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Analysis of LVDS and HVDS for its Effects at the Loading Points

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***Abstract*: Power is a crucial component for India's economic development. Advancement of productivity expansion will be contingent on a financially and financially successful electricity industry capable of attracting additional investment. Generating capacity inside the electric power industry are strongly reliant on the off-taker's, transportation, and distributing organizations' reputation. In generally, electromagnetic electricity is generated in power plants that are positioned far from where the users live. It is then distributed to users via a vast transmission and distribution. The modern power generation system is based on Alternating Current (AC). The purpose of this article is to conduct a comparison analysis of the results at load locations in the voltage and low power distribution channels.**

Keywords: HVDS, LVDS, Distribution system, LV, HV.

I. Introduction

The distribution system comprising 11kV lines or feeders upstream of the 33kV substation is the direct and indirect power distribution infrastructure that generally affects Indian consumers. Each 11kV feeder that emerges from the 33kV transformer is divided into many subsidiary 11kV wires that transport power to the load sites (localities, industrial areas, villages, etc). A transformers drops the voltage from 11kV to 415V at these load locations, allowing different consumers to engage via a 415V line, also known as a Low Tension (LT) line, either at 240V as a single-phase supply or at 415V as a three-phase stockpile. A feeders could be an overhanging line or a cable buried beneath. Because of the high number of consumers in metropolitan locations, an 11kV feeder can be up to 3 kilometers long. Rural areas, from the other hand, have substantially longer feeder lengths, up to 20 kilometers. A 415V line should generally be limited to 0.5-1.0 kilometers in length. When buses are moved farther from the transformer in conventional distribution networks, the current there at buses drops, and the losses are substantial. The use of low power for transmission is the cause of significant losses since the power in the reduced voltage network was high, resulting in additional loses. As a result of the low throughput inside the high voltage distribution system (HVDS), we can significantly reduce the costs through using voltage output for distribution. Because of the long bare LT conductors inside the current framework, pilferage is relatively straightforward, and numerous unauthorised interconnections are pinched from the bare LT conductors.

Large three-phase 11 kV major distribution terminals with multiple spur connections and three-phase power transformers converting 11 kV to 400V are used in India's current distribution network. Low-voltage distribution systems use four core connections, lengthy reduced lines, and many loads fed from a large toroidal transformer, resulting in greater system losses that affect voltage stability and distributing operation of the system [1]. Low voltage transmission is accomplished through the use of a combination of three-phase four-wire, three-phase five-wire, solitary component three-wire, and single phase two-wire low implement and monitor. The low and high voltages line widths are roughly 2:1 in this supply system. Leakage currents are common in the procedure of providing power to consumers due to technical and economical inefficiencies. The energy dissipated in the connections and apparatus used for power conversion, distribution, and redistribution is the primary cause of system losses. Errors in the smart meter of malfunctioning equipment and in the assessment of unlimited internet energy production are the sources of business loss.

Changing to a three-phase system In the agricultural industry, the High - voltage power Distribution Network maintains improved output voltages to agricultural water pumping and provide dependability to customers [3]. Power is mostly supplied via overhead wires in HVDS (11 kV). This system combines 11 kV three-phase and single-phase configurations of small volume transmission systems (5 kVA, 10 kVA, 15 kVA) to extend supply to 8 to 10 customers with the fewest low shear zones, ideally at least shielded ceiling - mounted cable network, reduction of losses, overburdening, power distribution malfunction, and increasing system efficiency. To offer mechanical integrity to the wrapping, this system utilizes 10 kVA copper wrapped capacitors having noload leakage.

II. Literature review

Issah B.Majeed et al. [1] This article compares and contrasts HVDS and LVDS principles in terms of process effectiveness. This is accomplished by studying system losses in radial AC distribution channels on HV and LV distribution channels. The challenges of transmission losses may necessitate a network migration from LV to HV. This study solves this issue by determining the best number of unit converters in the HV network utilizing HVDS optimization, especially, linear programming with both the Matlab image processing toolbox. When compared to the LVDS, research conducted on such a test distributed generation utilizing CYMEDIST software reveal that the optimized HVDS has a better voltage distribution and a complete system reducing losses of 29.50 percent. As a result, the optimized HVDS has reduced processing costs and higher yearly realized loss reductions.

Erwin Normanyo et al. [2] This study describes a strategy used in rectangular microstrip patch to convert a current Low Voltage Distribution System (LVDS) to a High Voltage Distribution System (HVDS). In the Matlab image processing tool box, HVDS minimization is presented using mathematical optimization approaches. The process is explained by the outcomes of a test procedure. The multi objective optimization algorithm computes the HVDS's optimal amount of unit separators. The bulk converter in the LVDS can be represented by an equivalent community of unit transformer in the HVDS using this approach. The conversion process has the benefits of eliminating transformers no-load inefficiencies. As a result of the lower running costs, the distributing converters' economy picks up.

Tiago Soares Vítor et al. [3] The basic goal of voltage control in distribution channels, as discussed in this paper, is to maintain existing voltages within an appropriate range even under loading scenarios. The Volt/Var control—a strategy that integrates voltage source inverter devices and voltage regulation controllers in order to achieve a satisfactory system operation—has performed this duty. As the distribution grid is modernized, advanced machine learning and updated Volt/Var control schemes must be devised to address continue to present scenario issues and to take use of technology advancements in equipment. Under these conditions, Volt/Var control must provide an elevated electricity supply while also meeting stringent grid performance standards. Intelligent systems with a computationally effective optimization algorithm are created to address these issues. In this sense, this chapter covers everything from basic ideas to complex themes on Volt/Var control, setting the groundwork for a comprehensive optimisation problem and presenting Volt/Var optimisation as a determining tool for achieving current operational goals.

Ahmadi et al. [4] This research investigates the prospect of using data from smart thermostats to help understand transient response. To improve the accuracy of volt-VAR optimization (VVO) approaches for distribution channels, the demands are treated as wattage components. VVO techniques are an element of the distributing control system and can be utilized for loss minimization, voltage regulation, and conserving frequency reduction, among other things. The VVO problem is added and the solution quadratically restricted problem is formulated, which is solved quickly using advanced subsidiary techniques, according to a predictable approach developed. For day-ahead planning and operations, the suggested framework is capable of optimally regulating shunt capacitors, static var compensators, and under-load tap changers (ULTCs). That under some dynamic loading in a circumferential experimental setup, the results show that waste improvements of up to 40% and required power reduction of up to 4.8 percent are possible. Mathematical simulations are also used to illustrate the influence of load voltage dependency.

