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ENERGY EFFICIENCY AND RELIABILITY IN ELECTRICAL DISTRIBUTION NETWORK BY IMPLEMENTING HIGH VOLTAGE DISTRIBUTION SYSTEM

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ABSTRACT
The paper presents Energy Efficiency(EE) and Reliability in Electrical Distribution System . In the Distribution Handling System (DHS), the vital necessity for the improvement of Energy Efficiency is loss reduction. About 10% of power generated is lost in its delivery System. Out of this, about 40% loss happens in distribution system.
Loss saving can be realized by governing the current flow through the conductors. Also, control of Reactive Volt Ampere (VAR) flow in the electrical network results in loss reduction. Voltage profile improvement occurs due to loss reduction. Traditionally, the most obtainable Reactive Volt Ampere resources in the distribution system are switchable shunt capacitor banks. Nowadays, Distributed Energy Resources(DER) are another added important VAR resource because of their growing penetration, that brings innovative chances as well as encounters for loss saving. By the coordinated control of these switchable shunt capacitor banks and Distributed Energy Resources, optimum loss reduction and power quality of distribution network can be realized. Distribution utilities, also, adopt On Load Tap Changer (OLTC), for voltage profile improvement . Another effective technique for enhancement of voltage profile and loss reduction in distribution network is implementation of High Voltage Distribution System (HVDS). Re-arranging the existing Low Voltage Distribution System (LVDS) into High Voltage Distribution System (HVDS). A large capacity Distribution Transformer (DTR) in Low Voltage Distribution System is replaced with many number of small capacity Distribution Transformers in High Voltage Distribution System. This paper presents the analysis of High Voltage Distribution System (HVDS), which is the best method to enhance the Energy Efficiency and Reliability of an Electrical Distribution system. This method reduces the length of LT lines and results in loss reduction, voltage profile improvement, reduction of power failure rate, reduction of accidents, reliability etc. Also, unauthorized power theft can be avoided ,unlike in LVDS. Simulink modeling of the above system is done in MATLAB platform. The results show that HVDS system improves the voltage profile and minimize the loss and thus maintain power quality

KEYWORDS: Energy Efficiency, Distributed Energy Resources , Distributed Generation, Low Voltage Distribution System, High Voltage Distribution System, Distribution Handling System.

1. INTRODUCTION
The present scenario of Power Sector demands concentration in commercial and financial sustainability of utilities, for facing the increasing demands for power. Lots of funds are used in the augmentation of Generation. Energy Savings are better than energy Generated. India has healthier opportunities to implement Energy Efficient technologies[1]. It is necessary to improve the quality and economy of the electricity distribution procedure in India, which has increased, varying from year to year. Conventionally, in Electrical Distribution Network, voltage and power 3 loss are controlled by adopting On load Tap Changer (OLTC) and switched shunt capacitors [2],[3]and[4]. In most cases, these devices are operated locally without having coordination with others. Nowadays, factors such as environmental issues, system expansion regulations, and fast developments in Distributed Energy Resources(DERs) have led to the high penetration of DERs in distribution

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systems. DERs are an important Reactive Volt Ampere (VAR) resource in the distribution network [5]- [6]. Distributed Generation (DG) changes power flows, which affects the voltage and reactive power control in distribution network[7]. Therefore, in the presence of Distributed Generation, coordinated voltage and reactive power control is needed.[8]-[9] Optimum VAR flow and voltage profile could not be achieved by local voltage control operation in the distribution systems. It is possible with the coordination of voltage and VARpower control equipment [9]. Another technique for improvement of voltage profile and loss reduction in distribution network is implementation of High Voltage Distribution System(HVDS). Restructuring of an existing Low Voltage Distribution System (LVDS) in to High Voltage Distribution System(HVDS), which is known as one of the solutions to attain better voltage and loss profile and reliable supply. A large capacity Distribution Transformer (DTR) in Low Voltage Distribution System is replaced with many number of small capacity Distribution Transformers in High Voltage Distribution System. HVDS is considered as the best method to improve the performance of a distribution network by achieving net decrease in technical losses in the distribution network.[11]- [12]. Existing LVDS system, has high energy loss and poor voltage profile. It is possible to decrease the power losses and improve voltage profile, in a short period of time, with low payback period. This can be achieved by implementing HVDS. In HVDS, small capacity Distribution Transformers are used and HT line i.e.,11 kV line is run up to or near to the consumer load as possible and install small rated distribution transformer, (15 kVA) to provide supply to the consumers through a short distance of LV service line [10]. Providing electric supply to 5 to 9 consumers with least low voltage lines. Results of the load flow analysis shows a huge reduction of line losses, which is reduced to about 5%. Also, there is no chance of unauthorized power tapping on HT lines and end consumer will get constant voltage and the voltage drop is very less when comparing with existing LVDS system[13]. HVDS system reduces both technical and non - technical losses, to an appreciable level, in distribution system. The non- technical losses include power theft, irregular billing, unauthorized electric connections, and the technical losses include I2R power losses[14]. These power losses affect the quality of power supply, in respect of voltage magnitude, and more tariff charge on genuine consumers. The voltage profile can be improved by reducing I2R power losses. [15]

2. MATERIALS AND METHODS

Analysis of existing and proposed distribution systems

Analysis of Existing Distribution System:-

The existing Low Voltage Distribution System (LVDS) of the Kerala State Electricity Board Ltd(KSEBL) at an area named "Peyad" in Thiruvananthapuram district of Kerala State, is analyzed for power loss and voltage profile. Fig.1 shows the existing three-phase LT, 433 V Electrical distribution system of "Peyad" area.

