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Advanced Control Technology for Grid Connected RES Systems

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ABSTRACT

Technology advances swiftly as time goes on. The current study offers the Teaching and Learning Based Optimization (TLBO) Methodology for Grid Connected RES System. Every day, a new algorithm for an optimization problem was created. The current work's optimization-based Tuned PI controller control technique for Grid Connected PV System for increasing power quality in a distribution system uses the Teaching and Learning Based Optimization (TLBO) Algorithm. The entire system is modelled using the MATLAB/SIMULINK platform. A grid converter's PI controller with TLBO tuning improved power quality by lowering THD, as shown by the research's conclusion..

1. Introduction:

Today, the power sector is a vital part of every organisation and is essential for both economic growth and a country's well-being. The power sector in India is the most varied. In India, conventional energy sources account for the majority of power production, though demand for non-conventional energy sources is also rising.[1]-[5] Because of the significance of power generation, it is important to produce high-quality power. But there are a number of power quality difficulties brought on by the range of loads. As a result, improving power quality is a difficult task for the power industry and power engineers. Various techniques have been used in recent years to compensate for power quality. [6]-[10]

The Teaching and Learning Based Optimization (TLBO) based Grid Converter is employed in this study as a compensator for the enhancement of power quality. Grid Converter (STATCOM) is a shunt compensator, with PV System as its input. The use of the Grid Tied PV System Converter Control Technique Based on Teaching and Learning Based Optimization (TLBO) Algorithm is demonstrated in the study. For the tuning of the PI Controller in STATCOM control, a new optimization technique is suggested. Finally, this study illustrates how a tuned PI controller for a grid converter using Teaching and Learning Based Optimization (TLBO) can improve power quality. [10]-[15]

2. TeachingandLearningBasedOptimization(TLBO):

The Teacher and Learner Mechanism underlies the Teaching and Learning (T&L) inspired optimization method put out by Rao et al. (2011, 2012), Rao and Savsani (2012), and Rao and Patel (2012). A meta-heuristic population-based optimization called Teaching and Learning (T&L) such as HS, ACO, PSO, and ABC, are based. A straightforward mathematical model called the Teaching and Learning (T&L) based optimization method is used to address various optimization issues. This research focuses on a new optimization technique that is based on teaching and learning (T&L). The classical heuristics' shortcomings, such as local optimal trapping, a lack of ability to locate close-by extreme points, and a lack of an effective mechanism to handle restrictions, are overcome by the proposed T&L-based optimization algorithm. Our T&L-based optimization technique states that a learner can acquire knowledge in two different ways: I from a teacher (known as the teacher phase) and (ii) through engaging with other learners (called learner phase). The population in this algorithm is referred to as the learners. Design variables are referred to as the learners' subjects. The top student is given teacher status.

A. *TeacherPhase:*

The instructor is the source of all knowledge for the student. The instructor makes an effort to raise the class's average grade through his instruction. The best student is one whose knowledge has reached teacher level, which means that the teacher has forced the students to catch up to him in knowledge. Practically speaking, however, is impossible because not all students are smarter. This happens as.

Let M_i=mean

T_i=teacherat anyiterationi.

T_iMakesthemeanM$_i$tomovetowardsitsownknowledgelevel,therefore$T_i$chosen asM$_{new}$.Hencethebestlearneristreatedasteacher.

Thedifferenceofthecurrentmeanresultofeverysubjectandthecorrespondingresultoftheteacher foreverysubject is given by,

$$Difference = r*(M_{new} - T_F M_i) \quad (1)$$

Where T_F= teaching factor.Itisgiven asfollows:

$$T_F = round[1 + rand*(0,3)*(2-1)] \quad (2)$$

Thisdifferencemodifiestheexistingsolutionaccordingto thefollowingexpression

$$X_{new,i} = X_{old,i} + difference \quad (3)$$

Where $X_{new,i}$ istheupdatedvalueof$X_{old,i}$.Accept$X_{new,i}$.

B. Learnerphase:

The input for the learner phase is the teacher in learner phase learner gains knowledge learnergains knowledge by two ways: one is gaining knowledge form teacher. And other is by sharingknowledgebetween learner's interactions.

Thelearnerphaseisshows asfollows.

