4. Chief Engineer (PSETD), CEA made a brief presentation (copy enclosed as **Annexure II**) apprising the members of the Committee about the

    - Options available for optimization and Optimum utilization of RoW including Urban / Forest areas and ;
    - Revisions currently being undertaken by CEA in the Regulations on Safety and Technical Standard for construction of Electric Lines for addressing growing congestion in existing corridor of transmission network and RoW problems.

    He further suggested that there is a possibility of dividing the route of transmission line into three broad categories such as normal route, Route through Reserved forest areas and Route through Urban areas/Populated areas and notifying different RoW for different category. Specific technical measures may be taken in forest areas and urban areas /populated areas for optimization / optimum utilization of existing RoW.

5. Joint Secretary, MoP stated that there is a need to explore more such innovative solutions like Gas Insulated transmission lines for urban / city areas like Bengaluru where cost is not the major issue but availability of RoW / transmission corridor is extremely difficult. She asked CEA, Powergrid and states to look into the worldwide / international practices to overcome such problem and come out with other technical options vis-à-vis comparison of their cost.

6. Representative from Haryana stated that there is a need to incorporate RoW consideration right from micro planning stage and various options should be explored for optimum utilization of the existing RoW as far as possible. The capacity of existing transmission lines with lower capacity of conductors can also be increased by increasing the size of the conductor or using higher capacity conductors or using multi circuit towers. Before planning new transmission system, the existing capacity should be optimally utilized by upgrading the transformers as well as existing transmission lines in the existing

ROW.

7. Representative from UP stated that more & more use of narrow based towers, monopoles, re-conductoring with HTLS conductors (wherever feasible)etc should be considered. It would be preferrable to reduce the number of transformation level i.e. going for 220/33 kV substations instead of 220/132/33 kV sub-stations (eliminating 132kV level).

8. Joint Secretary, MoP asked CEA to explore the possibility of coming out with some detailed guidelines with regard to Inclusion of Narrow Base, monopole towers, Multi circuit towers, use of with high ampacity conductors right from the planning stage keeping in view future RoW constraints.

9. Representative from Powergrid and KPTCL suggested for modifying the safety Regulations of CEA for allowing construction of buildings upto a certain height under an overhead line in urban areas keeping adequate safety margin by raising of towers heights.

10. Director (CEI), CEA disagreed with the above proposal of Powergrid stating that vertical and horizontal clearance are primarily decided based on the minimum safety clearance and electric field exposure of human being beneath the bottom most conductor and at the edge of the ROW at 2 m above the ground level. As per present practice theses values are kept 5 kV/m at the edge of RoW and 10 kV/m just below the bottom most conductor, keeping in view the human safety. If construction of buildings is allowed under the existing line, then the land owner would be free to make any unauthorized construction under the line which may endanger the human safety as it would not be possible to stop such construction activities and it may not be possible always to have spans free from mid span joints. The representative of UP was also not in favour of such construction as it would be very difficult to stop such illegal constructions in rural areas. PGCIL was suggested to look in to the possibilities of increasing the height of tower to accommodate such small size houses under the transmission lines.

11. After detailed deliberations on various issues, following was decided:

    - To further explore any other technological options available for reduction of RoW based on worldwide practices and the cost implication.

- PGCIL to provide international practices for addressing the RoW issue in urban / populated / forest areas.
- To explore the possibility of framing detailed guidelines to incorporate RoW consideration at micro planning stage and to explore various options for optimum utilization of the existing RoW as far as possible right at planning stage
- To explore the possibility of dividing the route of transmission line into few broad categories such as normal route, Route through Reserved forest area and Route through Urban areas/Populated area and notifying different RoW for different category suggesting specific technical measures for urban / populated areas / forest areas.

Meeting ended with a vote of thanks to Chair.

F.No. 3/4/2016-Trans

Date/time of the meeting: 30.09.2016 at 3.00 pm
Venue: Ministry of Power, Conference Room
Shram Shakti Bhawan, New Delhi-110001

Sub: Second meeting of the committee for finalization of compensation in regard to Right of Way (RoW) for transmission line falling in urban areas.

