Imperial Journal of Interdisciplinary Research (IJIR)
Vol-2, Issue-9, 2016
ISSN: 2454-1362, http://www.onlinejournal.in

High Voltage Distribution System for Agricultural Feeders

[1]Sk. Md. Tayyab & [2]N. C. Kotaiah.
[1]M.tech Student,RVR&JC College of Engg.,
[2]Prof.,Dept.of EEE,RVR&JC College of Engg.

Abstract: *This project presents the comparison of existing low voltage distribution system with proposed high voltage distribution system in terms of energy losses. The main objective of this project is to present the reduction of losses and maintain voltage profile constant in distribution system by implementing H.V.D.S over L.V.D.S. The study is based on a real time low voltage agricultural feeders in Andhra Pradesh state*.

Index Terms: *LVDS,HVDS,MTR,DTR,MATLAB.*

1. Introduction.

In recent decades, different schemes have been proposed to reduce the losses in the distribution system and hence, to increase the efficiency of electric devices and power distribution networks. In distribution systems, the voltage at buses reduces when moved away from the substation, also the losses are high**.** The reason for high losses is the use of low voltage for distribution as in the low voltage system; the current is high and thus more losses. Thus by using high voltage for distribution we can reduce the losses as current in HVDS (high voltage distribution system) is low.

The main advantage of using high voltage for distribution is to reduce the theft of energy and decrease in unauthorized connection as the LT lines are virtually eliminated and even short LT lines required will be with insulated cables. This makes direct tapping very difficult and thus increases the authorized connection which will improve revenue. Also the current in the proposed method is low due to high voltage and thus low power losses. It also helps in avoiding unnecessary iron losses in overrated distribution transformer which otherwise occur in the existing system and hence reduces technical losses.

To check the feasibility of the proposed work, the annual saving and payback period of the proposed method is also determined. Here B.E.E(Bureau of Energy Efficiency) rated transformers are used in order to save the energy and also power generation which in turn helps to reduce the global warming and carbon emissions into the atmosphere. Carbon credits are also calculated. A carbon credit is a generic term for any tradable certificate or permit representing the right to emit one tone of carbon dioxide or the mass of another greenhouse gas with a carbon dioxide equivalent (tCO_2e) equivalent to one tone of carbon dioxide.

Carbon credits and carbon markets are a component of national and international attempts to mitigate the growth in concentrations of green house gases (GHGs). One carbon credit is equal to one tone of carbon dioxide, or in some markets, carbon dioxide equivalent gases. Carbon trading is an application of an emissions trading approach. Greenhouse gas emissions are capped and then markets are used to allocate the emissions among the group of regulated sources.

The goal is to allow market mechanisms to drive industrial and commercial processes in the direction of low emissions or less carbon intensive approaches than those used when there is no cost to emitting carbon dioxide and other GHGs into the atmosphere. Since GHG mitigation projects generate credits, this approach can be used to finance carbon reduction schemes between trading partners and around the world.

D.S.M(Demand side Management) measures are considered for the project which includes:-

- ISI marked pumps.
- Friction less foot valves.
- ISI marked delivery & Section pipes.

1.1 Distribution System:

The primary and secondary power distribution network, which generally concerns the consumer in India, is the distribution network of 11kV lines or feeders downstream of the 33kV substation. Each 11kV feeder which eminates from the 33kV substation branches further into several subsidiary 11kV feeders to carry power close to the load points (localities, industrial areas, villages, etc). At these load points, a transformer further reduces the voltage from 11kV to 415V to provide the last-mile connection through 415V line also called as Low Tension (LT) line to individual customers, either at 240V as single-phase supply or at 415V as three- phase supply. A feeder could be either an overhead line or an underground cable. In urban areas, owing to the density of customers, the length of an 11kV feeder is generally up to 3 kms. On the other hand, in rural areas, the feeder length is much larger even up to 20 kms. A 415V line should normally be restricted to about 0.5-1.0 km. In existing distribution systems, the voltage at buses reduces when moved away from the substation, also the losses are high. The reason for high losses is the use of low voltage for distribution as the current is high in the low voltage system and thus more losses. Thus by using high voltage for distribution we can reduce the losses as current in high voltage distribution system (HVDS) is low. In the existing system pilferage is very easy because of lengthy bare LT conductor, and thus many unauthorized connections are tapped from the bare LT conductor.

1.2 Nature of Rural Loads:

- Loads in rural India are predominantly pump sets used for lift irrigation.
- These loads have low p.f.
- Existing system is to lay 11 KV lines, employ 3 phase DTRs 11kv / 415 volts and lay long L.T lines.
- To fetch a load of one pump set of 5 HP - two or three L.T. spans are to be laid.
- They run for about 1500 Hrs in a year of 8760 hours.

