Cost Benefit Analysis of High Voltage Distribution System(HVDS)

Low Voltage Distribution System (LVDS) system

For supplying the power to the consumers, it is generally a practice of Distribution company (Discom) to lay 11KV lines from 33/11Kv Substation, erect a 3phase 11kv/0.415KV Distribution Transformer (DT) substation at one convenient location, and then lay long LT lines up to the nearest load center to give connections to the consumers /households.

In this case, DTs of various capacities, depending on load requirement are installed to supply the power to one or more than one consumers. If loads of consumers are less, then even more consumers would be supplied from one DT.

Disadvantages with LVDS

i. Poor tail end voltages/poor voltage regulation.
ii. High technical losses due to more line losses in longer LT lines.
iii. More scope of power theft due to accessibility of bare LT lines
iv. Frequent jumper cuts and fuse blow outs at DT level due to over loading etc.
v. Fault in a single high capacity DT like in LVDS affects the entire consumers connected to it, and this causes a total outage, poor availability and reliability of power supply to the consumers in the area.
vi. Difficulty to augment the DT capacity (in case the existing DT is overloaded) due to non-availability of space (for DT beyond 200KVA capacity). To accommodate bigger size DTs, changes would be required in DT mounting structure or DT to be installed on Plinth structure.
vii. To avoid the pilferage of electrical energy due to theft by hooking/ tapping the LT lines, conversion of longer LT overhead lines with bare conductors to Aerial Bunched Cables (ABC) through overhead or underground system is more expensive.

High Voltage Distribution System(HVDS), as discussed below, is one of the techniques to overcome above disadvantages.

High Voltage Distribution System(HVDS)

To improve quality (Voltage profile) of electric supply and reduce losses in the system, HVDS can be used by the Discoms as an alternate to LVDS, in which 11 KV lines are extended upto or as nearer to the load center as possible, and small size transformers ranging from 10KVA to 100KVA etc, depending on load requirement can be installed to supply power to consumers.

To avoid the pilferage of electrical energy due to theft by hooking the LT lines, LT line with insulated wires like Aerial Bunched Cables (ABC) can be installed through overhead or undergone system. This system requires more DTs, its associated accessories, more HT lines and less LT lines than LVDS system.

Advantages of HVDS:

i. Low technical losses due to reduction of LT lines
ii. Loss due to theft/tapping can be reduced /eliminated in smaller length of LT lines & by use of ABC conductors with less expenses.
iii. Improved voltage regulation at consumer end due to low voltage drop resulting from less loading and shorter line length.
iv. Fault in any single DT will cause an outage for a limited numbers of consumers connected to it, leading to improved availability and reliability of power supply to the other consumer consumers in the area.
v. Reduced physical zone of supply and number of consumer through a lower capacity DT will lead to development of community consciousness and ownership feeling. This will be helpful in timely maintenance of transformer and curb on theft.
vi. Ease of augmentation of DT capacity in case of increase of load.
vii. Help in reducing the demand in distribution, transmission and generating system when used in large scale by Discoms.

Disadvantages of HVDS:

i. More Capital expenditure and more O&M Expenditure due to large numbers of DTs and its related accessories.
ii. More requirement of associated accessories and stocks need to be maintained.
iii. HVDS will contribute more for increase in system fault level, and therefore, there will be a need to upgrade short circuit level of equipment, protection system and re-coordination of the settings in the protection system after certain time period.

As with all systems, there exists pros and cons in HVDS also. Therefore, the selection of the HVDS over LVDS should be based on Cost-Benefit Analysis arrived at by comparing two systems under similar conditions for entire useful life.

In order to carry out the Cost-Benefit Analysis of LVDS and HVDS, a simple network has been considered and the impact in the load feeder by replacing a LVDS with HVDS has been analyzed. The scenario for elimination of existing level of electricity theft (considered at 2% of load) has also been considered by replacing the bare conductor in LT lines of LVDS system with ABC in HVDS. The network configuration adopted is at Annexure. Other assumptions are as below:

Assumptions:

1. Load in the area, has been maintained same on both the systems, except in the HVDS with ABC in LT Lines, reduced load has been considered to the extent of the theft existing in LVDS(considered at 2% of load).

2. Similar Star rated transformers in both the system have been considered
3. Uniform 3-phase system for LT side and HT side, and same conductor have been considered.
4. Average Unit Rate of Electricity has been considered at Rs 4.5 /Unit (for calculation system loss to equivalent Rs loss for Payback period.
5. Full load for the system for about 2920 hrs (33%) in a year and average load (50% level) for balance period has been considered.
6. Discount rate of 10% per year has been considered for Present Value (PV) calculation.
7. **Cost Estimates:**
   a) 11 kV OH line (with Bare conductor) = 4.5 lacs/km (3-phase, 3-wire)
   b) LT OH line (with Bare conductor) = 3.5 lacs/km (3-phase, 4-wire)
   c) LT OH line (with ABC conductor) = 8.0 lacs/km (3-phase, 4-wire)
   d) Cost of installation of DTs and related parameters

Rating (KVA)	Max. Losses at 50% loading (Watts)	Max. Losses at 100% loading (Watts)	Cost of system (in Lac)
12.5	120	375	1.35
25	175	480	1.57
50	360	550	2.15
63	400	580	2.50
100	520	1800	3.00
250	1117	3688	6.5

Following two scenarios has been analyzed with above assumptions and data.

Scenario-I

In the present case of study, following configuration for LVDS and HVDS, and the related parameters of DTs as shown above at sr no-7 of assumptions and Loading patterns has been considered.