List of Participants

Ministry of Power

1. Ms. Shalini Prasad, Additional Secretary - In the chair
2. Smt. Jyoti Arora, Joint Secretary (Trans)
3. Shri Ghanshyam Prasad, Director (Trans)

Central Electricity Authority (CEA)

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STATE SECTOR

Govt. of Karnataka, Bengaluru

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Government of Uttar Pradesh/UPPTCL, Lucknow

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15. Shri Yatendra Kumar, SE (Trans)

Government of Kerala/KSEBL

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Government of Haryana/HVPNL

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Annex ii

COMMITTEE
FOR FINALISATION OF COMPENSATION IN REGARD TO
RIGHT OF WAY (RoW)
FOR
TRANSMISSION LINES IN URBAN AREAS

CENTRAL ELECTRICITY AUTHORITY
(MINISTRY OF POWER)

In first meeting of the Committee held on 30.08.2016, it was decided that CEA shall explore different technical options available for further optimizing the Right of Way width, Safety clearances such as:

- **New compact tower design.**
- **Possibility of including caging of conductor in the existing/ new tower to reduce swing of conductor.**
- **Feasibility of underground cable laying for EHV lines.**
- **Feasibility of Gas insulated lines etc.**

- **Chief Engineer (PSP&PA-I), CEA had taken meeting on 23.09.2016 to explore the different technical options available for optimizing the Right of Way width for transmission lines**

- **M/s Powergrid, M/s Sterlite Grid Limited, M/s Kalpatru Power Transmission Limited and M/s Essel Infra projects Limited have been requested to furnish the calculations of RoW for different voltages within a week's time based on the broad parameters/factors like Type of conductor, Design Span, string type, swing angle, meeting safety clearance and electrostatic field requirement.**

Transmission line towers

(a) Self-supporting type [Lattice structure / monopole type]

(b) Guyed type.

In India self-supporting lattice structures are common for EHV transmission lines. Use of Monopole structures are increasing in specific areas.

Monopole Structure:

- Much reduced Foot print, Less Component, Fast erection
- Limited manufacturers
- High cost and difficulty in transportation
- To be used with reduced span at 400kV level
- For multi circuit, special design consideration to be made