S. ChouhanA et al. [5] This study proposes a novel iterative technique for the problem of determining the ideal switch amount and location. By decreasing overall disruption costs at every step of the analysis, the suggested iterative algorithm can discover the answer faster than previous switch optimization strategies. The suggested method does not rely on data from outdated utility surveys such as variable switch investment capital and consumer interruption costs. As parts of the US Department of Energy (DOE) financed West Martinsville Super Circuit project, the suggested approach was successfully deployed on Mon Power's, a FirstEnergy subsidiary, distribution system (WVSC). To showcase the usefulness of the suggested technique, IEEE 34-bus and 123-bus test feeders are used to evaluate the proposed methodology. The theoretical model was constructed in Matlab, and the results demonstrate that the suggested iterative technique may significantly decrease the search space and discover the best number and location of buttons with minimal processing cost.

Mashood Nasir et al. [6] The following are the topics covered in this paper: Due to voltage deregulated, power dissipation, and other management concerns related with renewable power sources' intermittent renewables, a higher absorption level of solar and wind power inside the power distribution system is one of the key issues for distributing system operators. Effective reactive power regulation of distributed generators (DGs) that really can lead to system voltage enhancement and energy loss reduction should indeed be handled to tackle these difficulties as a consequence of the rise penetration of renewable energy sources of distributed generators (DGs). The optimal reactive power control (OPRC) of DGs in the electricity system is proposed in this work using a general agreement network model. The proposed technique has been found to be effective in optimizing the cross function of distribution networks, combining power outage and power fluctuations. The suggested algorithm's efficiency and adaptability were confirmed by testing it on 6-bus and 162-bus distribution channels and comparing results to the central management technique.

A.Gupta et al. [7] The current distribution and transmission system is compared to the planned live electrical distribution model in the this research. The research is based on an actual reduced transformer in the state of J&K. The investigation is being conducted in order to determine this same economic loss inside the existing low voltage (LT) distribution network, and then to transform this medium voltage power scheme to a suggested high voltage distribution system (HVDS), which includes load disconnection and the replacement of one sizable transmitter with several smaller power transformer. Since power loss in distribution channels is critical, the use of low power for transmission in existing systems is the primary cause of these losses. Because of the voltage level in the existing power grid, throughput is high, resulting in considerable power dissipation as well as the possibility of connecting and so therefore energy theft. The goal of this work is to reduce the losses by using the LT less or less LT 'HVDS' system, and then to calculate the reductions in loss in units or yearly saving in rupees as a result of the project method. The annual savings and payback duration of the suggested approach are also computed to check overall capability of the proposed work.

Ritula Thakur et al. [8] In the past, using energy was a top priority because it was readily available and had the capabilities to function labor, but as time has passed, the focus has shifted to conserving electricity rather than consuming it. In reality, it has become a necessary component for increasing one's quality of life, as well as its absence is linked to poverty and poor living conditions. The link among energy providers and customers is formed through inter - and intra and transport channels. The efficient operation of the electrical infrastructure component is required to keep the power industry and the growth of the economy growing. As a result, the current scenario is marked by unacceptably heavy losses, voltage stability and supply chain risk, invoicing area, revenue generation, numerous supply outages, and hence consumer unhappiness, among other things. To eliminate voltage stability, the transmission sector needs a cost-effective system to offer electrical power at a reasonable cost and with a low voltage drop. As a result, we want a cost-effective method for State Electricity Boards to offer electrical power to varied users with minimal voltage drop and reduced voltage control. This article discusses the many components of a High Voltage Distribution Network that was commissioned to enhance the voltage drop profiles in the distributing sector in order to increase customer satisfaction in a cost-effective manner.

Marvin Barivure Sigalo et al. [9] Using ERACS, this paper investigates the determine the nature of distributed energy resources on medium voltage (MV) and low voltage (LV) networks, particularly the modifications in voltage stability, real and reactive tends to flow caused by the addition of small scale distributed generators (SSDGs) both at the MV and LV thresholds of distribution channels.

Soo-Bin Kim et al. [10] A reactive power control approach that combines the PF(P) and Q(V) methods is proposed in this study. The suggested technique calculates the responsive output power by combining the dispersed battery's power flow and voltage profile parameters. In comparison to the present technology, the suggested technique increases the voltage regulating capabilities of the power control while lowering network inefficiencies. The proposed technique was evaluated in terms of voltage control capability and networking losses by modeling and simulating the low voltage communications network, and the effectiveness of the designed approach and the creation and operation were contrasted and examined. Reactive power was formerly controlled by a single variable name, such as the voltages at the point of interconnection or the effective output power of a generating units. The power control capacity of the PF (P) approach, which delivers specific power factors based on the power output of generating units, is robust, but networking inefficiencies are high. The Q (V) approach, which delivers a fixed quantity of power flow depending on the specific power, has lower transmission losses but poor voltage control.

III. METHODOLOGY

Reduced distribution centers use three terminals, lengthy reduced lines, and many loads supplied from such a large transformer, leading to increased leakage currents that affect voltage stability and distributed generation effectiveness. Whenever buses be moved farther from the transformer in the electric network, the current at the busses drops, and the losses are substantial. Use of low power for transmission results in substantial losses since the velocity in the reduced voltage system is very important.

Energy losses are common in the process for supplying power to consumers due to some technical and economic inefficiencies. The main cause of high losses is thought to become the utilization voltage level for power distribution, which results in high present and hence increased losses. Thermal management loss from electricity travelling via conductor, electromagnetic losses in converters, resistor loss in field winding and copper loss, resistance loses in network, and inefficiencies in energy meters are all examples of technical losses. These inefficiencies cannot be completely eliminated, but they can be minimized. The work has concentrated on the development of both low and high electricity distribution channels in the MATLAB/SIMULINK framework, as well as comparative evaluation.

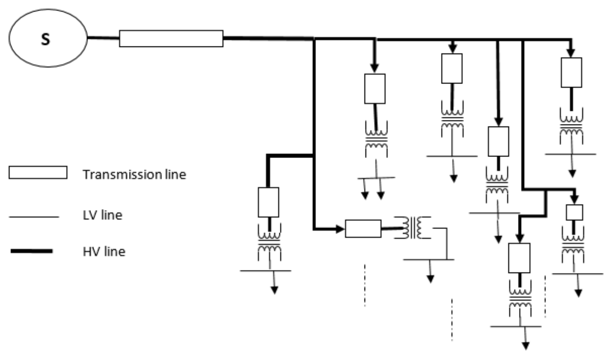

Figure 1 High Voltage Distribution system MATLAB/Modeling Block Diagram

The live electrical transmission system is shown in Figure 4.2, which was created using the Matlab programming. Small 65KVA transformers were used in the simulations a little before the load sites. The high strain is start running to the point loads, then stepped down to the desired 230 V phase to grounding voltages to produce the load efficiency, as shown in the diagram. As shown by the dark and light wires, this network has more high pressure lines then low tension lines going across it. High voltage distribution systems (HVDS) are used to reduce induced reduction, increase healthy and fresh products, and minimize electricity generation fraud.