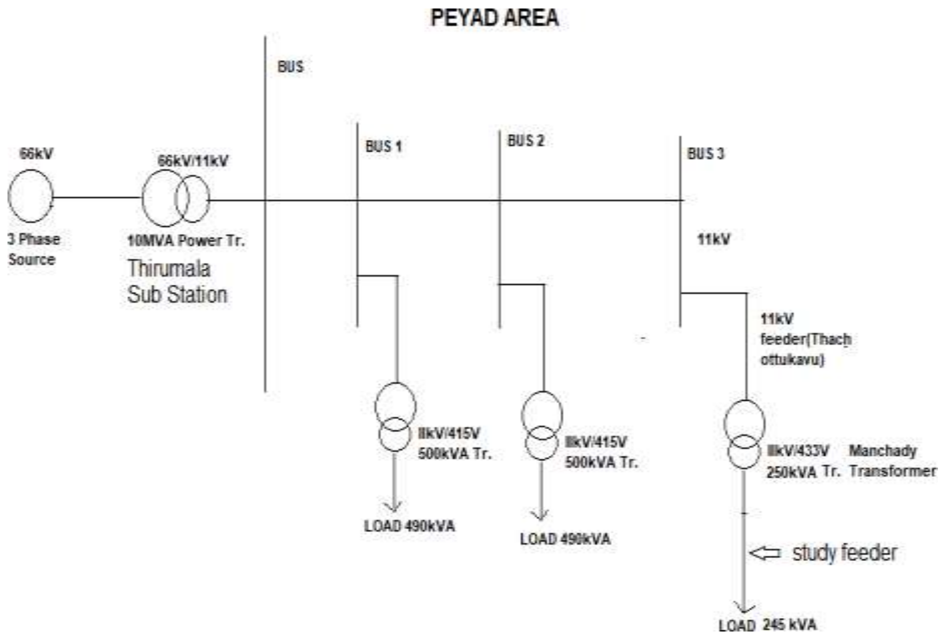

Fig.1. KSEBL Electrical Distribution in "Peyad" Area

The LT lines coming from "Manchady" Transformer of capacity 250kVA,11kV/433V and is installed in the"Peyad- Thachhottukavu" named 11kV feeder . Electric supply to the consumers of this 250kVA Transformer is effected by drawing long run of LT lines to consumer ends. Particulars of this Low Voltage Distribution System(LVDS) are given in Table 1.

Table 1. Particulars of LVDS

Sl No	Particulars of LVDS	Remarks
1	Nature of load on Transformer	95% loaded
2	Category of Consumers	Domestic and Commercial
3	Length of the LT lines	0.8Km
4	Conductor &Conductor Resistance/KM	Rabbit, 0.5426
5	Connected Load	245kVA

The existing LVDS is analyzed and evaluated the voltage profile and power loss, for different load profile. That is at peak load time (6pm to10pm), normal load time(6am to 6pm) and at off peak time(6pm to 6am). At peak load time, maximum consumer load comes in to the system and at normal load time, normal load comes and at off peak load time, least load comes in to the system.

Determination of Power Loss

The calculation of losses in power lines and distribution transformer for both existing LT system and proposed HVDS system are calculated as follows.

Line loss in KW = 3 x[(Cum load in kVA/(1.732xvoltage in KV x DF) ^{2} x Length in Km x Resistance per Km/1000]

Line loss in Units = 3 x [(Cum load in KVA/ (1.732 x voltage in KV x DF)^2 x Length in Km x Resistance per Km x LLF x 8760] /1000

Where;

Voltage = 11 KV for HT line & 433V for LT line
Diversity factor(DF) =1.5forHTline&1.1forLTline
Load Factor (LF) = 0.18 for HT line = 0.36 for LT line
Line Loss Factor (LLF) = 0.36 for HT line & 0.18 for LT line

Total loss, $P_T = P_L + P_O + P$
Total Loss per annum, $P_a = (P_T \text{x } 8 \text{ x } 365) /(1000)$
Reduction in Losses = Losses in existing LVDS − Losses in proposed HVDS
Annual Savings = Price of a unit x Reduction in Losses
Capital outlay = Total transformer cost + Miscellaneous cost (includes cost of labor, cost of dismantling the existing mains)
Payback Period = (Capital Outlay / Annual Savings)
Where,
P = Total power loss in the line
P_L= Transformer load losses
P_O= Transformer no load losses
P_a= Total loss per annum
Number of hours per day= 24
Number of days in a year = 365
Price of a unit is taken as Rs. 5

Table 2: Transformer No Load Loss and Load Losses

Sl No	Distribution Transformer kVA rating	No load/ Iron losses of Transformer (watts)	Load / Copper losses of Transformer (watts)
1	250	750	4625
2	15	60	275

Algorithm for determining Voltage Profile and Loss reduction

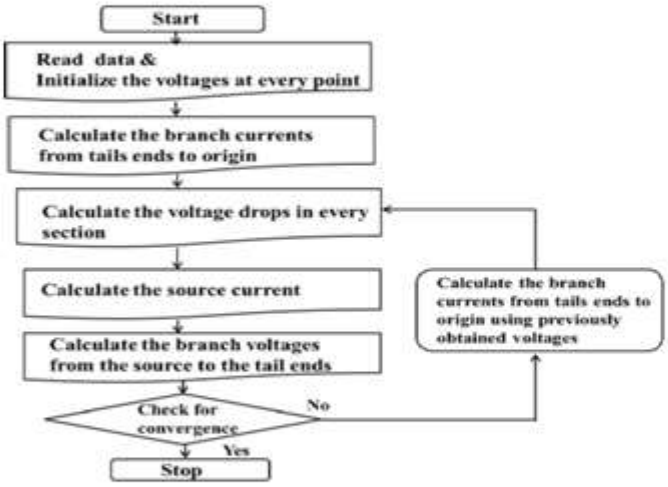

Fig. 2: Algorithm for determining Voltage Profile and Loss reduction in Distribution System

On Analysis of the existing LVDS System, it is seen that the voltage to the consumers is decreasing as the distance of the consumers from the power supplying transformer (here one 250kVA, 11kV/433V Transformer), increases. This is because of the long run of LT lines. Decreased voltage affects the proper functioning of consumer equipment/appliances. The line losses I^2R loss, in different line segments of LT line, are comparatively more.

Drawbacks of LVDS

i Huge losses, low (poor) tail end voltages, more voltage fluctuations, frequent power interruptions.
ii Because of frequent failures of Distribution Transformer, high expenses need for the maintenance and repair of Transformers.
iii Very difficult to monitor the unauthorized tapping on LT lines or power theft.
iv If failure of large capacity distribution transformer happens, it has to be replaced or repaired, which takes more time and also, more consumers will be affected.

Analysis of the Proposed Distribution System (Replacement of LVDS with HVDS)

The proposed system is the replacement of existing Low Voltage Distribution System (LVDS) with High Voltage Distribution System(HVDS), where High Voltage lines (11kV) are run long distance (i.e, near to consumer end) and using many number of small capacity DTRs. Instead of the existing 250kVA,11kV/433V distribution Transformer("Manchady" named Transformer), 17 nos. small size transformers of capacity 15kVA,11kV/433V, are mounted on 9 meter PSC poles(which are already there and 50m apart) and drawing HT lines(11kV) through these poles and supply is fed to consumers from these pole mounted small capacity Transformers, using short length low voltage lines i.e., weather proof wires. This arrangement reduces the long run of LT lines. Fig.3 shows the pole mounting arrangement of small rating (15kVA) Distribution Transformer for HVDS.