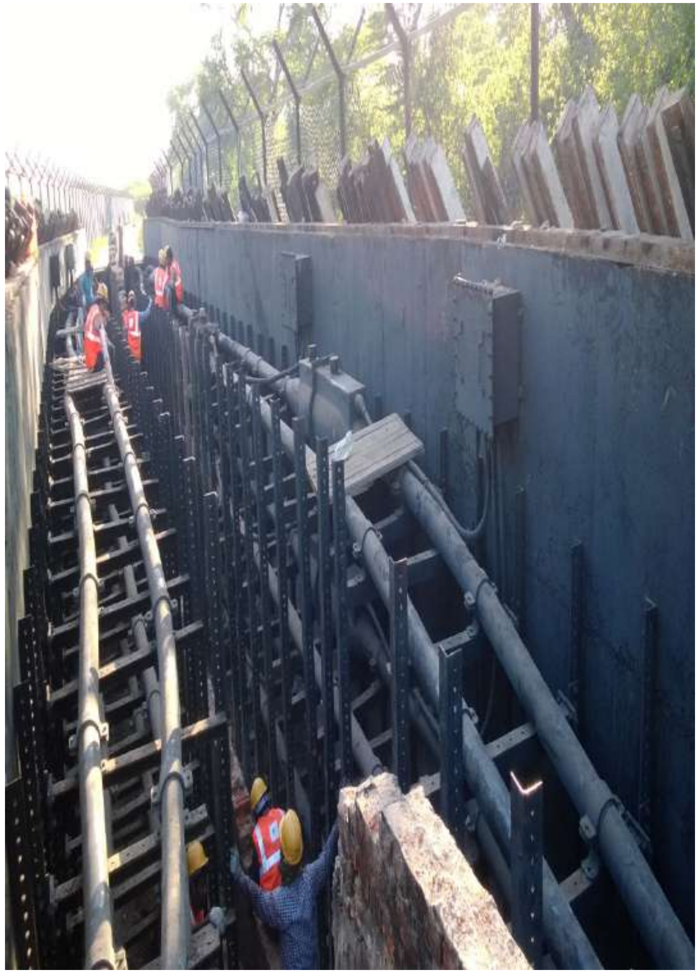
OPTIONS AVAILABLE FOR TRANSMISSION OF POWER

(A) LATTICE AND MONOPOLE STRUCTURE

(B) MONOPOLE WITH MULTI CKT & MULTI VOLTAGE

XLPE CABLE & GITL

(C) XLPE CABLE



(D) GITL ABOVE GROUND

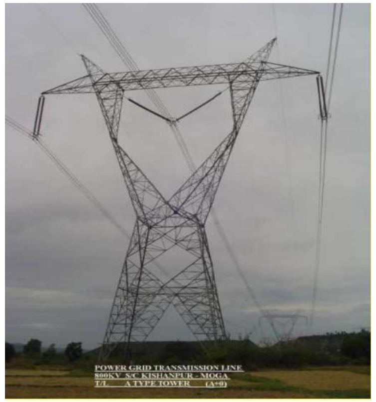
(E) GITL UNDERGROUND

ROW Depends on

- Configuration of Tower [S/C (Horizontal / Delta) or D/C)
- Span length
- Sag of Conductor

  [Depends on type of conductor used and maximum operating temperature of the conductor, Span]
- Length of Cross arm length / Distance from centre line of tower

  [Depends on swing angle, wind velocity, metal clearance, cage width or tower body width at bottom conductor location]
- Minimum horizontal safety clearance
- Configuration of insulators and Length of insulator string [I, V, Y]
- Wind velocity and angle of swing
- Electrostatic field below bottom most conductor (10kv/m) and at edge of RoW (5kV/m) at about 1.8m / 2.0m above Ground



Central Electricity Authority (Measures relating to Safety and Electric Supply), Regulations 2010

Clearance from buildings of lines of voltage and service lines not exceeding 650 Volts.- (1) An overhead line shall not cross over an existing building as far as possible and no building shall be constructed under an existing overhead line.

(2) Where an overhead line of voltage not exceeding 650 V passes above or adjacent to or terminates on any building, the following minimum clearances from any accessible point, on the basis of maximum sag, shall be observed, namely:-

(i) for any flat roof, open balcony, varandah roof and lean-to-roof-

(a) when the line passes above the building a vertical clearance of 2.5 metres from the highest point, and

(b) when the line passes adjacent to the building a horizontal clearance of 1.2 metres from the nearest point, and

(ii) for pitched roof-

(a) when the line passes above the building a vertical clearance of 2.5 metres immediately under the line, and

(b) when the line passes adjacent to the building a horizontal clearance of 1.2 metres.


POWER GRID TRANSMISSION LINE
800KV S/C KISHANPUR - MOGA
T/L A TYPE TOWER (A+0)

Right of Way (RoW)

Voltage Level (kV)	Conductor	Span (m)	Minimum Electrical Clearance (m)	RoW (m) (existing)
66	Wolf	250/200	2.3	18
132	Panther	320/200	2.9	27
220	Zebra	350/200	3.8	35
400	Moose	400/250	5.6	46
765 (S/C delta)	Bersimis	400/250	9.0	64
765 (D/C)	Hexa Zebra	400/250	9.0	67
1200	Moose	400/250	13.0	89
+/- 500 HVDC	Lapwing	400/250	7.4	52
+/- 800 HVDC	Lapwing	400/250	10.6	69

Option available for optimization and Optimum utilization of RoW including Urban / Forest areas