The main goal of employing voltage output for transmission is to reduce energy thefts and unauthorized connections by essentially eliminating (low tension) LT lines and replacing even short LT lines with shielded aerial bunched cables (ABC). This made a direct taps extremely difficult, which raises the number of authorized connections and eliminates additional failures, improving reliability. The proposed system converts an existing low voltage (LT) network into a large electrical distributed generation. Each 11kV feed in the switchgear is divided into many subsidiary 11kV feeders that bring electricity to loading locations.

The examination of these minimum and maximum distribution channels was expanded to include the security and reliability challenges that arise when renewable resources are used to feed the network..

IV. RESULT AND DISCUSSION

The voltage drop and large electrical distribution channels are two primary types of something like the electrical distribution network which are being examined for respective capacity characteristics in this study. A high-capacity converter at a load center distinguishes the LVDS. This distributor serves several clients via lengthy low voltage (LV) lines, as well as high voltage (HV) lines, such as 11kV, which are the principal wholesalers in the MATLAB/SIMULINK system.

The work was carried out with a focus on comparing results obtained depending on the aforementioned cases:

Case 1: In order to analyze load terminals in distribution channels, a study was done.

The electrical characteristics and associated possible quality at the unloading sites across both low voltage and high energy distribution channels were discussed in this scenario. The graphs show the attainable multiple AC voltage output, as well as the corresponding harmonic current levels.

The power flow are always shown to investigate the electricity regained as a result of the program's inefficiencies being reduced.

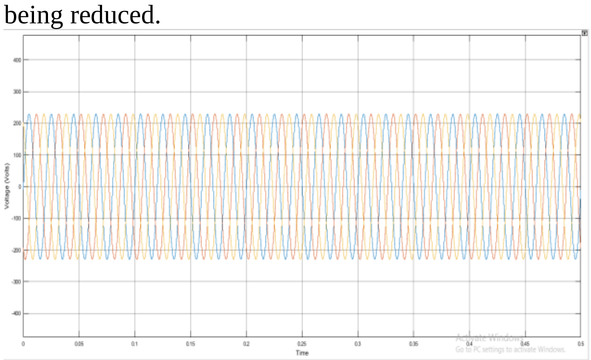

Figure 2 Voltage available at the load points in HV distribution system

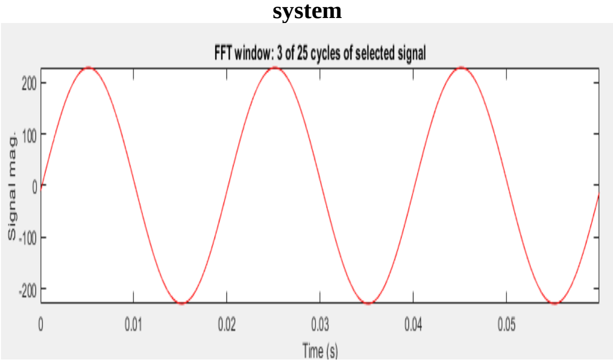

Figure 3 FFT transform derivation for distortion analysis in voltage of HV system

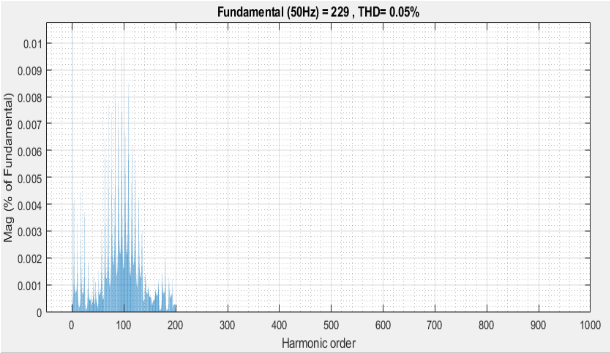

Figure 4 THD% calculation of voltage available at the load point in HV system

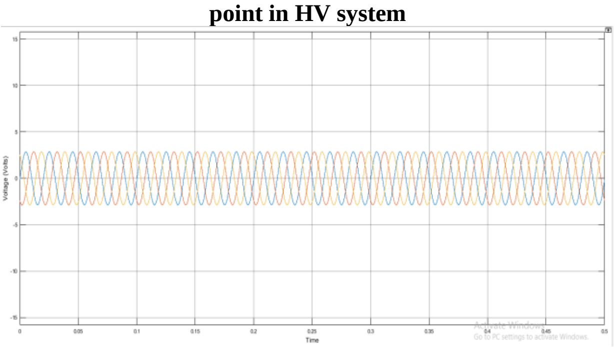

Figure 5 Current at the load points in HV distribution system

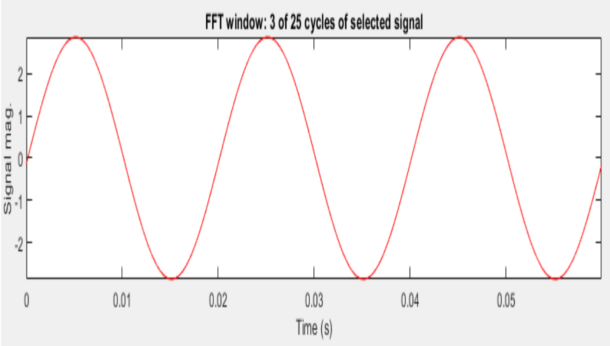

Figure 6 FFT transform derivation for distortion analysis in current of HV system

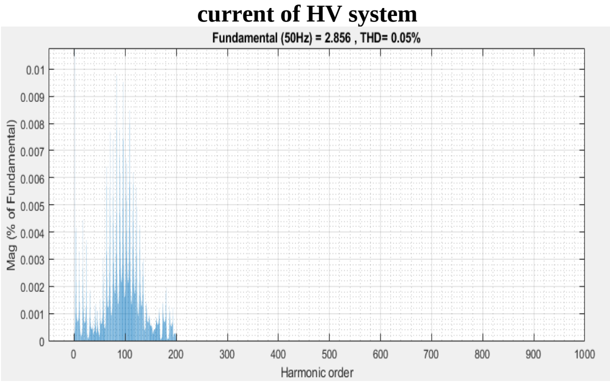

Figure 7 THD% calculation of current in HV system

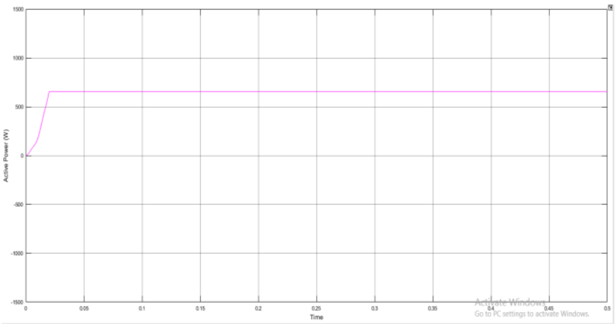

Figure 8 Active Power waveform at the load points in HV distribution system

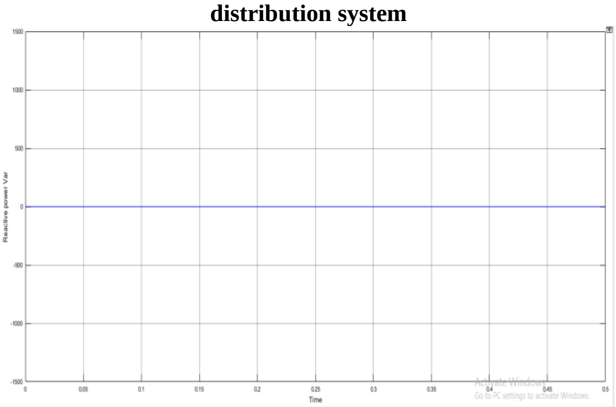

Figure 9 Reactive Power waveform at the load points in HV distribution system

The voltage of 229 V has a deformation degree of 0.05 %, and the current accessible there at load is roughly 2.88 A with a total harmonic current percent of 0.05 percent, according to the HV systems engineering at the loading point. The effective available power is 654W in the platform designed with varied loads at large electrical distribution network.