Items	**LVDS System**	**HVDS System**
No. of DTs	1	**8**
Capacity of DTs, KVA, each	100	**12.5**
Capacity of DTs, KVA, aggregate	100	**100**
Length of HT line, kms	0.5, single line	3.0, (two lines)
Length of LT line, kms	3.5, (two lines)	0.8, (eight lines)
Cost of Total System, Rs lacs	17.50	**27.10 (bare conductor), 30.70 (with ABC)**
Loading pattern	Peak Load=100% of (peak load=connected load) for 8hrs/day	
	Off peak Load =50% of (peak load=connected load) for 16hrs/day	

Summary of Results for 25years and Present Value basis (Scenario-I):

Sr No	Details	HVDS with Bare conductor in LT	HVDS with ABC in LT
i	Additional investment in HVDS	9.60 lacs	13.20 lacs
ii	Additional O&M cost in HVDS	43.57 lacs	59.91lacs
iii	Total of Additional Investment	53.17 lacs	73.11 lacs
iv	Savings of system loss in HVDS	244.95 lacs	187.24 lacs
v	Payback period	0.217066 years/ 2.6947 months	0.390449 years/ 4.6853 months

Scenario-II

In the present case of study, following configuration for LVDS and HVDS and the related parameters of DTs as shown above at sr no-7of assumptions has been considered.

Items	LVDS System:	HVDS System:
No. of DTs	1	**8**
Capacity of DTs, KVA, each	250	**2x50+6x25**
Capacity of DTs, KVA, aggregate	250	**250**
Length of HT line, kms	0.5 single line	3.0 (two lines)
Length of LT line, kms	3.5 (two lines)	0.8 (eight lines)
Cost of System, lacs	21.00	30.02 **(bare conductor)** **33.62 (with ABC)**
Loading pattern	Peak Load=100% of (peak load=connected load) for 8hrs/day	
	Off peak Load =50% of (peak load=connected load) for 16hrs/day	

Summary of Results for 25years and Present Value basis (Scenario-II):

Sr No	Details	HVDS with Bare conductor in LT	HVDS with ABC in LT
i	Additional investment in HVDS	9.02 lacs	12.62 lacs
ii	Additional O&M cost in HVDS	40.94 lacs	57.28 lacs
iii	Total of Additional Investment	49.96 lacs	69.90 lacs
iv	Savings of system loss in HVDS	1854.38 lacs	1788.3064 lacs
v	Payback period	0.026940 years/ 0.323282 months	0.039085 years/ 0.469021 months

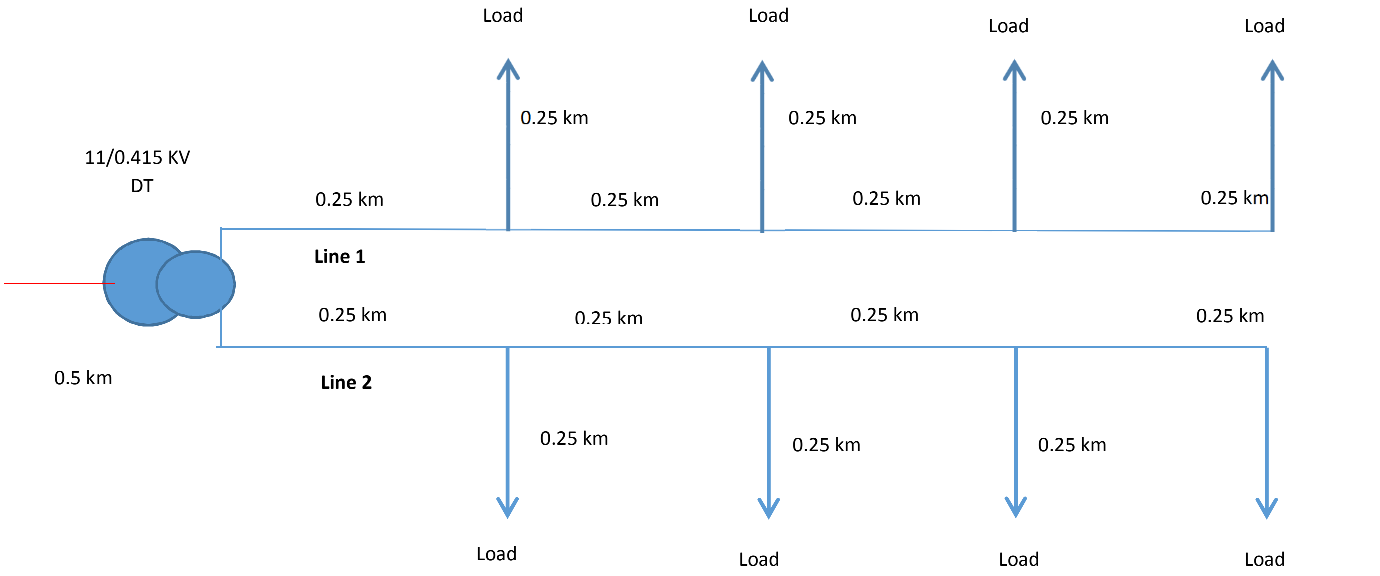
Conclusion:

From the two scenario of analysis presented above, it can be concluded that if a system with higher loads in LVDS is replaced by HVDS (with ABC or bare conductor in LT system), then not only the cost of investment is recovered in very short span of time, but also help improve the consumer satisfaction on account of reliable power supply and stable voltage profile available in the feeder.

Annexure

Configuration of LVDS and HVDS considered

LVDS



HVDS