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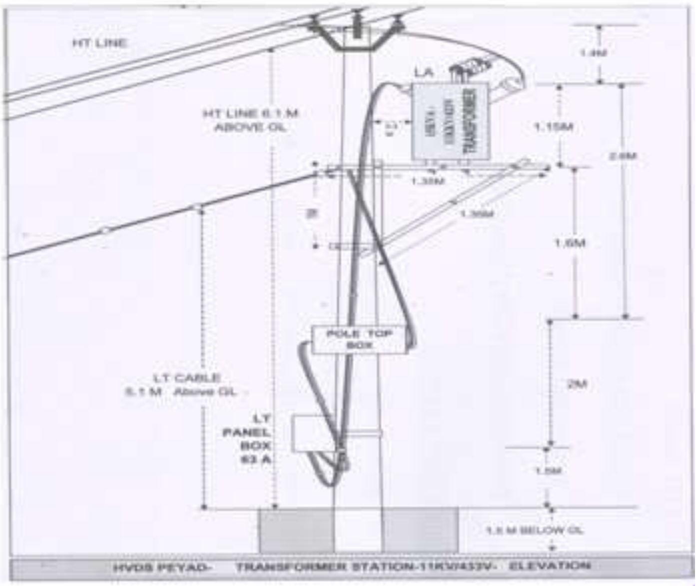

Fig.3: Pole mounting arrangement of small rating Distribution Transformer for HVDS

The below table 3shows the particulars of HVDS.

Table 3: Particulars of HVDS

Sl.No.	Particulars	LVDS	HVDS
1	Length of the HT lines		0.8Km
2	Length of the LT lines	0.8Km	
3	Conductor	Rabbit	Racoon
4	Conductor Resistance per KM	0.5426	0.3623
5	Distribution Transformer(s)	1 no. 250kVA, 11kV/433V	17 nos. 15kVA, 11kV/433V

The proposed HVDS system is analyzed and evaluated the voltage profile and power loss, for different load profile. HVDS results in loss reduction, voltage profile improvement, reduction of power failure rate, reduction of accidents etc. Also, unauthorized power theft can be avoided.

3. RESULTS AND DISCUSSION

Matlab simulation results with LVDS

The MatLab circuit is developed for conducting LVDS analysis. MatLab simulation results with LVDS system for various load profile are given below.

At Peak Load

At peak load condition, the voltage waveforms at three poles (LVDS) are shown in fig. 4.

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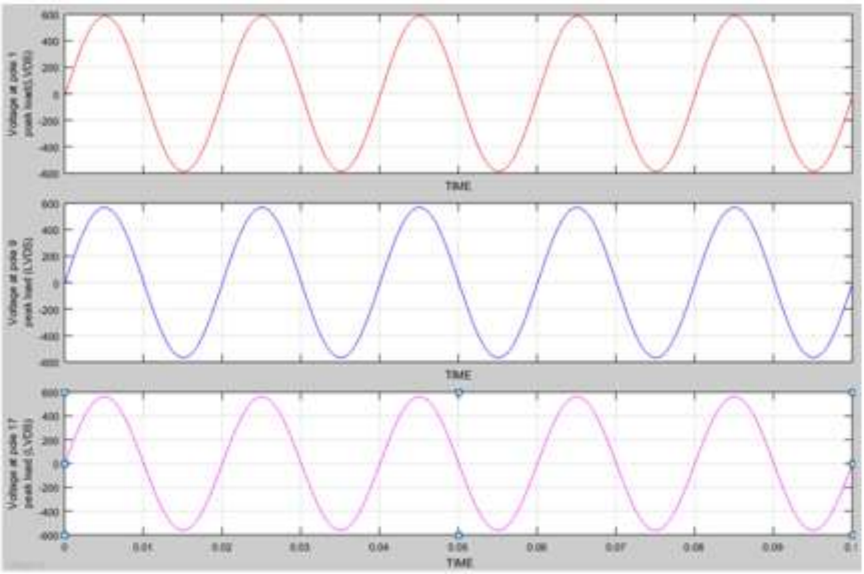

Fig. 4: Voltage Waveforms at three Poles - LVDS - Peak Load

At peak load condition, the waveforms of currents in LT line sections(LVDS) are shown in fig. 5.

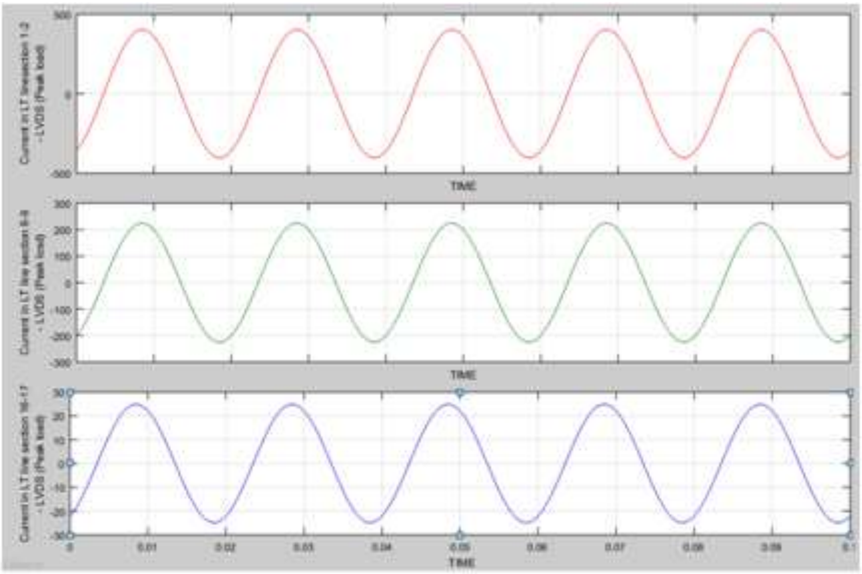

Fig.5: Current Waveforms in LT line Sections - LVDS – Peak Load

At Normal Load

At normal load condition, the voltage waveforms at three poles (LVDS) are shown in fig. 6