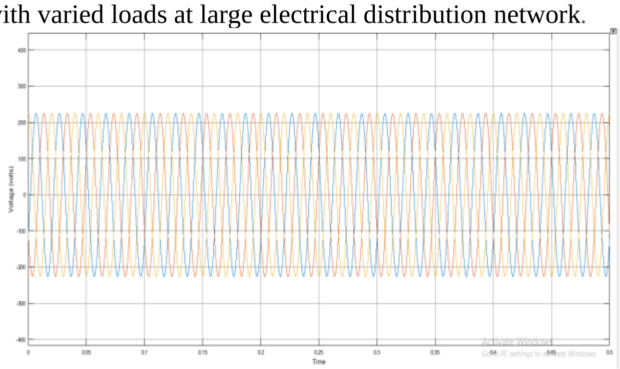

Figure 10 Voltage available at the load points in LV distribution system

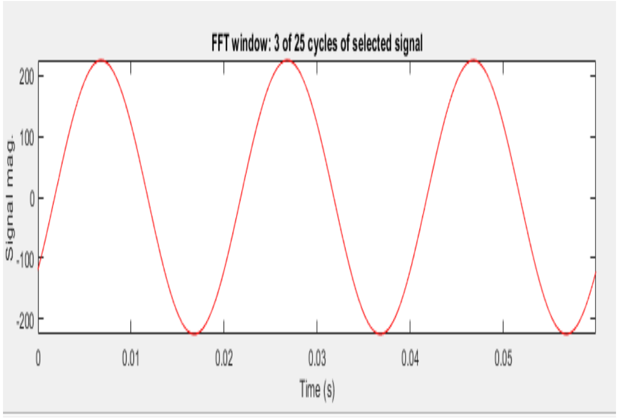

Figure 11 FFT transform derivation for distortion analysis in voltage of LV system

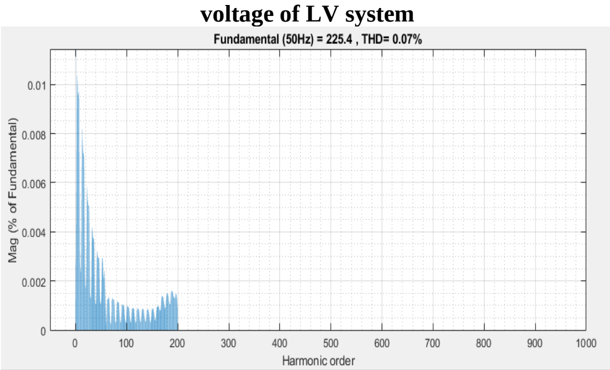

Figure 12 THD% calculated in the voltage of LV system

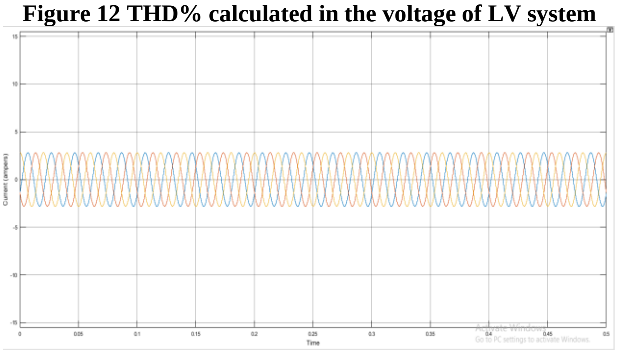

Figure 13Current at the load points in LV distribution system

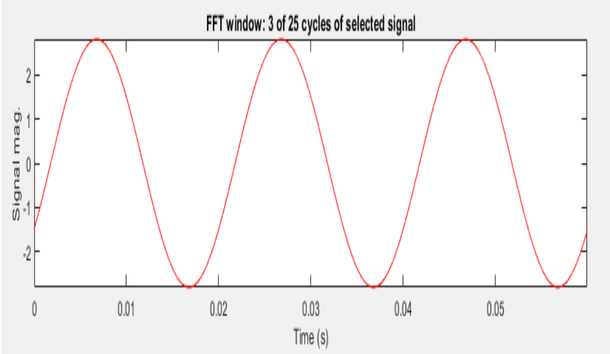

Figure 14 FFT transform derivation for distortion analysis in current of LV system

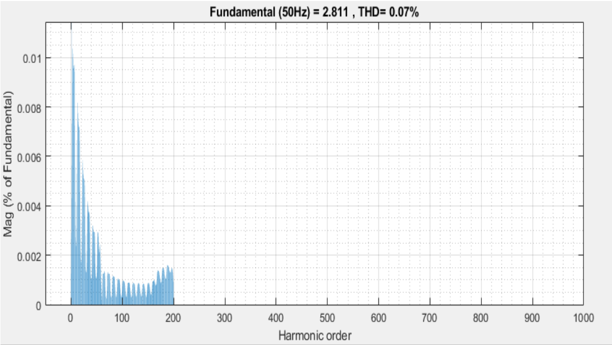

Figure 15 THD% calculated in the current of LV system

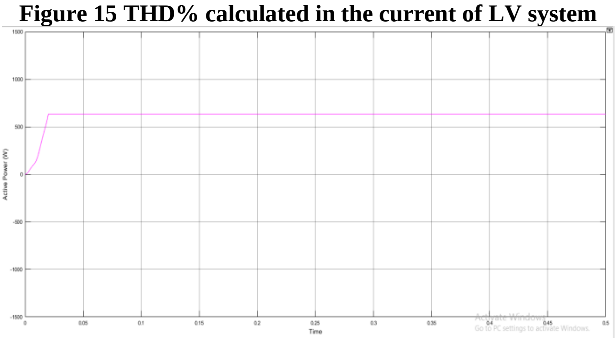

Figure 16 Active Power waveform at the load points in LV distribution system

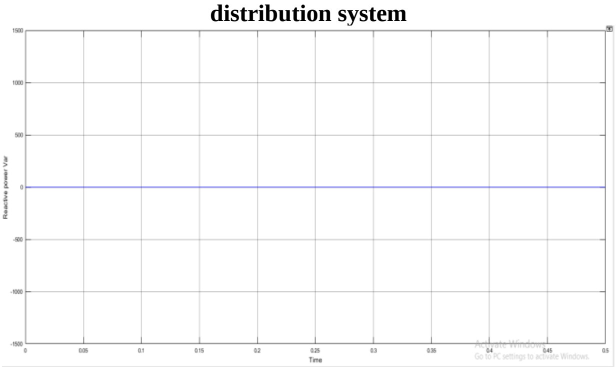

Figure 17 Reactive Power waveform at the load points in LV distribution system

The voltage of 225.4 V has a deformation level of 0.07 percent, and the present accessible at the load is roughly 2.811 A with a cumulative harmonic current proportion of 0.07 percent, according to the LV systems engineering at the maximum stress. The active electricity is 633.7W in the system built with varied loads at power transmission and distribution levels.