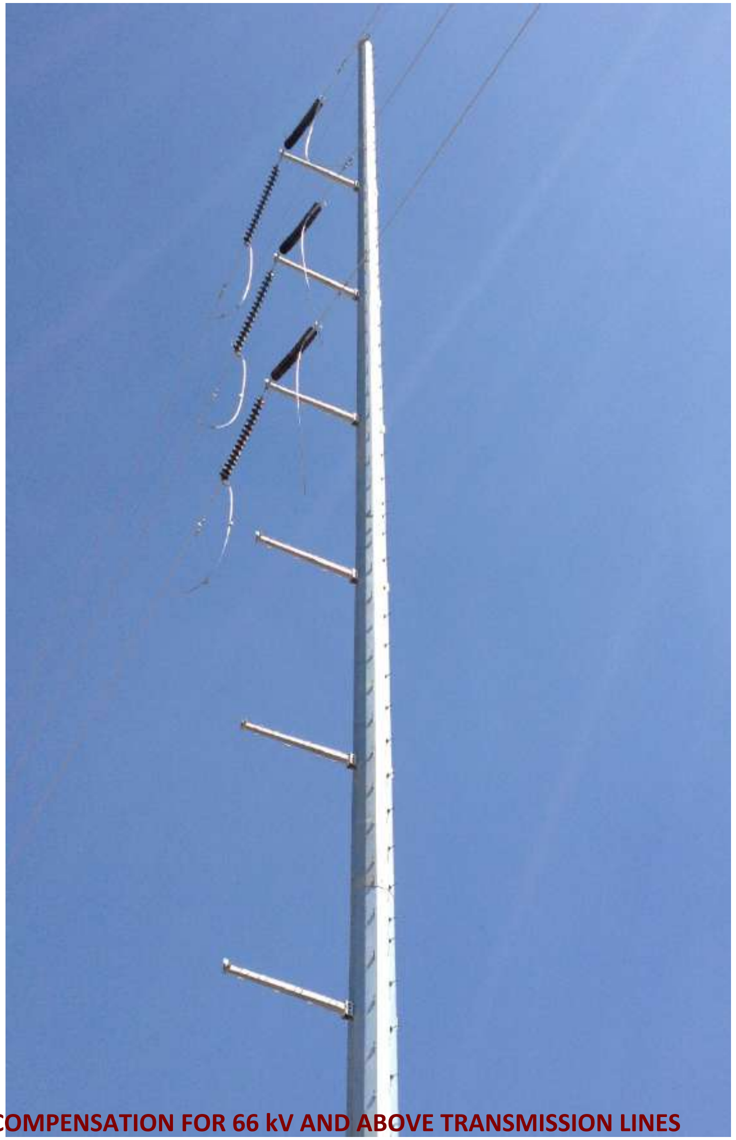
Sl. No11	Description
1	Reduction in Span length
2	Use of Tension towers
3	Reduction in foot print of tower base [Monopole, Narrow base]
4	Use of Multi-circuit towers
5	Use of Muti-circuit & Multi-voltage towers to reduce RoW
6	Upgrading of the existing line or urating with high Ampacity conductor (HT/HTS) in the existing corridor
7	Use of Monopole with one side stringing
8	Use of XLPE cable / GITL

Option available for optimization and Optimum utilization of RoW including Urban / Forest areas

Sl. No11	Description
9	Use of multi-circuit / multi-voltage with extended towers to save trees (without cutting of trees) maintaining required safety clearance over the trees [as done in case of Jaldapara Reserve forest area by PGCIL]
10	Use of compact tower with insulated cross arm
11	Possibility of use of VSC based HVDC can be explored
12	Use of covered conductors upto 66kV level

Raised Tower height requiring no cutting of trees (Multi ckt & mutli voltage)