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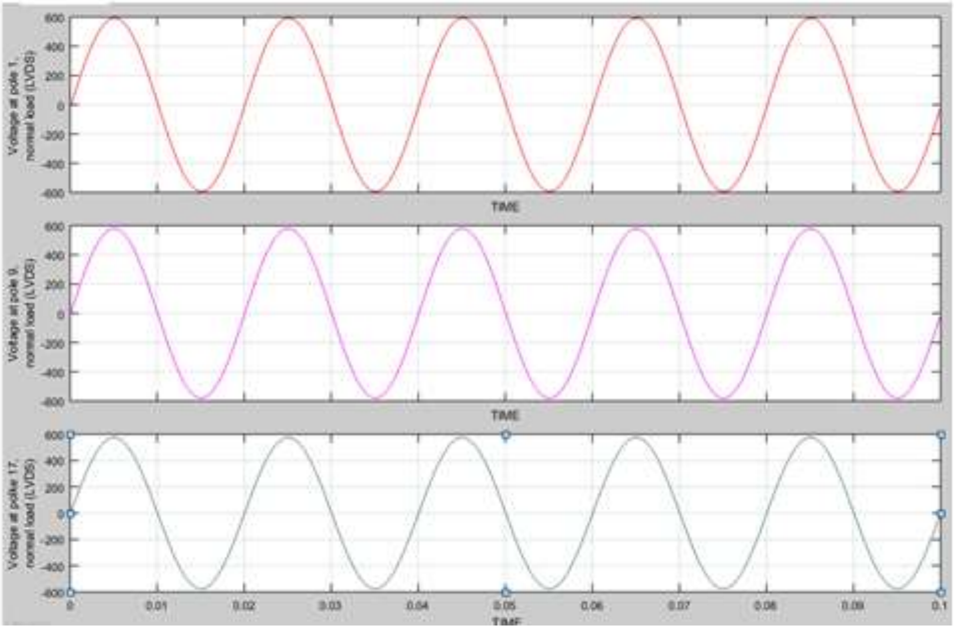

Fig 6: Voltage Waveforms at three Poles - LVDS - Normal Load

The waveforms of currents in LT line sections at normal load (LVDS) are shown in fig. 7.

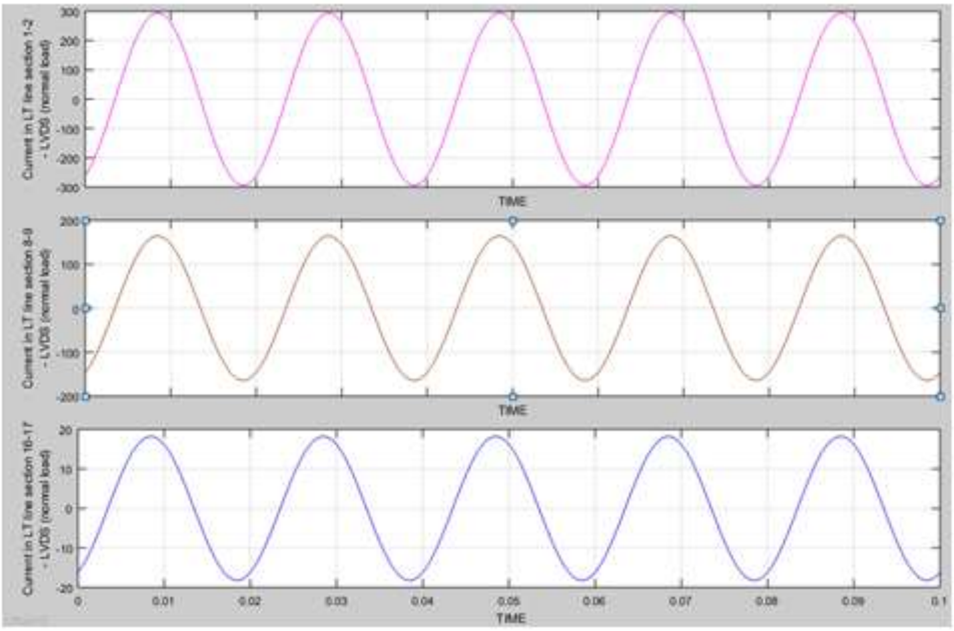

Fig.7: Current Waveforms in LT line Sections - LVDS - Normal Load

At Off-Peak Load

At off-peak load condition, the voltage waveforms at three poles (LVDS) are shown in fig.8.

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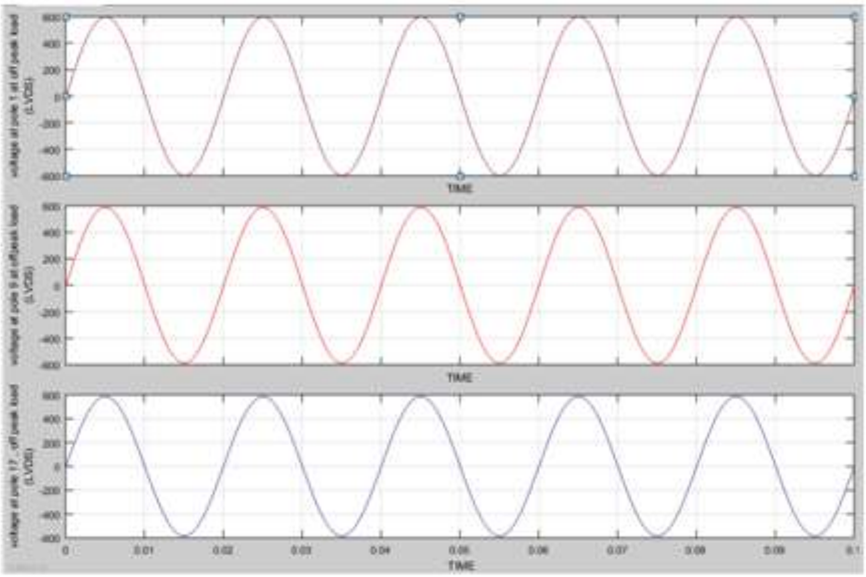

Fig. 8: Voltage Waveforms at three Poles LVDS - Off-peak Load

The waveforms of currents in LT line sections at off-peak load condition (LVDS) are shown in Fig. 9

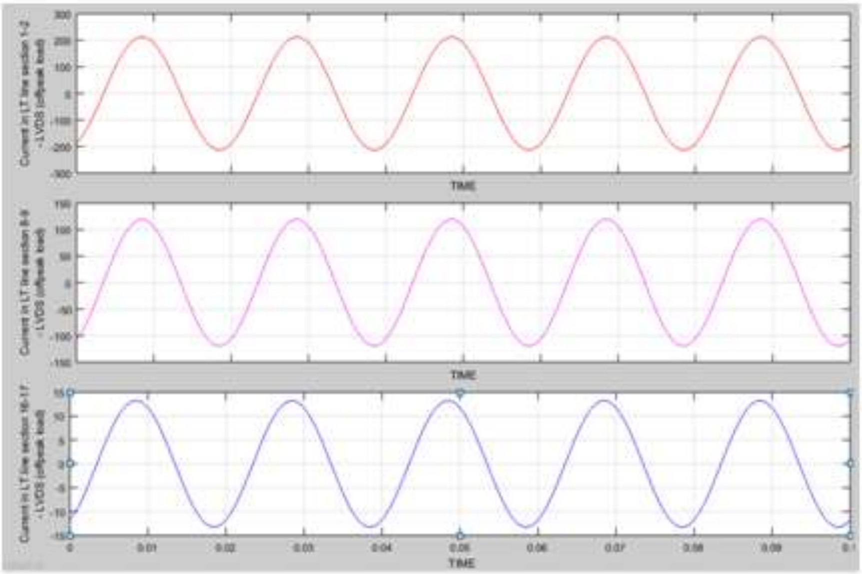

Fig.9: Current Waveforms in LT line Sections - LVDS - Off-peak Load

MatLab Simulation Readings with LVDS

The simulation readings such as voltage, currents and line loss for various load conditions with LVDS system are shown in below table 4.