Case: 2 Overload impacts on transmission system are investigated.

We must examine the performance of this system that includes an electrical transmission line as well as continuous power demands in order to conduct a stability research. We need to look at system reliability from of the ac side, which we computed in our work by observing the effects of loading on the voltage line of 11KV in various distribution channels. In all cases, the goal is achieved by determining the THD percent in the current.

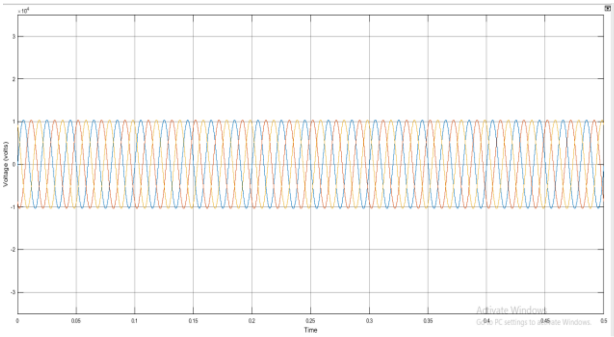

Figure 18 Transmission line voltage in the 11KV line for HV distribution system

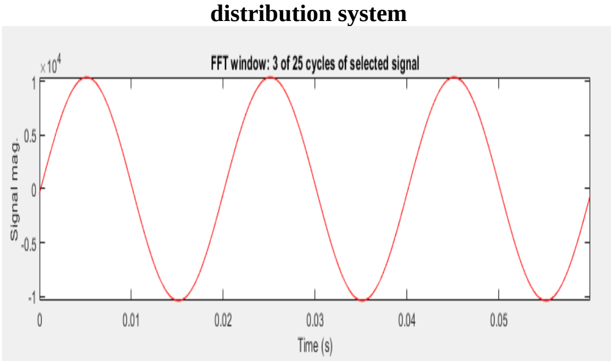

Figure 19 FFT transform derivation for distortion analysis in 11KV high voltage line due to loading in HV system

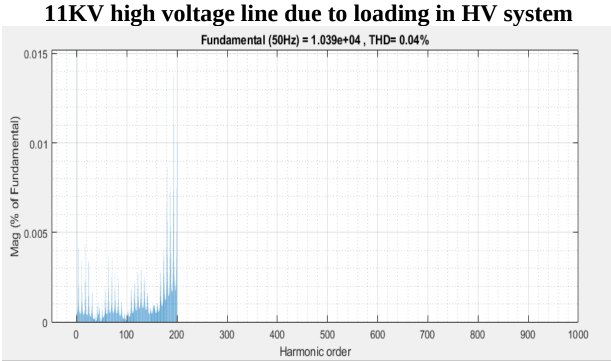

Figure 20 THD% reflected in the high voltage 11KV distribution line due to HV system loading

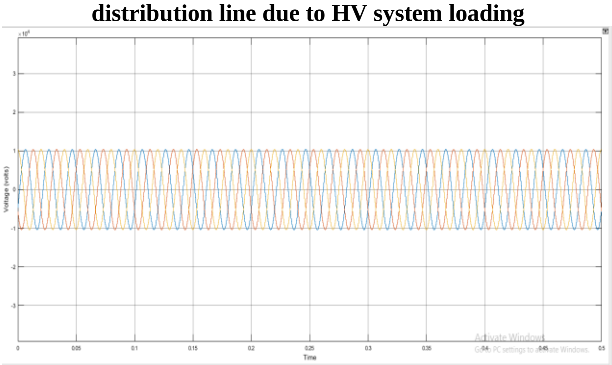

Figure 21 Transmission line voltage in the 11KV line for LV distribution System

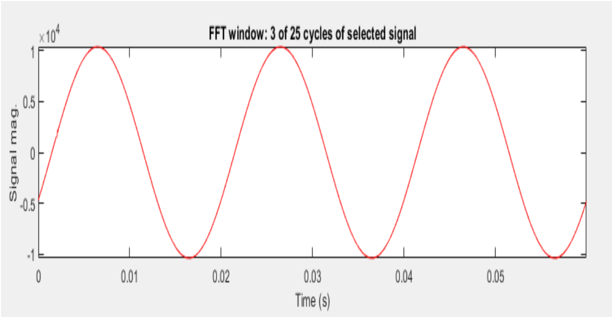

Figure 22 FFT transform derivation for distortion analysis in 11KV high voltage line due to loading in LV system

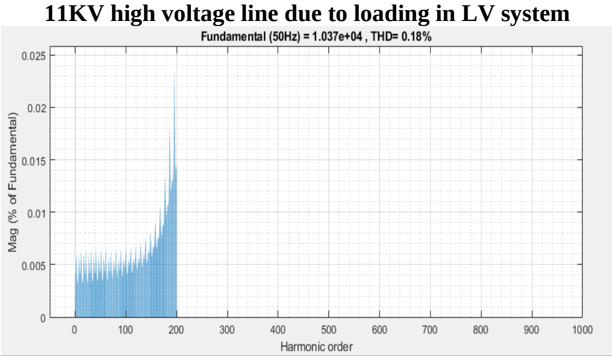

Figure 23 THD% reflected in the high voltage 11KV distribution line due to LV system loading

In terms of THD percent mirrored on the voltage applied but also due to overloading, the case diagram verified that large electrical distribution networks are more successful than distribution and transmission systems. In the modulated signal, the deformation in the HV system was found to be 0.18 percent lower than in the LV system, which was 0.22 percent higher.

The purpose of this paper is to demonstrate how live electrical systems (HVDS) can be a superior distribution system than the one now in use (Low Voltage Distribution System, LVDS). This phase has confirmed the jobs performed on the HV and LV systems.