Randomlyselecttwolearners X_i and X_j wherei≠j

$$X_{new,i} = X_{old,i} + r*(X_i - X_j) \text{ If } f(X_i) < f(X_j)$$

$$X_{new,i} = X_{old,i} + r*(X_j - X_i) \text{ If } f(X_i) > f(X_j) \quad (4)$$

Admit $X_{new,i}$ ifitgivesbetterfunctionvalue.

3. TLBOTopology forGridConverter:

This work proposes a control method for the converter in a grid-tied PV system based on the Teaching and Learning Based Optimization (TLBO) algorithm. For the tuning of the PI Controller in STATCOM control, a new optimization technique is suggested. In MATLAB, a 110 KW PV Grid system is simulated. Below is a picture of the block diagram.

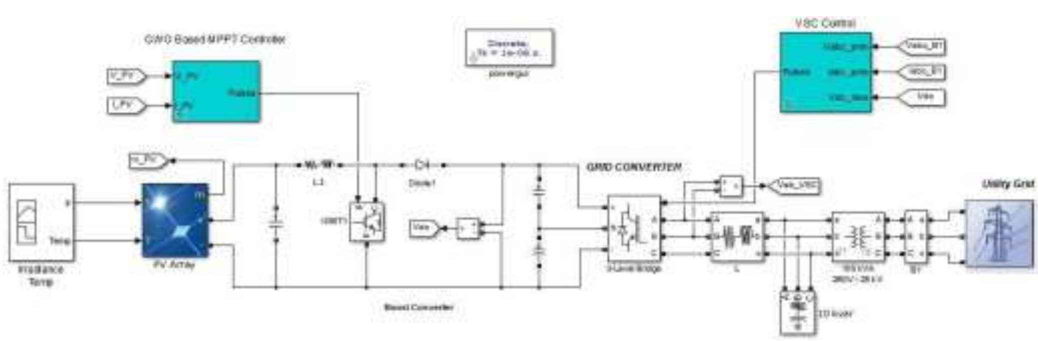

Fig:1ModelofTLBObasedgridconverter

ThestructureofaGridConverterislikethreephaseinverter.IGBT'sareusedasswitchesin the Grid Converter. Since IGBTS are fully controlled switches. Total six IGBT's are used i.eforeach arm 2 switches areused, atotal of 3armsarethereinaGrid Converter. [16]-[20]

In this model a 110 KW PV module is connected to 5 KHz 500 V Boost converter whichbooststhePVModuleVoltageto510Virrespectiveofchangesitmaintainstheconstant510V.

The Grid tied Converter is coupled with the boost converter. In this type, a grid converter is a three-level, 490-volt voltage source converter. The boost converter's grid converter receives a steady 490 V DC voltage. Through a 110 KVA Transformer, the Grid Converter is connected to the Utility Grid.

4. ResultsandDiscussion:

TheproposedmodelintestedinThreeCaseswithVariableIrradianceandTemperature.
TheTw0differentcasesareshownbelow.Case
1:PSO basedGridConverter.
Case2:TLBObasedGridConverter.

AllthetwocasesaretestedwiththevariableIrradianceandTemperaturei.e

- Pmpp @ 1010 W/m^2, 26deg=110.7 kW@ 263.5 V
- Pmpp @260 W/m^2, 26deg=23.4kW@ 255.1 V
- Pmpp @ 1010 W/m^2, 45deg=91.9kW@ 240.2 V

Case1: PSObasedGrid Converter:

The PSO-optimized algorithm is used in this case to harness the gain values of the PI controller. We can say that the controller is tuned by the PSO algorithm because the PI controller produces the optimised output with the aid of the optimised gain value because the gain values are tuned values for the PSO algorithm. The corresponding results are listed below.

The following figure shows the Variable Irradiance, Variable Temperature. Mean Power,MeanVoltage,Dutycycle.IntheMeanPower,MeanVoltageanddutycycleoscillationsexits.At1000 W/m^2, 25 deg the Maximum power is 100.7 KW and in this condition the output power ofthe PV module is 263.5 V. At 240 W/m^2, 25 deg the Maximum power is 24.4 KW and in thiscondition the output power of the PV module is 265.1 V. At 1010 W/m^2, 40 deg the Maximumpoweris92.9 KW and in this condition theoutputpowerofthe PV moduleis 240.2 V.