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Table 4: Simulation Readings with LVDS for Various Load Conditions

	PEAK LOAD				NORMAL LOAD				OFF PEAK LOAD			
SL.NO.	VOLTAGE(V)	LINE SECTION	LINE SECTION CURRENT(A)	LINE LOSS(WATTS)	VOLTAGE(V)	LINE SECTION	LINE SECTION CURRENT(A)	LINE LOSS(WATTS)	VOLTAGE(V)	LINE SECTION	LINE SECTION CURRENT(A)	LINE LOSS(WATTS)
POLE 1	414.8	1 to 2	285.1	6615.54279	419.5	1 to 2	208.1	3524.643598	423	1 to 2	150.8	1850.86069
POLE 2	412.7	2 to 3	266.8	5793.52251	418	2 to 3	194.8	3088.509586	421.9	2 to 3	141.3	1625.00751
POLE 3	410.8	3 to 4	248.7	5034.10905	416.6	3 to 4	181.6	2684.124998	420.9	3 to 4	131.8	1413.84522
POLE 4	409	4 to 5	230.6	4328.02394	415.3	4 to 5	168.5	2310.845228	419.9	4 to 5	122.3	1217.37383
POLE 5	407.3	5 to 6	212.5	3675.26719	414	5 to 6	155.4	1965.500132	419	5 to 6	112.8	1035.59334
POLE 6	405.7	6 to 7	194.6	3082.17093	412.9	6 to 7	142.3	1648.089713	418.2	6 to 7	103.3	868.503737
POLE 7	404.3	7 to 8	176.7	2541.23102	411.9	7 to 8	129.3	1360.717901	417.5	7 to 8	93.88	717.327054
POLE 8	403.1	8 to 9	158.9	2055.0332	410.9	8 to 9	116.3	1100.855909	416.8	8 to 9	84.45	580.457405
POLE 9	401.9	9 to 10	141.1	1620.4106	410.1	9 to 10	103.3	868.5037371	416.2	9 to 10	75.03	458.185078
POLE 10	400.9	10 to 11	123.4	1239.37111	409.4	10 to 11	90.31	663.8083836	415.6	10 to 11	65.63	350.570895
POLE 11	400	11 to 12	105.7	909.328961	408.7	11 to 12	77.37	487.2100545	415.1	11 to 12	56.23	257.339952
POLE 12	399.2	12 to 13	88	630.28416	408.1	12 to 13	64.45	338.0779855	414.7	12 to 13	46.85	178.644742
POLE 13	398.6	13 to 14	70.37	403.038144	407.7	13 to 14	51.54	216.2020845	414.4	13 to 14	37.47	114.271633
POLE 14	398.1	14 to 15	52.76	226.558636	407.3	14 to 15	38.65	121.5822133	414.1	14 to 15	28.09	64.2206249
POLE 15	397.7	15 to 16	35.16	100.616402	407	15 to 16	25.76	54.00858086	413.9	15 to 16	18.73	28.5526619
POLE 16	397.5	16 to 17	17.58	25.1541004	406.8	16 to 17	12.88	13.50214522	413.8	16 to 17	9.363	7.13511694
POLE 17	397.3		TOTAL LOSS	38279.663	406.7		TOTAL LOSS	20446.182	413.7		TOTAL LOSS	10767.889

From the above results, it is seen that, on the existing LVDS System, the voltage to the consumers is decreasing as distance from the power supplying transformer (here one 250kVA, 11kV/433V Transformer), increases. This is because of the long run of LT lines. The line losses I^2R loss, in different line segments of LT line, is comparatively more. At normal load time, voltages are more than peak time, as load is less and losses are less. At off peak time, voltages are more than peak & normal time, as load is much less and losses are the least.

At peak load time, maximum consumer load comes in to the system and at normal load time, normal load comes and at off peak load time, least load comes in to the system.

Matlab simulation results with HVDS (proposed system)
The MatLab circuit is developed for conducting HVDS analysis and the MatLab simulation results with HVDS system for various load profile are given below.

At Peak Load
At peak load condition, the voltage waveforms at three poles with HVDS are shown in Fig.10.

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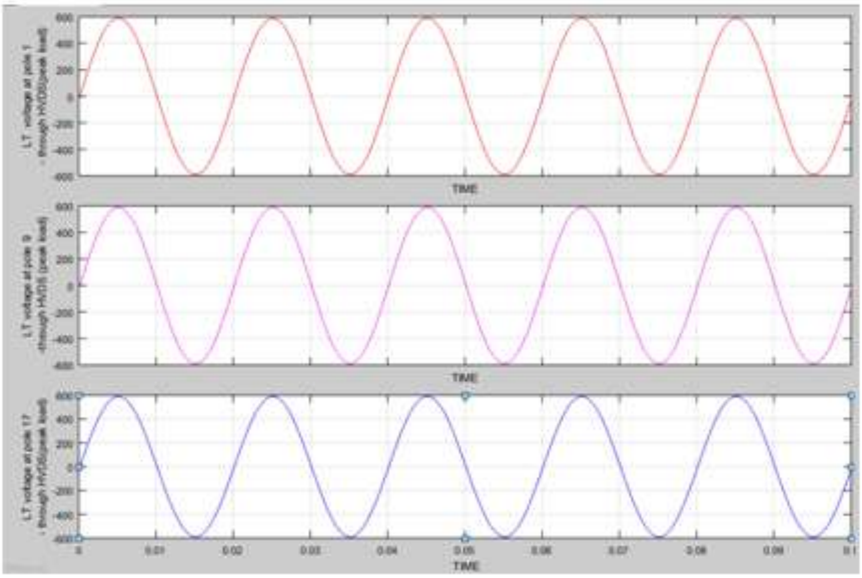

Fig.10: Voltage Waveforms at three Poles - HVDS - Peak Load

At peak load condition, the waveforms of currents in HT line sections with HVDS are shown in Fig.11.