2. Losses in Distribution Network.

The losses prevailing in the existing power distribution system can be classified as: a) Technical losses b) Non-Technical losses. Technical losses on distribution systems are primarily due to heat dissipation resulting from current passing through conductors and from magnetic losses in transformers. Technical losses occur during transmission and distribution and involve substation, transformer, and line related losses. These include resistive losses of the primary feeders, the distribution transformer losses (resistive loses in windings and the core losses), resistive losses in secondary network, resistive losses in service line and losses in KWh meter. These losses are inherent to the distribution of electricity and cannot be eliminated but can be reduced. Non-Technical losses include tampering with the meter to create false consumption information used in billings, to making unauthorized connections to the power grid. Non-payment, as the name implies, refers to cases where customers refuse or are unable to pay for their electricity consumption. It is estimated that electricity theft costs in India is in crores in a year. Electricity theft is part of a phenomenon known as “Non-Technical Losses” (NTL) in electrical power systems. And thus it is necessary to focus on both sides i.e. on technical losses as well as on nontechnical losses and it can be achieved by using proposed HVDS method for distribution.

2.1. Reasons for Higher Losses:

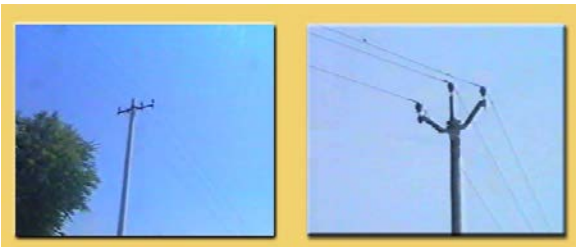
- Lengthy distribution lines.
- Inadequate size of conductors.
- Over-rated distribution transformers and hence their underutilization.
- Low voltage (less than declared voltage) appearing at transformers and consumers terminals.
- Distribution transformer not located at load center on the secondary distribution system.
- Low power factor.
- Poor HT/LT ratio.
- Poor quality of equipment.
- Too many stages of transformations.
- Transformer Losses.
- Bad workmanship.
- Direct tapping by the non-customers.
- Pilferage by the existing customers.
- Defective metering, billing and collection functions.

2.2 Loss reduction by HVDS:

HVDS project is to reconfigure the existing Low voltage (LT) network as High Voltage Distribution System, wherein the 11kV line is taken as near to the loads as possible and the LT power supply is fed by providing appropriate capacity transformer and minimum length of LT line with an objective to provide better quality power supply, reduction of losses and better consumer service. In the existing system, large capacity transformers are provided at one point and the connections to each load is extended through long LT lines. This long length of LT lines is causing low voltage condition to the majority of the consumers and high technical losses. In the HVDS project, long length LT mains are converted into 11 kV mains and thereby installing the appropriate capacity distribution transformer as near as to the end and the supply is provided to the consumer at suitable voltage level. By converting these lines to HVDS, the current flowing through the lines shall reduce and will bring down the technical losses in the LT line drastically. This can be explained by one single illustration that for a 100 KVA load the amperage at 11kV is 5 amperes where as it is 140 amperes at LT voltage of 415 Volts. The prevailing low voltage in the LT line is also affecting the efficiency of the electric gadgets and breakdown is also very high. Also there is a tendency of unauthorized connections to hook to the LT lines which results in over loading of the transformers and failure of the transformers. The scheme consists of converting the existing 3 phase 4 wires lines to 11 kV systems using the existing supports and providing intermediate poles wherever necessary and individual transformers are provided to both agricultural loads and loads other than agriculture. The length of the LT lines is restricted to less than 300 meters. HVDS is most effective method in reducing the technical losses and improving the quality of supply in power distribution system. In this system high voltage lines are extended to as nearer to the loads as possible and erect small size transformers. This system aims at LT less system or less LT and the unavoidable short LT lengths to be covered by insulated wires like ABC (Aerial Bunched Cables). The major advantages of using ABC in HVDS are that the faults on LT lines are totally eliminated, thus improving reliability and also theft by direct tapping is avoided. As the authorized consumers do not allow unauthorized tapping by another as their transformer gets overloaded or may get damaged, resulting in outage of power supply for longer durations. It is noticed that the investment on conversion from conventional system to HVDS is recovered by way of loss reduction within a period of 3 to 5 years in most cases.