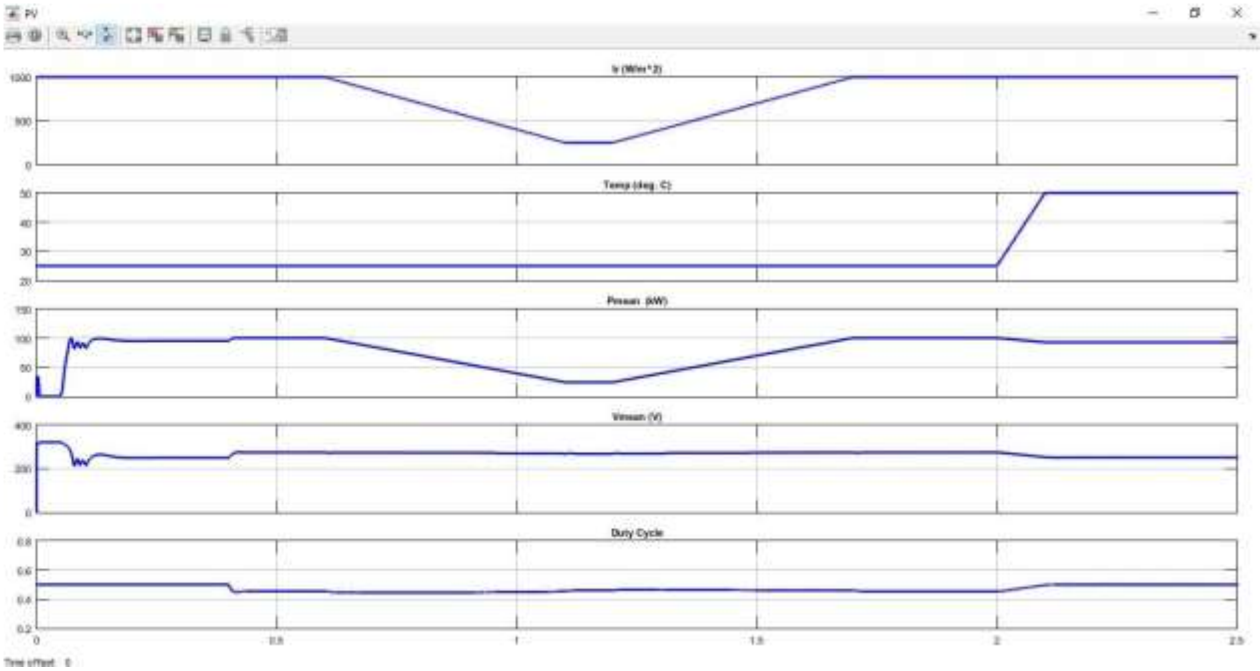

Fig: 2 Variable Irradiance, Variable Temperature. Mean Power, Mean Voltage,Dutycycle