Monopole Structure stringing on one side

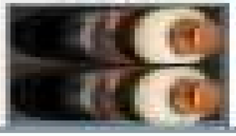


Underground GITL

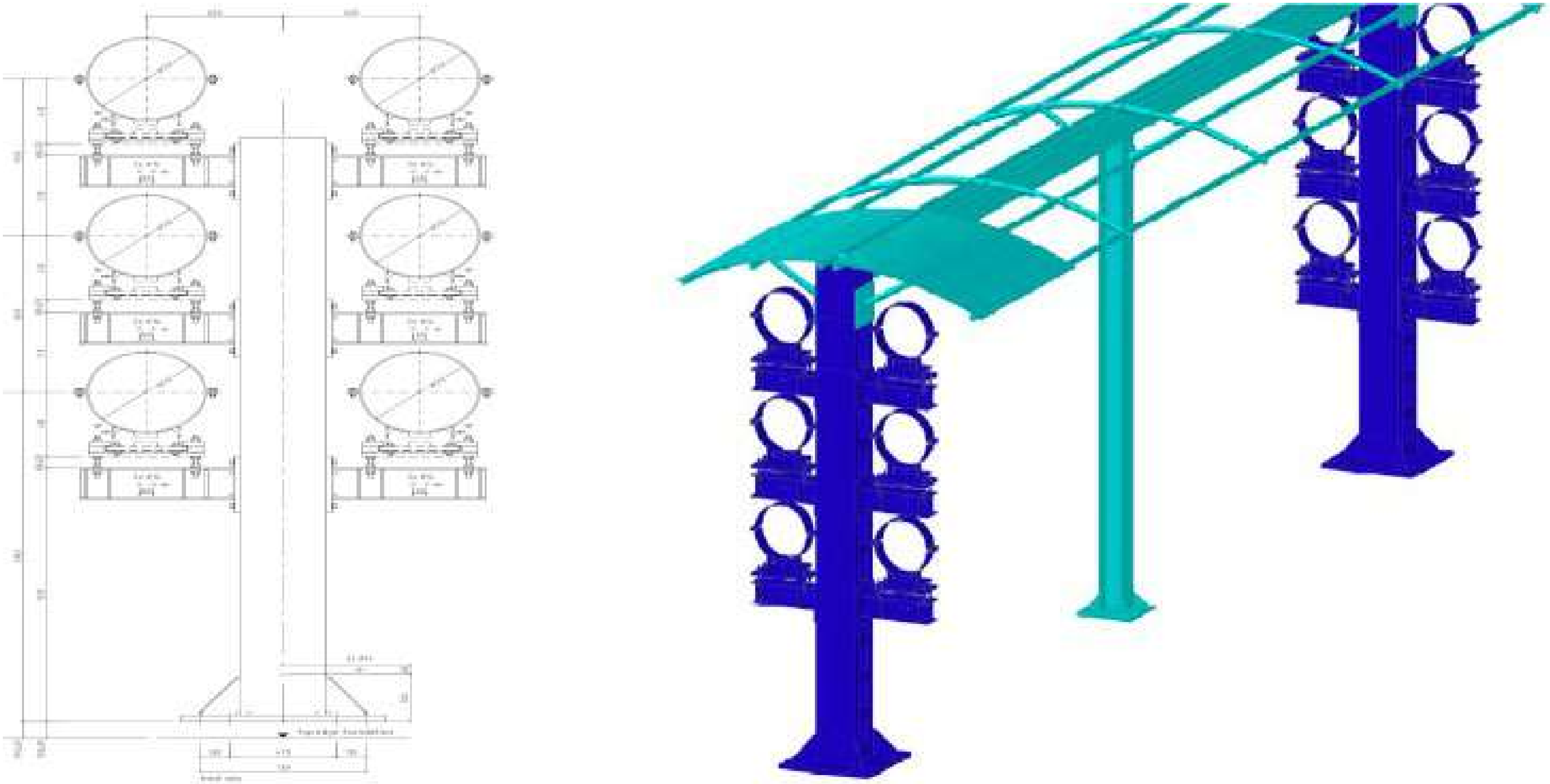
Prospect of Gas Insulated Lines

	GIL	XLPE Cable 2.500 mm2 (Cu)
Current	up to 5.000 A	up to 1.800 A (depending on ground)
Voltage	up to 550 kV	up to 550 kV
Capacity	55 nF/km	210 nF/km
Operational behavior	Same distance protection Pattern as in OHL circuits	Adopted distance protection pattern needed for cable sections
Electromagnetic behaviors	Meets most stringent governmental requirements (e.g. Switzerland)	>10 times higher EMF values