3. Conversion of existing LT 3ph 4 Line into HT Line.

Fig 1. LVDS & HVDS Systems



1. Existing LT 3Phase 4 wire line on support
2. Same support with HVD System

Fig 2. Connection diagram of LVDS

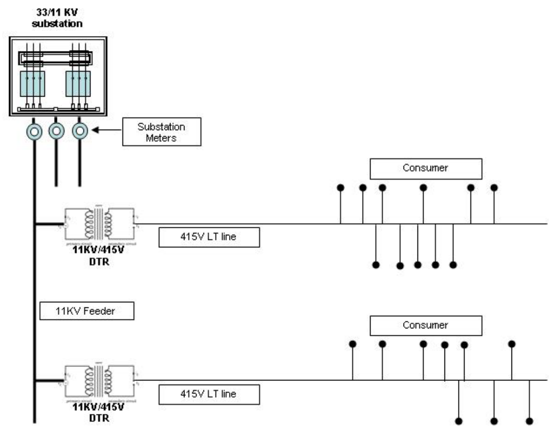
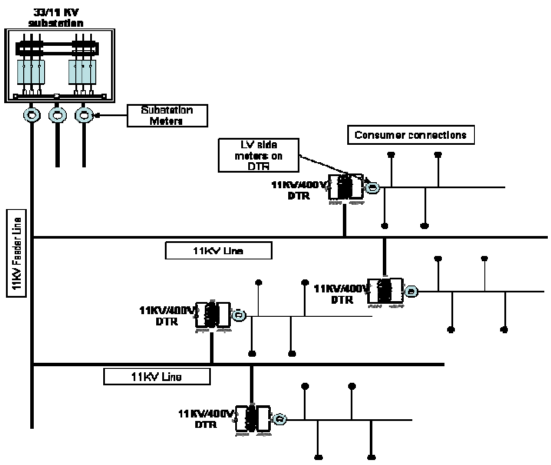


Fig 3. Connection diagram of HVDS



4. Comparison of existing LT & HT System.

HVDS represents North American practice whereby the HV line is extended up to the load point; in the instant case, supply is tapped off from 3-phase HV mains in proximity of an agricultural pump and provided via a distribution transformer of 10 kVA capacity to serve a 5-7 HP load, thus restricting the LT line to the length of the service cable. A typical schematic diagram of „before and after scenario is shown in Fig. The HVDS has been constructed by refurbishing and retrofitting LT lines using the same poles and conductors and erecting new insulators and hardware supports. Once conversion of LT to HT lines is completed, the transformer is installed either on a single or double pole structure, depending on angularity of the lines. The distribution systems shall be at high voltage and the L.T. system shall be the least or eliminated as far as possible. HVDS or high voltage distribution systems by converting existing LVDS is in progress in many Discoms reducing the technical losses appreciably. This can be explained by one single illustration that for a 100 KVA load the amperage at 11KV is 5 Amps where as it is 140 Amperes at L.T. voltage of 415 Volts.

Fig.4:LT System:

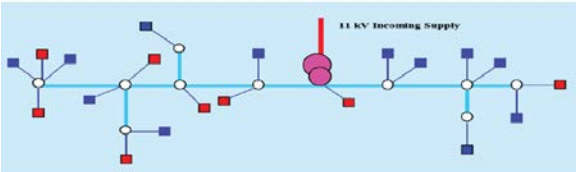
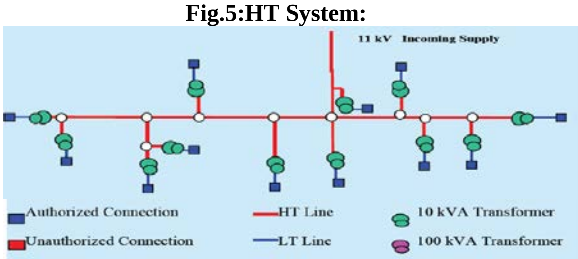


Fig.5:HT System:



4.1. Disadvantages of LVDS:

- Poor tail end voltages.
- High quantum of losses.
- Frequent jumper cuts and fuse blow outs.
- Motor burn outs almost twice in each cropping period of 100 days.
- DTR failures due to frequent faults.
- Loss of standing crops due to inordinate delays in replacement of failed DTR's.
- Theft of Energy.