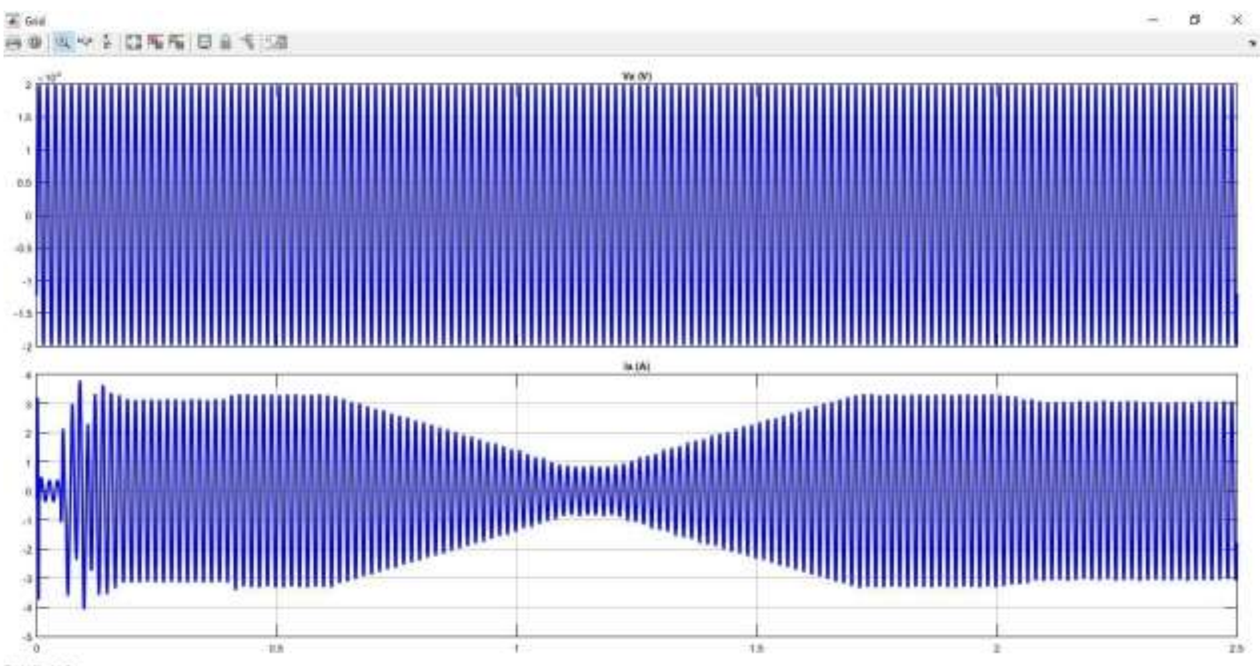

Fig:3GridVoltageandGridCurrent

TheabovefigureshowsthatgridvoltageisconstanteventhoughthevariableIrradianceandVariableTemperature.