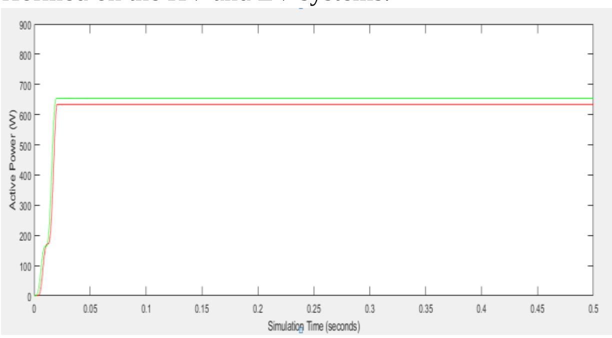

Figure 24 Comparative improvement of active power output from the LV and HV systems

HV and LV system study with grid interfaced solar wind energy systems at the load line - The technology has been implemented with photovoltaic energy wind power generation in this scenario. These power generation are on on natural phenomena such as wind, solar irradiation, and other environmental variables that are very variable. As a result, their output may contain the impact of various factors. The connecting among these resources for controlling the loads has been addressed in the voltage and low power distribution channels.

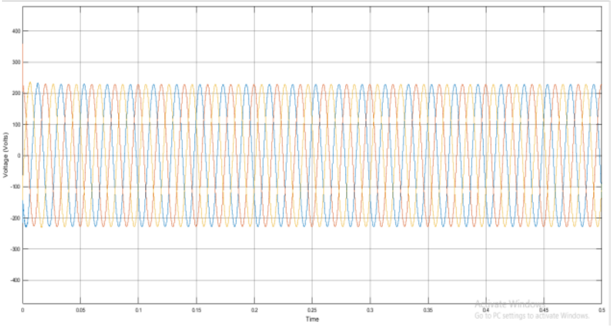

Figure 25 Voltage available at the load points in HV distribution system with renewable energy resources

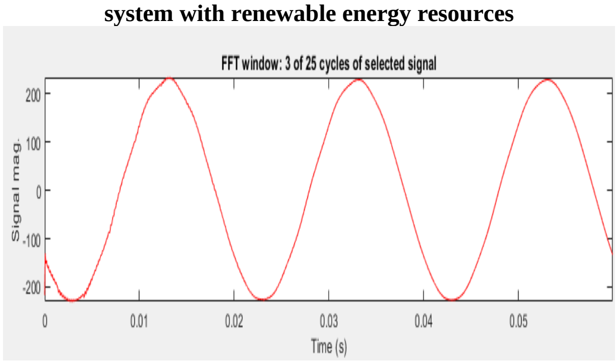

Figure 26 FFT transform of Voltage available at the load points in HV distribution system with renewable energy resources

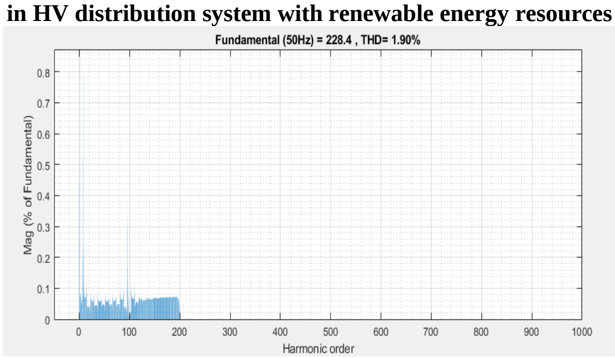

Figure 27 THD% in FFT Voltage available at the load points in HV distribution system with renewable energy resources

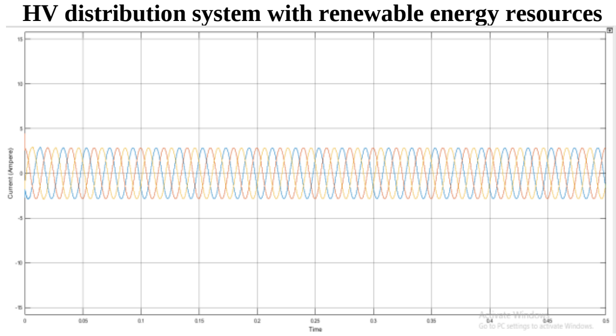

Figure 28 Current drawn at the load points in HV distribution system with renewable energy resources

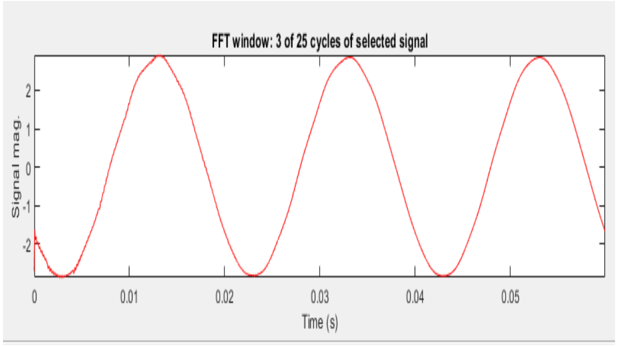

Figure 29 FFT transform of Current at the load points in HV distribution system with renewable energy resources

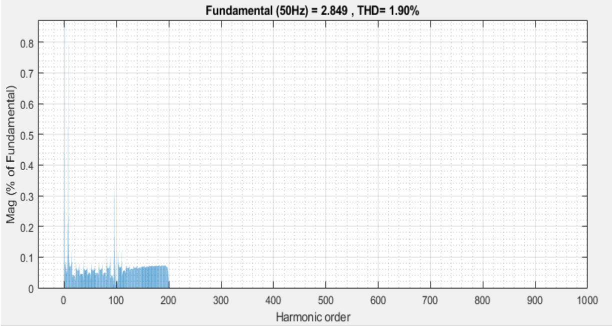

Figure 30 THD% in the Current drawn at the load points in HV distribution system with renewable energy resources

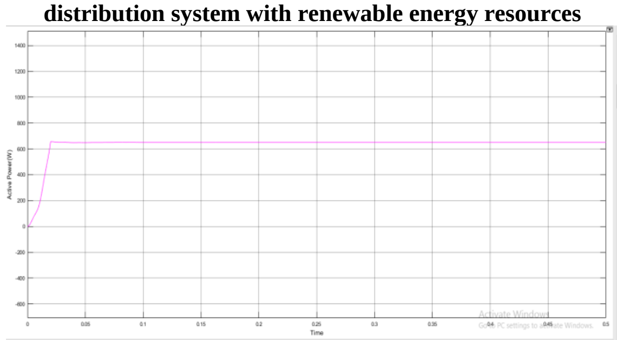

Figure 31 Active power at the load points in HV distribution system with renewable energy resources

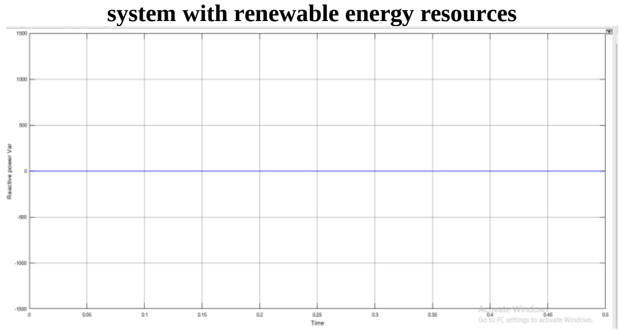

Figure 32 Reactive Power at the load points in HV distribution system with renewable energy resources

The voltage of 228.4 V has a deformation level of 1.90 %, and the current currently offered at the truck full is estimated 2.85 A with a total current harmonic proportion of 1.90 percent, according to the HV system analysis at the maximum stress with both the solar/wind hybrid energy system in the grid. The effective supply current is 650.3W in the system built with varied applications at distribution and transmission level.