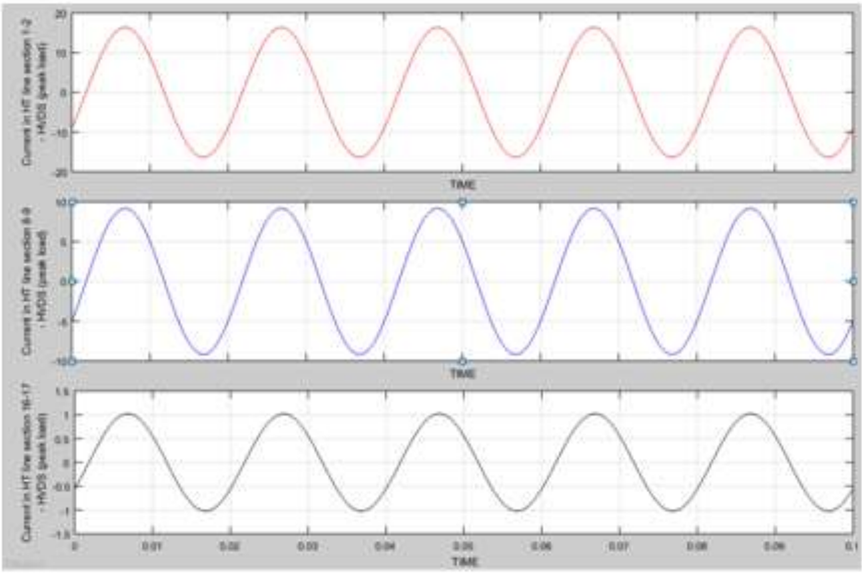

Fig. 11: Current Waveforms in HT line Sections - HVDS - Peak Load

At Normal Load

At normal load condition, the voltage waveforms at three poles, with HVDS are shown in Fig. 12.

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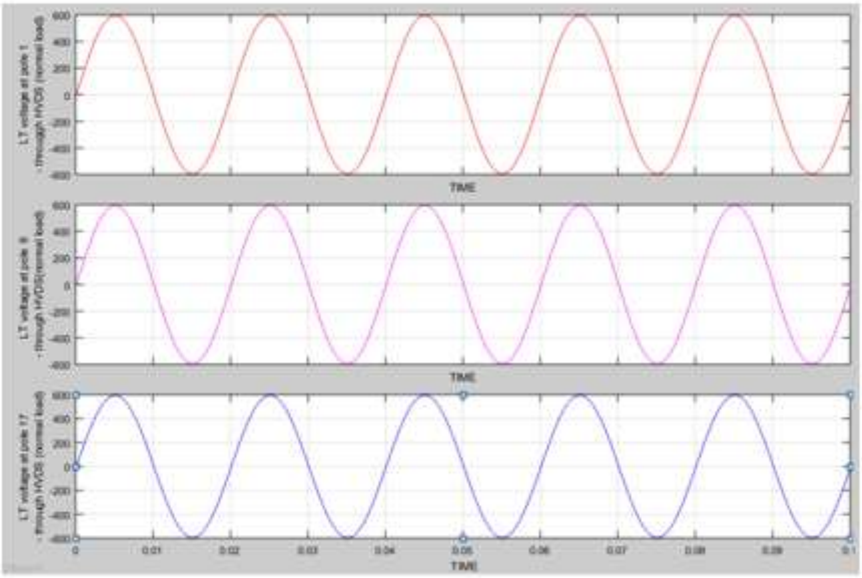

Fig12: Voltage Waveforms at Poles - HVDS - Normal Load

The waveforms of currents in HT line sections at normal load with HVDS are shown in Fig. 13

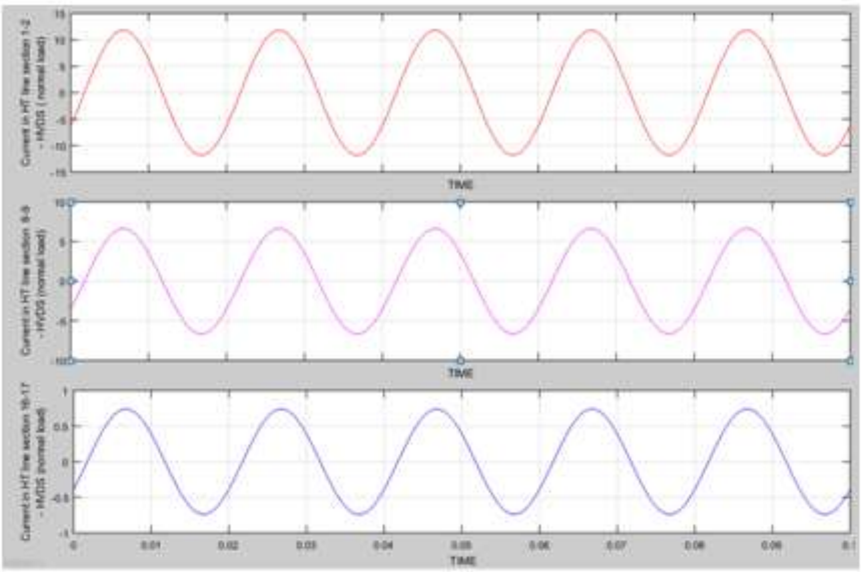

Fig13: Current Waveforms in HT line Sections - HVDS - Normal Load

At Off-peak Load
At off peak load condition, the voltage waveforms at three poles with HVDS are shown in Fig. 14.

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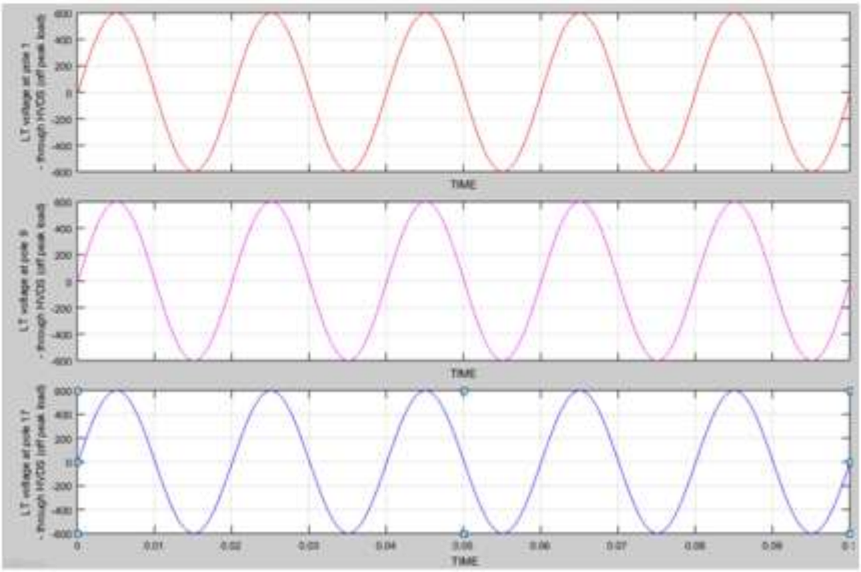

Fig. 14: Voltage Waveforms at Poles - HVDS - Off-peak Load

The waveforms of currents in HT line sections at off-peak load condition with HVDS are shown in Fig. 15.