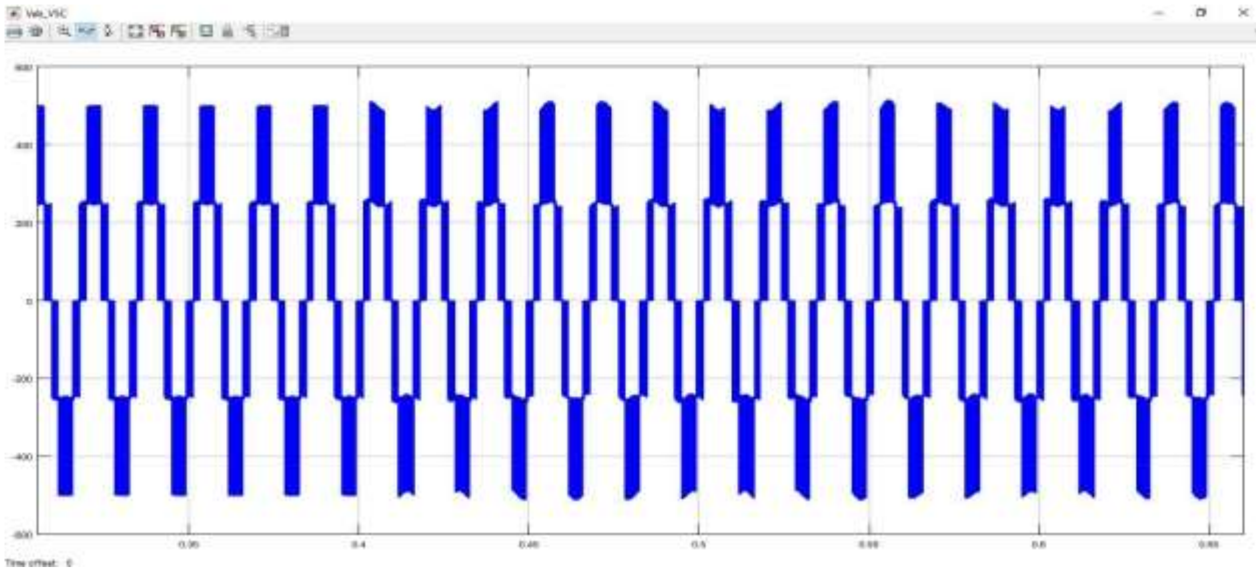

Fig:4GridConverterOutputVoltage

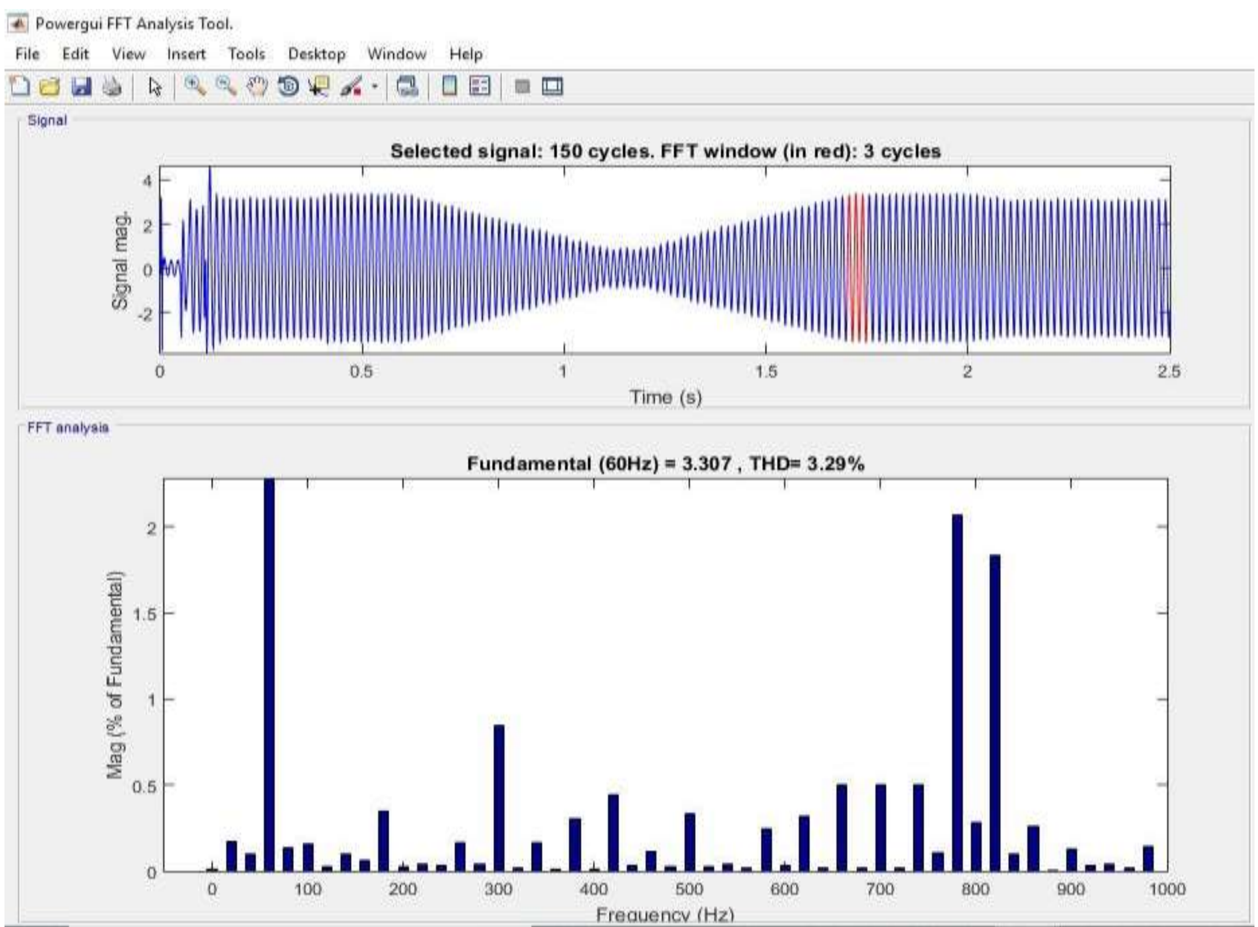

Fig:5THDanalysisofPSObasedGrid Converter.

TheTHD inthis caseis4.29%.

Case2:TLBObasedGridConverter:

In this instance, the gain values of the PI controller are harnessed with the aid of the Teaching and Learning Based Optimization (TLBO) optimised method. Since the gain values are tuned values for the PSO algorithm, we can say that the PI controller is tuned by the Teaching and Learning Based Optimization (TLBO) algorithm because it produces the optimised output with the help of the optimised gain value. Below are the results that correspond.

The following figure shows the Variable Irradiance, Variable Temperature. Mean Power,MeanVoltage,Dutycycle.IntheMeanPower,MeanVoltageanddutycycleoscillationsexits.At1000 W/m^2 24 deg the Maximum power is 100.7 KW and in this condition the output power ofthe PV module is 263.5 V. At 250 W/m^2 25 deg the Maximum power is 24.4 KW and in thiscondition the output power of the PV module is 255.1 V. At 1000 W/m^2 40 deg the Maximumpoweris 92.9 KW and in thiscondition theoutputpower ofthe PVmoduleis 240.2 V.