Areas of Use

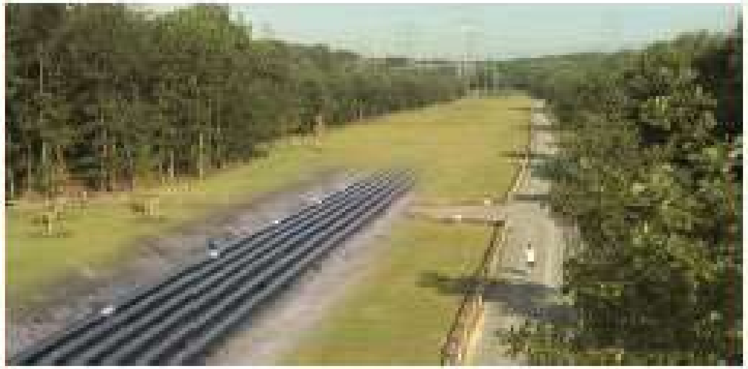
Application fields for transmission lines	OHL 	GIL 	Cable 
Lines with special constraints, requiring underground solutions (e.g., close to airports, through cities or villages, in space-restricted areas, <u>right of way</u> etc.)		✓	✓
Underground lines with power < ~ 2000A		(✓)	✓
Underground lines with power > ~ 2000A		✓	(✓)
Special requirements concerning EMF for AC		✓	
Installations where fire protection and / or explosion protection is crucial		✓	
Vertical transmission solutions		✓	
Standard lines in rural area	✓		