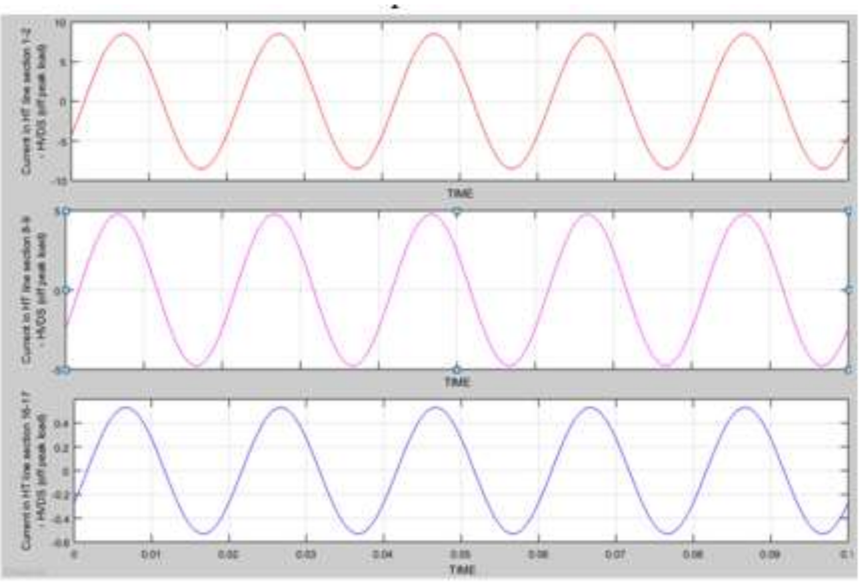

Fig.15: Current Waveforms in HT line Sections - HVDS - Off-peak Load

MatLab Simulation Readings with HVDS

The simulation readings such as voltage, currents and line loss for various load conditions with HVDS system are shown in below table. 5.

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Table 5: Simulation Readings with HVDS for Various Load Conditions

	PEAK LOAD				NORMAL LOAD				OFF PEAK LOAD			
SL.NO.	VOLTAGE(V)	LINE SECTION	LINE SECTION CURRENT(A)	LINE LOSS(WATTS)	VOLTAGE(V)	LINE SECTION	LINE SECTION CURRENT(A)	LINE LOSS(WATTS)	VOLTAGE(V)	LINE SECTION	LINE SECTION CURRENT(A)	LINE LOSS(WATTS)
POLE 1	416.5	1 to 2	11.56	7.262317992	420.9	1 to 2	8.351	3.789976878	424.1	1 to 2	6.007	1.96098764
POLE 2	416.5	2 to 3	11.57	7.274887991	420.9	2 to 3	8.363	3.800876746	424.1	2 to 3	6.019	1.96883028
POLE 3	416.5	3 to 4	10.11	5.554716575	420.9	3 to 4	7.3	2.89604505	424.1	3 to 4	5.256	1.50130975
POLE 4	416.5	4 to 5	9.389	4.79069223	420.9	4 to 5	6.785	2.501838648	424.1	4 to 5	4.88	1.29419357
POLE 5	416.5	5 to 6	9.402	4.803967789	420.9	5 to 6	6.798	2.511434833	424.1	5 to 6	4.893	1.30109805
POLE 6	416.5	6 to 7	8.68	4.094482728	420.9	6 to 7	6.276	2.140550425	424.1	6 to 7	4.518	1.10930775
POLE 7	416.5	7 to 8	7.222	2.834487599	420.9	7 to 8	5.219	1.480246991	424.1	7 to 8	3.754	0.76585778
POLE 8	416.5	8 to 9	6.5	2.29607625	420.9	8 to 9	4.697	1.19894901	424.1	8 to 9	3.379	0.6204917
POLE 9	416.5	9 to 10	5.778	1.814323259	420.9	9 to 10	4.175	0.947267316	424.1	9 to 10	3.003	0.4900837
POLE 10	416.5	10 to 11	5.055	1.388679144	420.9	10 to 11	3.653	0.725201907	424.1	10 to 11	2.628	0.37532744
POLE 11	416.5	11 to 12	4.333	1.020321343	420.9	11 to 12	3.13	0.532412531	424.1	11 to 12	2.252	0.27561088
POLE 12	416.5	12 to 13	3.611	0.7086219	420.9	12 to 13	2.6	0.3673722	424.1	12 to 13	1.877	0.19146445
POLE 13	416.5	13 to 14	2.889	0.453580815	420.9	13 to 14	2.088	0.236930288	424.1	13 to 14	1.502	0.12260254
POLE 14	416.5	14 to 15	2.167	0.255198088	420.9	14 to 15	1.566	0.133273287	424.1	14 to 15	1.126	0.06890272
POLE 15	416.5	15 to 16	1.444	0.113316716	420.9	15 to 16	1.044	0.059232572	424.1	15 to 16	0.7508	0.03063431
POLE 16	416.5	16 to 17	0.7222	0.028344876	420.9	16 to 17	0.52	0.014694888	424.1	16 to 17	0.3754	0.00765858
POLE 17	416.5		TOTAL LOSS	44.69401529	420.9		TOTAL LOSS	23.33630357	424.1		TOTAL LOSS	12.084361

From the above results, it is seen that, with HVDS, voltage to the consumers is improved than LVDS system, because 3 to 8 consumers are fed from a small capacity Distribution Transformer (15kVA), which is mounted on a single pole, near to the consumers, instead of a large capacity Distribution Transformer (250kVA) and long run of LT lines. Large capacity Transformer provides supply to about 40 to 50 consumers. Since, consumer gets improved voltage, their equipment/appliances function properly. As HT lines run, near to the consumer, the line

I^2R loss, in different line segments of HT line, are very less. At normal load time, voltages are more than peak time, as load is less and losses are less. At off peak time, voltages are more than peak & normal time, as load is much less and losses are the least.

HVDS, reduces losses & distribution transformer failure rate and improves the efficiency of the system.

Benefits of HVDS

The benefits of HVDS system compared to conventional LVDS system:-

1. Improved Voltage profile and less voltage fluctuations.
2. Very less line loss.
3. Unauthorized line tapping is prevented.
4. Accidents, because of the touching of snapped conductors, are decreased, as the HT feeder trips at substation.
5. Reduced Distribution Transformer failure rate.
6. In the case of Transformer failure, it will affect only 4 to 8 consumers, whereas in LVDS system, the failure of Transformer affects 40 to 50 consumers.
7. HVDS system is a reliable system.
8. Due to reduction in power loss, no additional generation capacity is required for new loads.
9. Distribution losses are reduced by 80% or more, depending on the load factor.