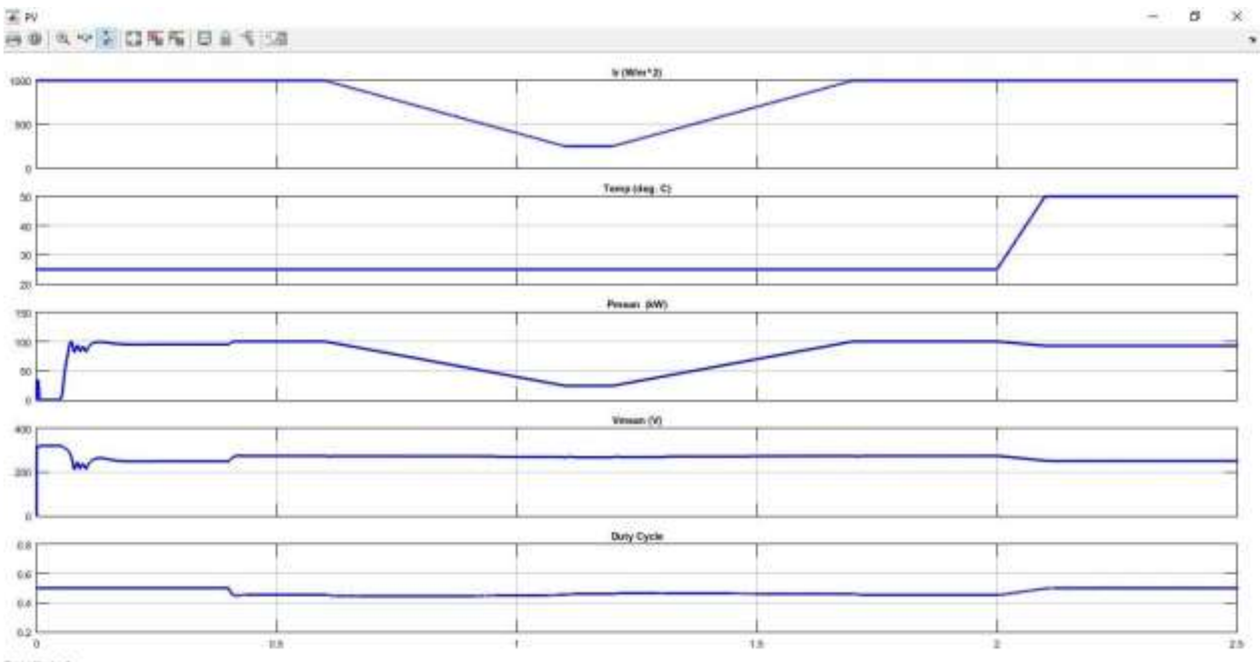

Fig: 6 Variable Irradiance, Variable Temperature. Mean Power, Mean Voltage,Dutycycle