GIL Installation Arrangement- Above ground




SIEMENS

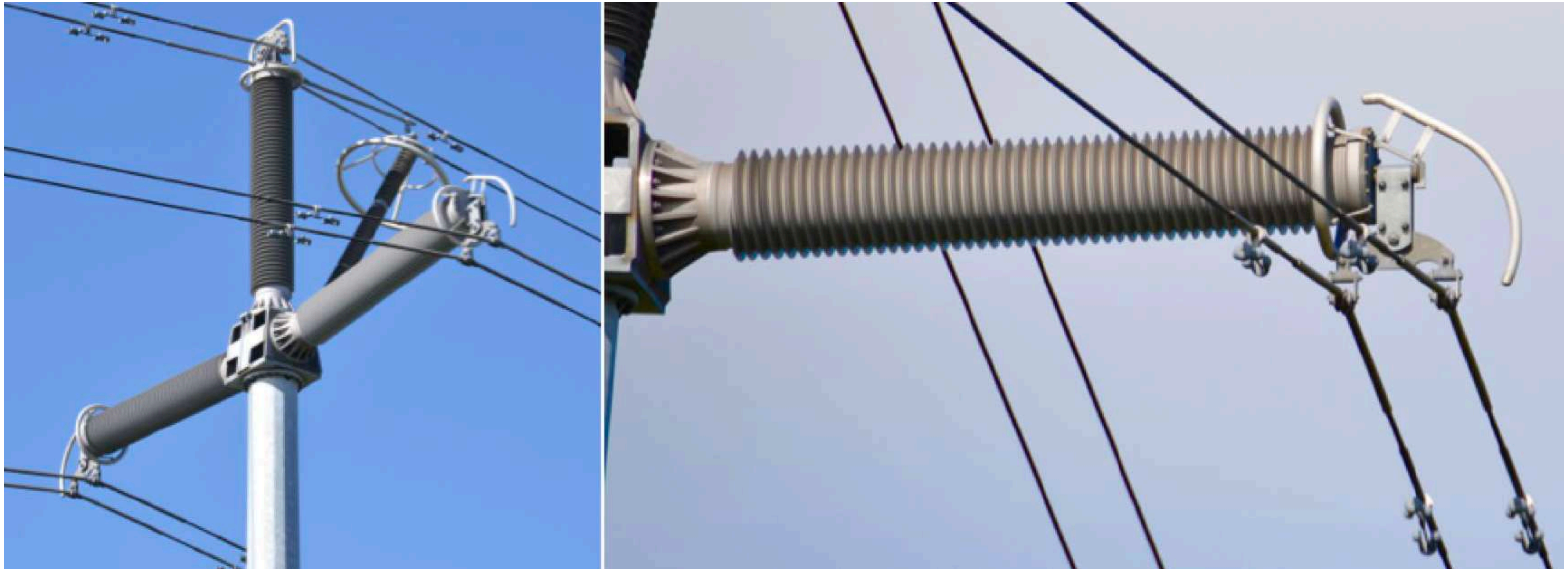
1 Transmission lines



2 Hydro power plants – vertical GILs

3 Substations and conventional power plants

400kV Hollow core composite Post Insulator with inner FRP tube



- Once the RoW corridor width is generalized, further optimization of ROW by reduction of span length and use of tension towers etc., may be considered for forest and urban areas

Route of Transmission line can be divided into three (3) broad category

- Normal Route
- Route through Reserved forest area
- Route through Urban areas / Populated area

Further Action by CEA:

CEA's Regulations on Safety and Technical Standard for construction of Electric Lines are under revision to include:

(a)Multi-circuit towers (more than two circuits) for 400kV and double circuit towers for 765kV transmission line shall preferably be used in approach section of substation / switchyard.

(b)The upgradation of existing AC transmission line to higher voltage AC line with multi circuits / multi voltages / compact AC line or HVDC line (VSC / LCC based) and uprating by use of new generation High Temperature Low Sag (HTLS) / High Ampacity conductors may be planned for electric power delivery system for efficient transmission of energy by way of enhancement of power flow per unit (per meter) of Right of Way (RoW), reduction in losses and for addressing growing congestion in existing corridor of transmission network and RoW problems.

THANK YOU

FOR

YOUR ATTENTION

Possibilities of reduction of transmission corridor width/adequate safety measures/revisiting clearance requirements

Objectives

- To explore the technological options for reducing the tower footing /base area/ corridor requirements
- To explore possibilities of reduction of transmission corridor width/selective restricted use of corridor in urban zones by using technical advances /raising heights of towers/adequate safety measures/revisiting clearance requirements especially for 220 kV and 132 kV levels

Optimizing Right of Way Width

S.no	Factors contributing to the RoW width	Options available for optimization of RoW
1.	Configuration of the Tower	a) Use of Narrow Base Multi circuit Tower b) Use of different voltage levels on Multi circuit tower
2.	Live Metal Clearance	No options available for optimization as clearances are to be maintained as per Standards
3.	Horizontal Clearances	No options available for optimization as Horizontal Clearance based on Safety norms cannot be compromised.
4.	Swing and Sag	a) Use of V Suspension String b) Use of HTLS Conductor c) Use of Tension tower d) Tower span

List of broad parameters/factors to carry out the calculation of RoW for different voltage types

S.no	Parameters affecting RoW	Voltage Levels									
		66 kV D/C	110 kVD/C	132 kVD/C	220 kVD/C	400 kVD/C	500 kV HVDC	800 kV HVDC	765 kV S/C (Horizontal / Delta)	765 kV D/C	1200 kV S/C
1	Type of Conductor	Wolf	Panther	Panther	Zebra	Twin/Quad Moose	Quad Lapwing	Hexa Lapwing	Quad Bersimis	Hex Zebra	Octa Moose
2(a)	Design Span (in metres)	250	320	320	350	400					
(b)		200				250					
3	Conductor Operating Temperature	85 degrees Centigrade (maximum)									
4	String type	I String				I & V String both					
5	Cage Width	Narrow Base & Conventional broad base towers. Tower outline diagram showing various dimensions and clearances with maximum swing									
6	Swing Angle	35 degrees									
7 (a)	Minimum Safety (line conductor to ground object) Clearances	To withstand Lightening Surges				To withstand Switching surges					
(b)		Minimum horizontal clearances as per Safety Regulations									