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Comparison of the Simulation Results Between LVDS and HVDS

Comparison of Voltage Profile

The Comparison of voltage profile between LVDS and HVDS at peak load, normal load and off-peak load are shown in Table 6.

Table 6 : Comparison of Voltage Profile Between LVDS and HVDS at different Load Profile

	LVDS- voltage at peak load(V)	HVDS – voltage at peak load(V)	LVDS- voltage at normal load(V)	HVDS- voltage at normal load(V)	LVDS – voltage at off peak load(V)	HVDS – voltage at off peak load(V)
POLE 1	414.8	416.5	419.5	420.9	423	424.1
POLE 2	412.7	416.5	418	420.9	421.9	424.1
POLE 3	410.8	416.5	416.6	420.9	420.9	424.1
POLE 4	409	416.5	415.3	420.9	419.9	424.1
POLE 5	407.3	416.5	414	420.9	419	424.1
POLE 6	405.7	416.5	412.9	420.9	418.2	424.1
POLE 7	404.3	416.5	411.9	420.9	417.5	424.1
POLE 8	403.1	416.5	410.9	420.9	416.8	424.1
POLE 9	401.9	416.5	410.1	420.9	416.2	424.1
POLE 10	400.9	416.5	409.4	420.9	415.6	424.1
POLE 11	400	416.5	408.7	420.9	415.1	424.1
POLE 12	399.2	416.5	408.1	420.9	414.7	424.1
POLE 13	398.6	416.5	407.7	420.9	414.4	424.1
POLE 14	398.1	416.5	407.3	420.9	414.1	424.1
POLE 15	397.7	416.5	407	420.9	413.9	424.1
POLE 16	397.5	416.5	406.8	420.9	413.8	424.1
POLE 17	397.3	416.5	406.7	420.9	413.7	424.1

Comparison of Loss Profile between LVDS and HVDS at different Load Profile

Comparison of loss profile between HVDS and LVDS at Peak Load is shown in Table 7

Table 7: Comparison of loss profile between HVDS and LVDS at Peak Load

Sl. No.	Particulars	Existing Loss - LVDS (kWH/Year)	Proposed Loss - HVDS (kWH/Year)	Annual energy Savings (kWH/Year)	% net reduction in losses (kWH/year)
1	Line Losses (Annual)	335333	394	334939	
2	No Load Transformer Losses (Annual)	6351	8935	-2584	
3	Transformer Load Losses (Annual)	40515	40953	-438	
	Total loss	**382199**	**50282**	**331917**	**86.84402628**

Comparison of Loss Profile Between HVDS and LVDS at Normal Load is shown in Table 8

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Table 8: Comparison of loss profile between HVDS and LVDS at Normal Load

Sl. No.	Particulars	Existing Loss - LVDS (kWH/Year)	Proposed Loss - HVDS (kWH/Year)	Annual energy Savings (kWH/Year)	% net reduction in losses (kWH/year)
1	Line Losses (Annual)	179107	201	178906	
2	No Load Transformer Losses (Annual)	6351	8935	-2584	
3	Transformer Load Losses (Annual)	19852	20067	-215	
	Total loss	**205310**	**29203**	**176107**	**85.78**

The comparison of loss profile between HVDS and LVDS, at off-peak load condition is shown in table9.

Table 9: Comparison of loss profile between HVDS and LVDS at Off-peak Load

Sl. No.	Particulars	Existing Loss - LVDS (kWH/Year)	Proposed Loss - HVDS (kWH/Year)	Annual energy Savings (kWH/Year)	% net reduction in losses (kWH/year)
1	Line Losses (Annual)	94328	105	94223	
2	No Load Transformer Losses (Annual)	6351	8935	-2584	
3	Transformer Load Losses (Annual)	10129	10238	-109	
	Total loss	**110808**	**19278**	**91530**	**82.60**

From the above tables, it is seen that, for the various load profile, huge loss reduction happens in HVDS system, compared to the LVDS system.

Cost Benefit Analysis

The Cost Benefit Analysis of replacing the existing LVDS system with HVDS system is shown Table 10.

Table 10: Cost Benefit Analysis

Sl.No.	Particulars	At Peak Load	At Normal Load	At Off-peak Load
1	% Net Reduction in Losses	86.8	85.78	82.6
2	Annual Energy savings (kwh/year)	331917	176107	91530

3	Annual Financial Savings (Lakh)@Rs. 5/kwh	16.59585	8.80535	4.5765
4	Capital Outlay of Proposed system (Lakh)	33	33	33
5	PayBack Period (Year)	1.99	3.75	7.21

From the above Cost Benefit Analysis, it can be concluded that, the proposed system of replacing the existing LVDS with HVDS, results in huge energy savings and the payback period varies from 2 years to 7 years which depends on the load profile. Thus, with the implementation of HVDS system, the Energy Efficiency and Reliability of the Electrical Distribution System can be realized.

Since, the HVDS results in huge energy savings and the payback period is acceptable , this system can be a feasible system, in Electrical Distribution System.

Advantageous and Disadvantageous of HVDS

The following are the benefits of implementing HVDS :

1. Failure rates are negligible because of no over loading and no meddling of LT line.
2. In the event of Transformer failure, only 4 or 5 consumers will get affected instead of 40 to 50 customers in original system.
3. Accidents due to touching of snapped conductors are reduced because of the fact that the HT feeder trips at substation..
4. Less damage to consumer appliances/equipment because of good voltage and less voltage fluctuations.
5. No extra generation capacity is needed for supplying new loads, due to reduction in power drawls.
6. The registered consumer will feel ownership and takes responsibility and not permitting others to interfere with the LT network, as the distribution transformers may fail if they are loaded beyond their capacity.
7. Distribution losses are reduced by 80% or more depending on the load factor.

Disadvantage is the initial investment cost is very high.

4. CONCLUSION

- HVDS results in considerable improvement in the system performance by reduction in technical and non-technical losses and also, improvement in voltage profile at the far end.
- In the existing LVDS system, there is a great drop in voltages on the low voltage line, thereby decreasing the efficiency of the consumer's load.
- HVDS scheme has focused to the formulation of new strategy of energy efficiency, reduction of transmission and distribution power losses by decreasing the power theft.
- The HVDS system has been identified as the required factor in energy efficient distribution. It provides reliable and quality power supply to consumers.
- Implementation of HVDS opens a path for the work in many other related areas.
- This methodology avoids power purchase from neighboring states and installation of new power plants.
- Because of the reduction of the real power losses and voltage drop, there is a great improvement in the efficiency of the electrical distribution network.
- Adoption of this innovative methodology has resulted in the improvement of commercial and technical performance and the outlook of energy scenario, in distribution system.

Future Scope
In the HVDS network, coordinated control of Distributed Generation and shunt capacitors can be studied.

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