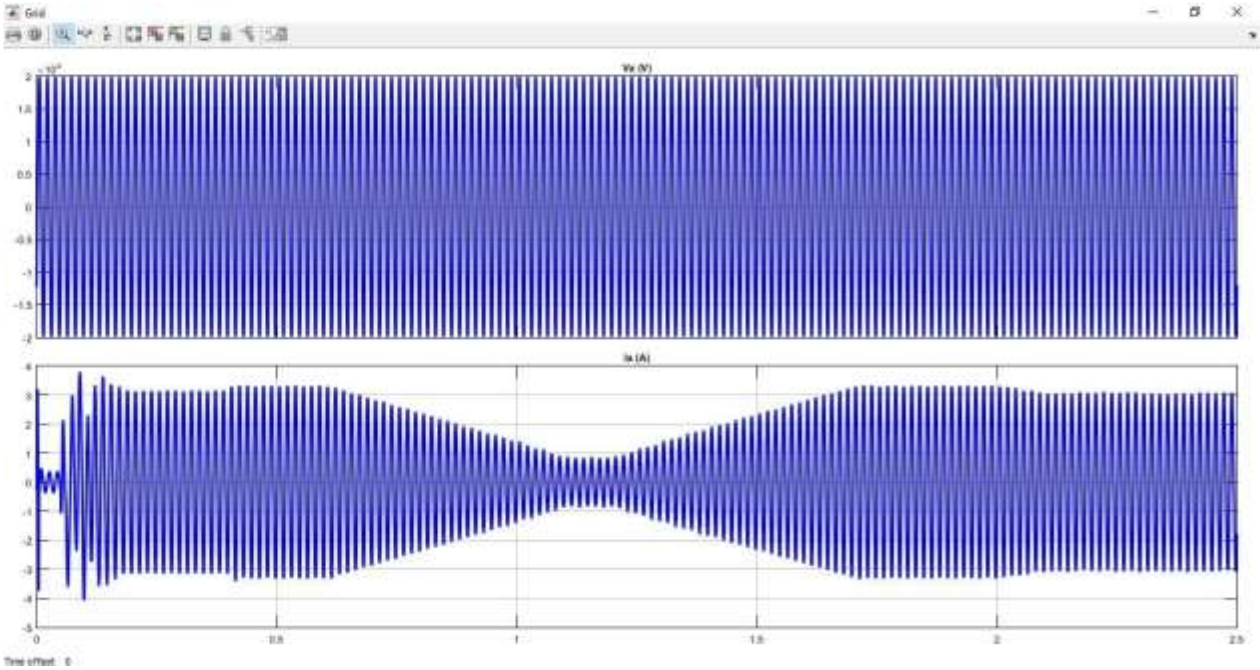

Fig:7GridVoltageandGridCurrent

TheabovefigureshowsthatgridvoltageisconstanteventhoughthevariableIrradianceandVariableTemperature.