4.2. Advantages of HVDS:

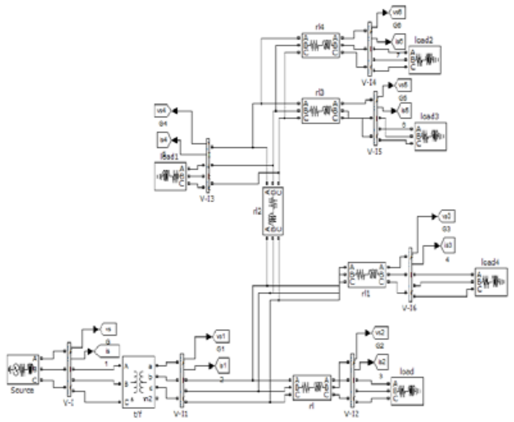
- Reduction in line losses since HV line is taken almost up to consumer load point and on LV side AB cable is used.
- Failure of agriculture DTRs are minimized as LT overhead line is avoided and also load per DTR is restricted. Hence, no failure on account of over load and LT faults.
- Reduction of unauthorized agriculture connections, as one small capacity (25KVA) DTR is erected for two or three agriculture consumers. The agriculture consumers will have a feeling of ownership of transformer due to limited connections on it.
- As 11KV line is taken almost to the load point, improvement in voltage profile near agriculture pump sets is observed resulting in good performance of motor.
- Pilferage of electricity is completely avoided as LT AB cable is used from DTR LV up to consumer bore well.

5.Case Study:

Case study of Gurzala-SS-14, Anjanapuram Feeder is presented. Anjanapuram is located in the premises of Gurzala.It is supplying load for 45 Agricultural Consumers in which, the 11kV is stepped down to 415V by using 100kVA Distribution Transformer.

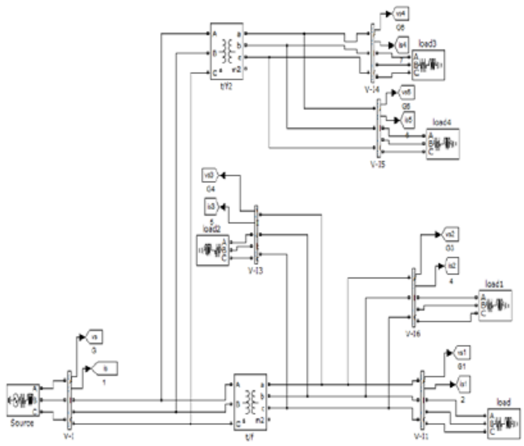
5.1 One of the LVDS Networks:

Fig.6: LVDS Network



5.2 One of the HVDS Networks:

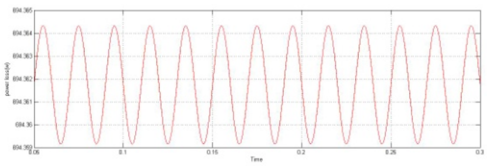
Fig.7: HVDS Network



5.3 MATLAB Simulation results:

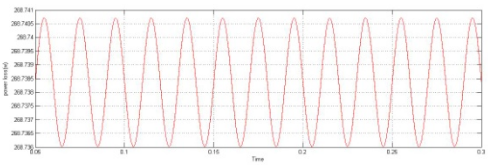
a)Power loss in LVDS: 694.4W

Fig.8: Power loss in HVDS System



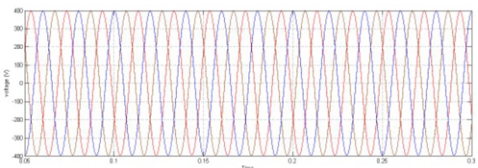
b)Power loss in HVDS: 268.7W

Fig.9: Power loss in HVDS System



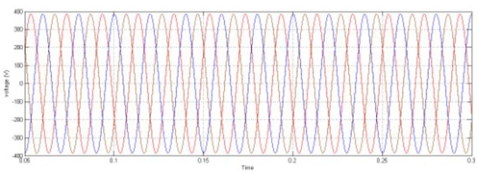
c)Voltage near MTR in LVDS: 396V

Fig.10: Voltage near MTR in LVDS System



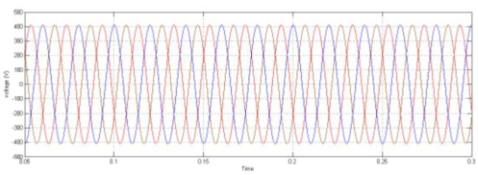
d)Voltage far away from MTR in LVDS: 385V

Fig.11: Voltage far away from MTR in LVDS System



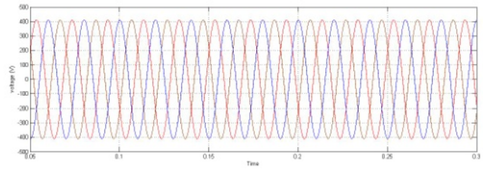
e)Voltage near DTR in HVDS: 410V

Fig.12: Voltage near DTR in HVDS System



f)Voltage far away from DTR in HVDS: 410V

Fig.13: Voltage far away from DTR in LVDS System



6.Statistics:

6.1.Investment :

a) Transformers - 100 DTR's
16kva -50t/f's & 25kva- 50t/f's
Total cost = 1,45,00,000Rs/.
b) Cable cost:
Cable cost for 2.457kms= 2.457*30,000 = 73,710Rs/.
c) Hardware cost
5% of cable cost = 3685.5Rs/.
Total investment cost= 1,45,00,000+73,710+3685.5 =1,45,77,395.5Rs/.

