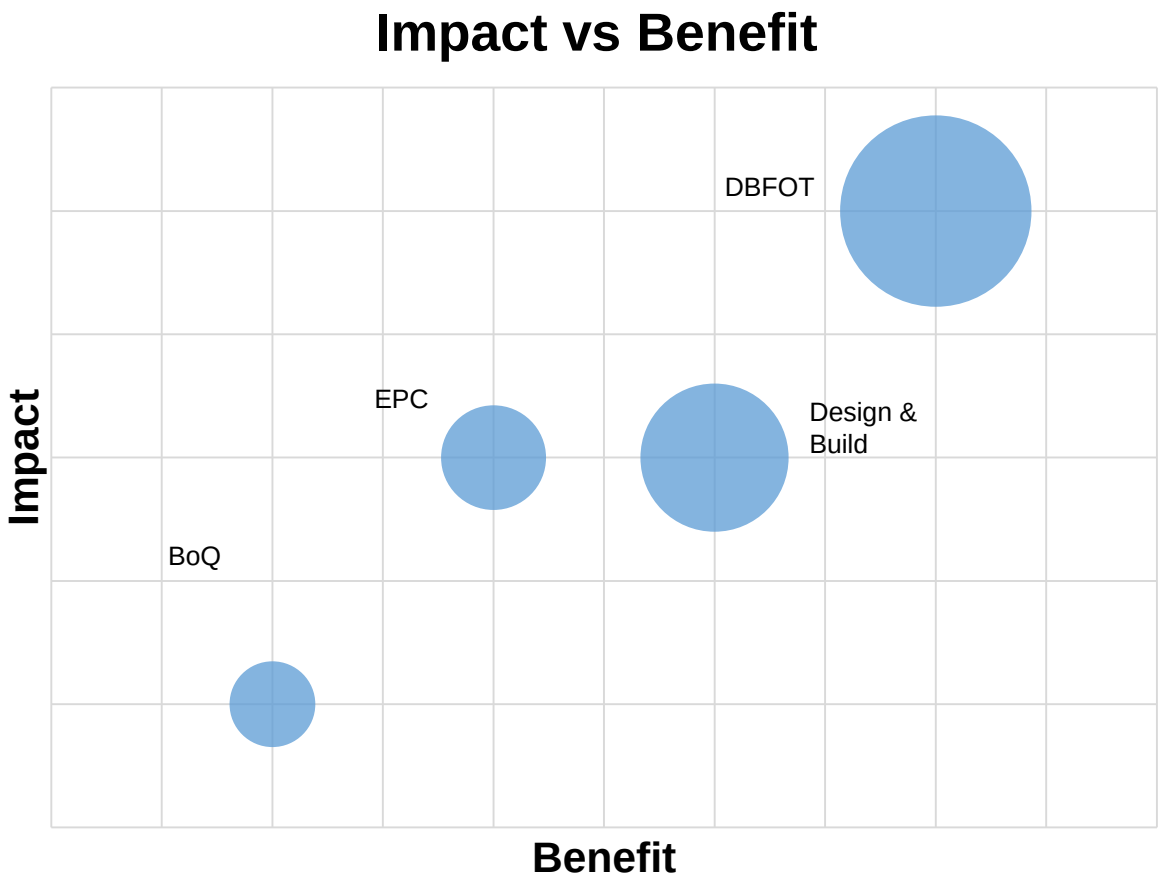
Parameter	BoQ	EPC	Design & Build	DBFOT
Willingness to introduce new technology	Low	Low	Medium	High
Willingness to introduce design innovations	Low	Low	Medium	High
Construction cost risk with Govt.	High	High	Medium	Low
Construction schedule risk with Govt.	High	High	Medium	Low
Lifecycle cost risk with Govt.	High	High	Medium	Low
Operating performance risk	High	High	High	Medium
Financing risk with Govt.	High	High	High	Low
Summary Assessment	Different contracts for supply and erection	Turnkey contract	A turnkey construction contract along with design	Strong model for large and mid-size projects
	Commercial risk with Government	Commercial risk with Government		

Conclusion



- In case of mid-scale and large scale infrastructure projects, DBFOT is a cost-efficient and time effective procurement model
- Reduces the impact on project cost and project schedule
- DBFOT attracts invite private capital thereby reducing the burden on government resources

DBFOT method of project procurement to be the preferred mode for mid/large scale infrastructure projects

Thank you