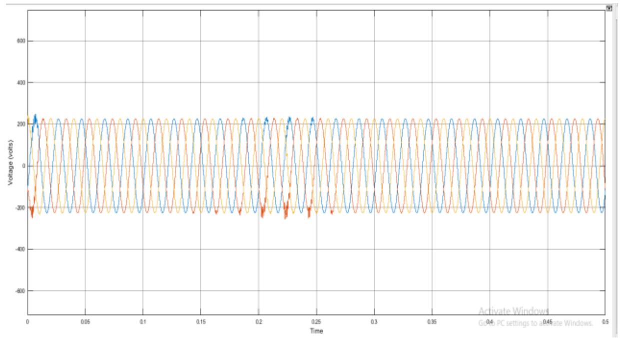

Figure 33 Voltage available at the load points in LV distribution system with renewable energy resources

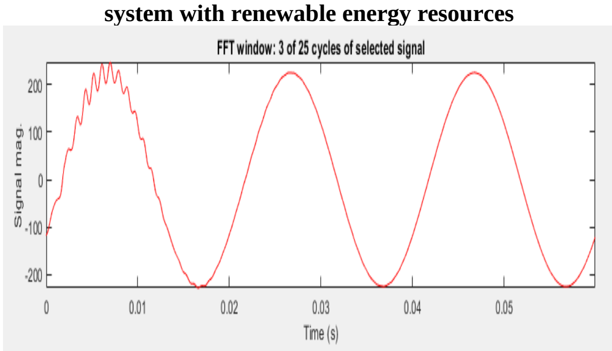

Figure 34 FFT transform of the Voltage available at the load points in LV distribution system with renewable energy resources

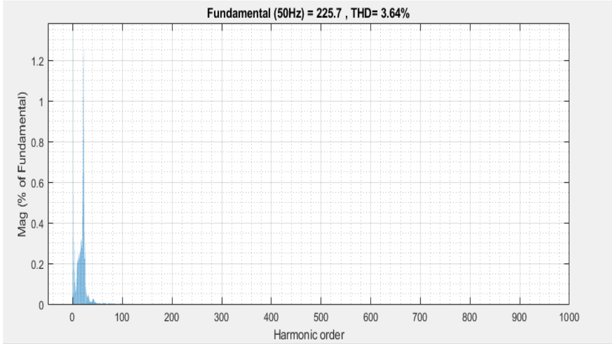

Figure 35 THD% in Voltage available at the load points in LV distribution system with renewable energy resources

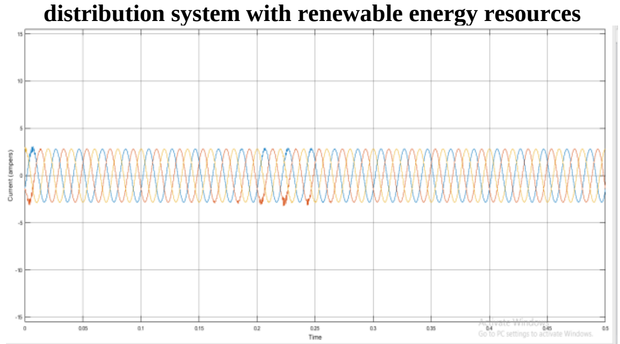

Figure 36 Current drawn at the load points in LV distribution system with renewable energy resources

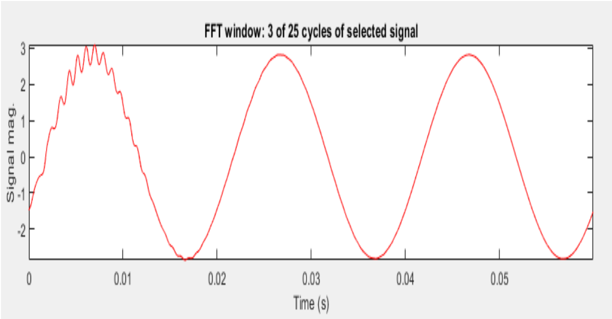

Figure 37 FFT transform of the Current drawn at the load points in LV distribution system with renewable energy resources

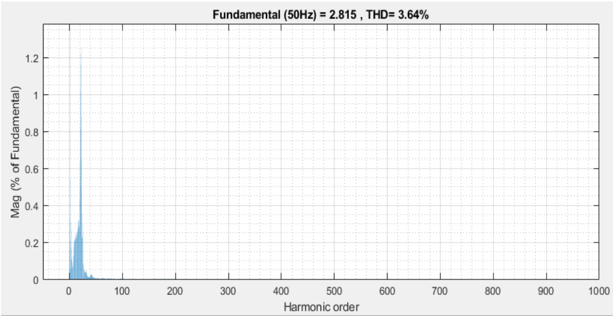

Figure 38 THD% in Current drawn at the load points in LV distribution system with renewable energy resources

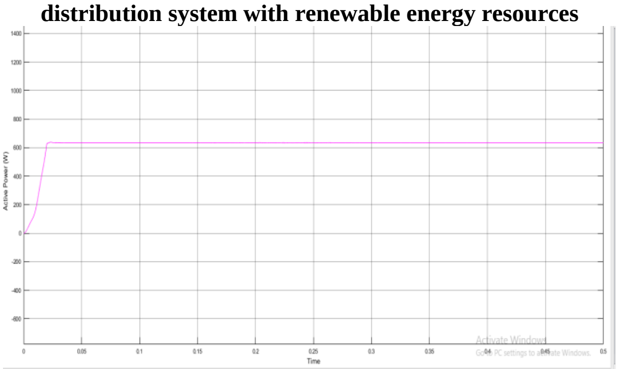

Figure 39 Active Power at the load points in LV distribution system with renewable energy resources

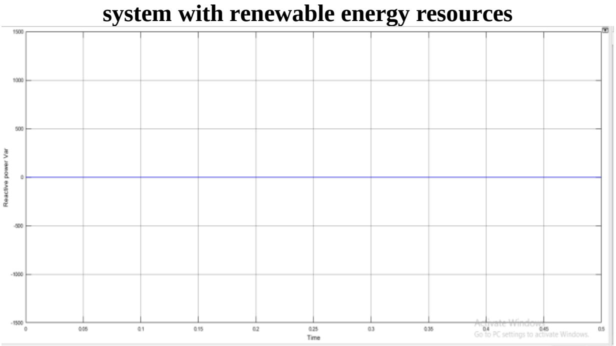

Figure 40 Reactive Power at the load points in LV distribution system with renewable energy resources

The voltage of 225.7 V has a deformation level of 3.64 percent, and the current currently offered at the massive amount is estimated 2.81 A with an overall harmonic current proportion of 3.64 percent, according to the LV systems engineering at the maximum stress with the solar/wind combined heat and power plant in the grid. The effective generated power is 635W in the system built with varied applications at distribution and transmission level.