6.2.Savings:

Total Unauthorised load: 122.5hp = 91.5kw
Theft in units for 6 months =7*91.5*183 = 1,17,211.5kwh
Loss due to LVDS =(5384.3*7*183)/1000 =6,897.288kwh
Total loss due to LVDS=117211.5+6897.288=1,24,108.788kwh
Total loss due to HVDS=(2282.1*7*183)/1000 =2,923.370kwh
Net loss=LVDS-HVDS=124108.788-2923.370=121185.418kwh=151481.772kvah
Savings for 6 months (in rupees)=7.35*151481.772=11,13,391.02Rs/.
Savings for 1 year(in rupees)=22,26,782.05Rs/.
Total MTR's=25
Savings for 5 MTR's=11,13,391.02
Savings for 25 MTR's=((25*1113391.02)/5)*2= 1,11,33,910.2 per annum
a) Savings for 5 years= 5*11133910.2=5,56,69,551Rs/.

b) Savings towards failure of DTR's:
11% in LVDS
Total expenditure towards repair cost= ((11/100)*25)*22,000 =60,500 per annum
Total expenditure for 5 years= 3,02,500Rs/.

c) Manday's towards replacement of failed DTR's:
For Lineman =(2*40,000)/30days = 2666
Percentage of failure = 11% in LVDS
= 25*11/100 =2.75 =3 t/f = 3*2666 = 7998 for 1 year

Savings towards employees cost agoinst replacement of D.T.R's= 7998*5 = 39,990

d) Savings towards carbon credits:
For 1 unit(kwh) generation of power we require 1.5 kgs of coal
For 1,21,185kwh = 1,21,185*1.5 = 1,81,777.5 kgs
For 5 years = 908887.5kgs = 908.887 tonns of coal

1 ton of coal on burning releases 2.86tons of carbon dioxide
908.887 tons of coal releases 2599.418tons of carbon dioxide
1 carbon credit = 1 ton of carbondioxide = 30 Euros = 2200Rs/.
Total carbon credits = 2599.418* 2200 = 57,18,719.6

Total savings = 6,17,30,760.6/Rs.

Net savings = Total savings - Investment = 6,17,30,760 - 1,45,77,395.5
= 4,71,53,365.

6.3.Payback period calculation :

Payback period = Total cost of the investment / Annual net cash flow
=1,45,77,396 / 1,23,46,152
= 1.2 years

7. Conclusions:

- The conversion of LVDS in to HVDS system results in increase in energy saving and reduction in losses.
- HVDS reduces the wastage of energy and optimization of power intake, there by promoting the environmental concerns.
- The chances of unauthorized connections and theft of energy are reduced.
- So, converting LVDS lines to HVDS lines will become more beneficiary to our future generation with less Distribution loss and less Agricultural Motor Burnouts.

8. References:

[1] Ankita Gupta, Sonia Grover and Sabina Miglani, " loss reduction planning using high voltage distribution system" VSRD International Journal of Electrical, Electronics & Communication Engineering, Vol. 2, 2012, ISSN No. 2231-3346.
[2] Mayank Kumar Arjariya, Dr. Amita Mahor, "Modified Distribution Networks using HVDS Techniques", International Journal of Engineering Research and Applications, ISSN : 2248-9622, Vol. 3, Issue 5, , pp. 1952-1955, 2013.
[3] B.R.Gupta, "Power system analysis and design", New Delhi, S.Chand & Company limited.
[4] Isha Bansal, Harmith Singh Gill, Ankitha Gupta, "Minimization of Losses by Implementing High Voltage Distribution System in Agricultural Sector", IOSR Journal of Electrical and Electronics Engineering (IOSRJEEE), ISSN: 2278-1676 Volume 1, Issue 5. pp.No 39-45, July-Aug. 2012.
[5] E.Vidyasagar, K.Devendar Rao & P.V.N. Prasad, "Reliability improvement of High Voltage Distribution system over Low voltage Distribution System", National conference on Power distribution, CPRI, Bangalore, 8th-9th November 2012.