In this scenario, the volt waveform are evaluated to determine the level of distortion by computing the Transformation function of the phase voltage. In the case of an LV distribution network, the research was done on the power transmission bus well before substantial transformers. In the instance of a high-voltage distribution network, the bus before to the tiny converters was chosen for investigation.

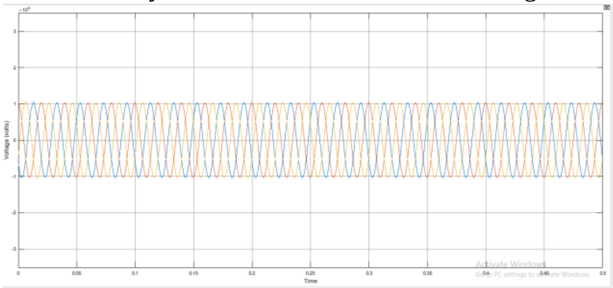

Figure 41 Transmission line voltage in the 11KV line for HV distribution system with the renewable energy resources

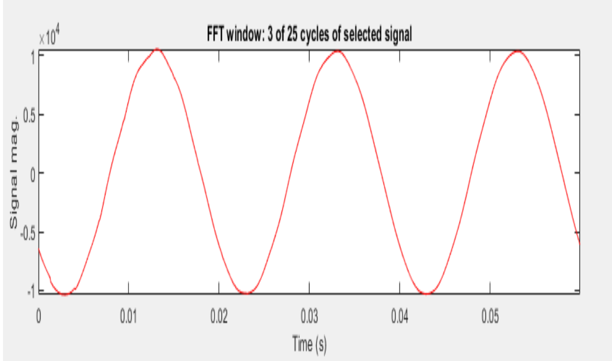

Figure 42 FFT transform of the Transmission line voltage in the 11KV line for HV distribution system having renewable energy resources

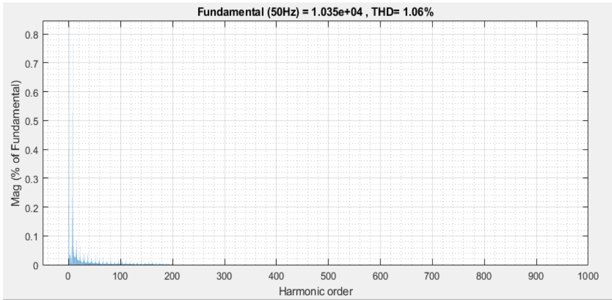

Figure 43 THD% in Transmission line voltage in the 11KV line for HV distribution system with the renewable energy resources

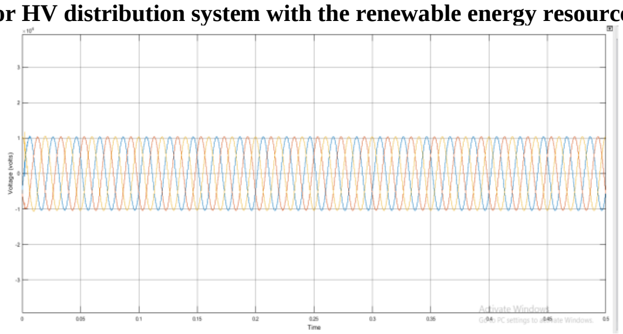

Figure 44 Transmission line voltage in the 11KV line for LV distribution system with the renewable energy resources

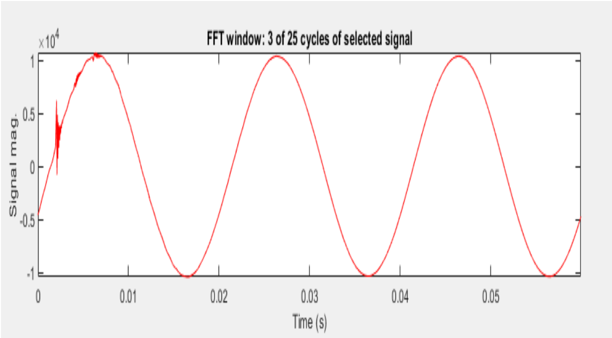

Figure 45 FFT transform of the transmission line voltage in the 11KV line for HV distribution system with the renewable energy resources

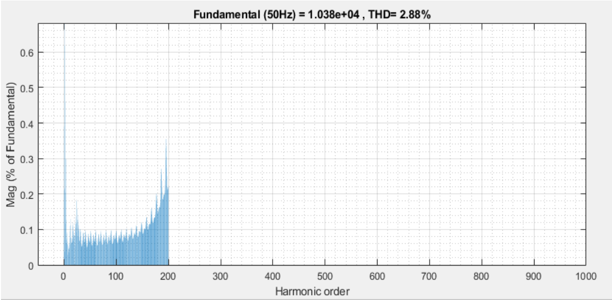

Figure 46 THD% in transmission line voltage in the 11KV line for HV distribution system with the renewable energy resources

V. CONCLUSION

The goal of the project is to conduct a guaranteed to find of the consequences at load sites in both the high power and high power distribution networks. The results showed a decrease in losses at the load busses, as well as an enhancement in voltage and power profiles. The following important improvements were presented in the comparison inferences:

• In the HV distribution system assessment, the battery voltage improved with a decrease in distortion from 0.07 percent to 0.05 percent at the loading terminal. The energy returned was around 3 volts. A similar increase in current was found in the large electrical distribution model.

• An increase of around 3% in active power was achieved as a result of the improved voltage and current profile.

• In an HV distributed generation, the impact of pressure on the transmission line was smaller than in an LV distributed generation.

The findings of the comparative evaluation indicated the follows based on the optimisation problem: The optimised HVDS has a good voltage profiles, leading to a positive voltage level; systems inefficiencies reduction lowers operational costs and boosts annual realized loss saves inside the optimal HVDS. As a result, this study offers a novel strategy to choosing unit converters for a transition from LVDS to HVDS that will provide network operators with reliable and cost-effective services.

The research was expanded to include the development of a minimum and maximum distribution network for solar and wind power that was also connected with an 11-kilovolt line. The findings led to the following important conclusions:

• A 2.4 percent increase in power production was discovered as a result of improved current and voltage consequences accessible at the supply terminals.

• The current and voltage profiles of solar radiation hybrid technology were found to be less deformed, with a THD percent of 1.90 percent, compared to 3.64 percent for medium voltage power systems.

• As in the previous scenario, the effect of overloading on the operating power 11KV distribution system was similarly reduced, with 1.06 percent compared to 2.88 percent in the LV distribution model.

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