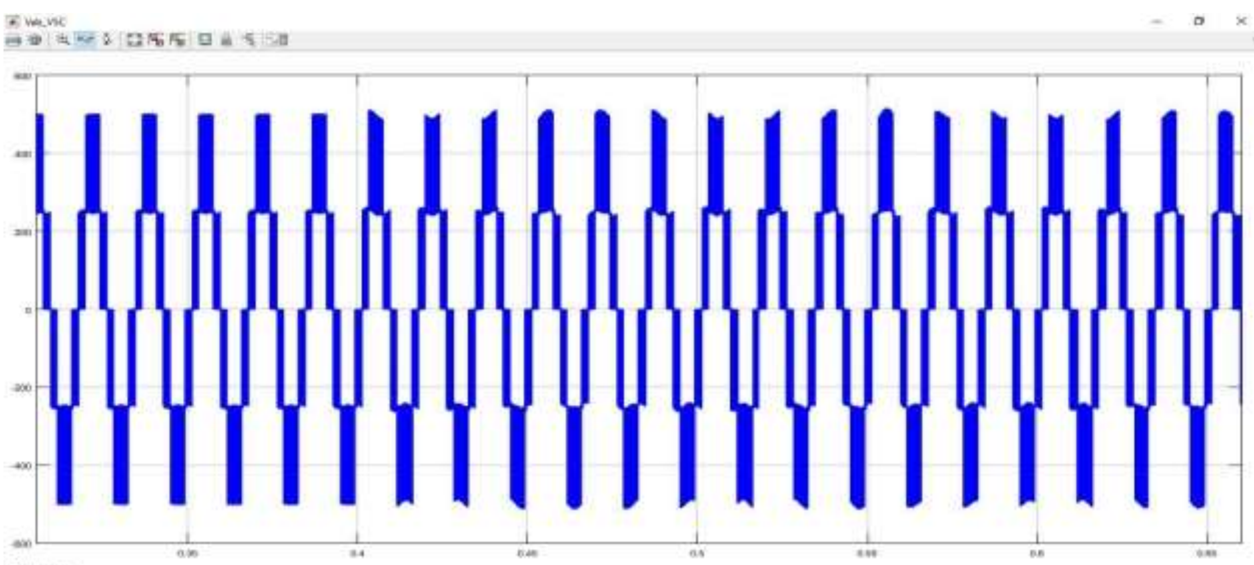

Fig:8GridConverterOutputVoltage

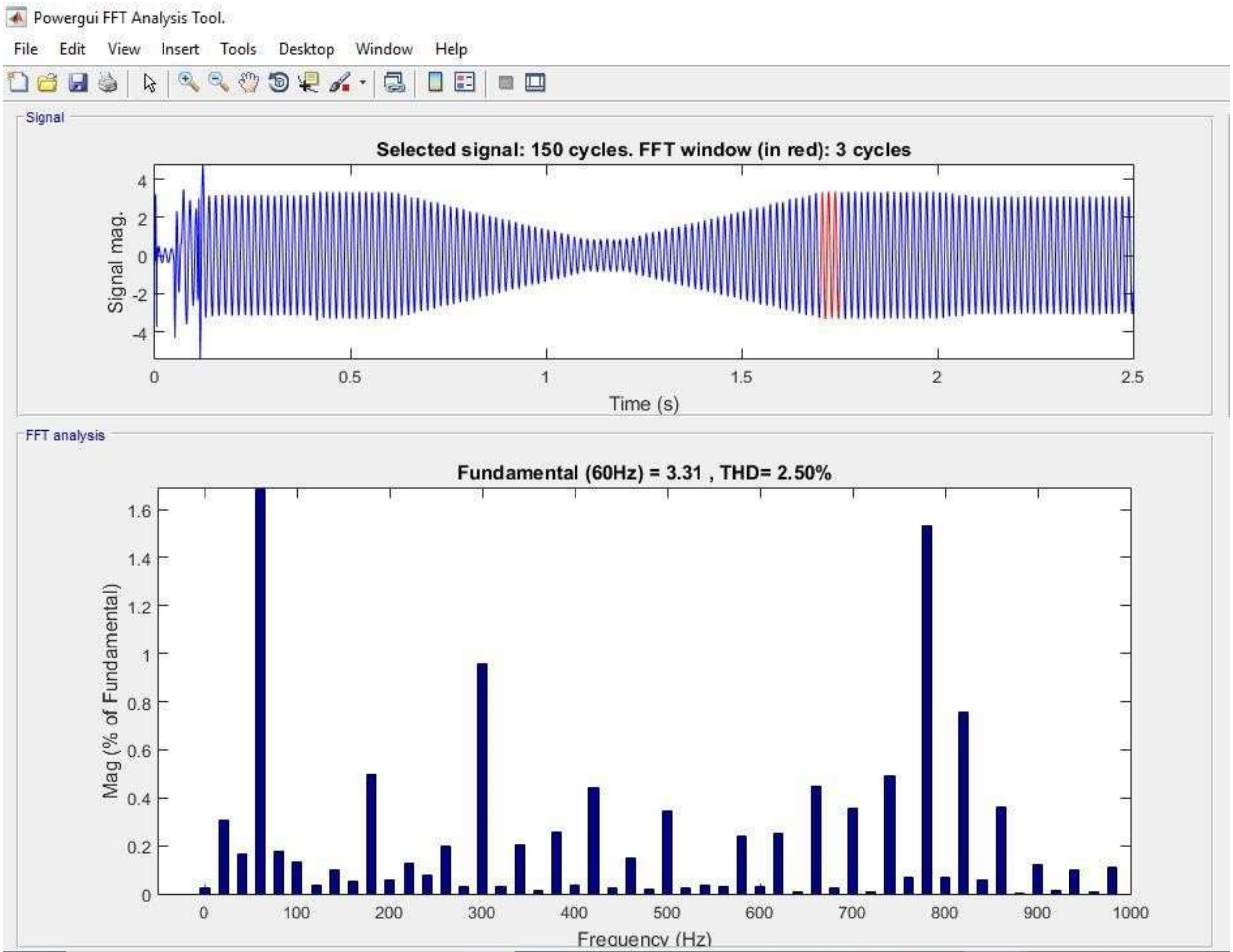

Fig: 9THDanalysisof TLBObasedGridConverter.

TheTHD inthis caseis2.60%.

ComparisonTable:I

Case	Mode	THD
1	PSObasedGridConverter	3.29 %
2	TLBObasedGridConverter	2.50 %

From the above comparison it is clear that a mark reduction in THD from 3.29 % to 2.60% isobserved with the proposed Teaching and Learning Based Optimization (TLBO) based GridConverter.

5. Conclusion:

This article uses MATLAB/SIMULINK to model the Teaching and Learning Based Optimization (TLBO) Tuned PI Controller based Grid Converter. The outcomes demonstrate why the Teaching and Learning Based Optimization (TLBO) Technique is the best PI Controller tuning technique. We can easily see from the THD study that THD has dropped from 3.19% to 2.50%. As a result, a Grid Converter's THD can be improved by using a Teaching and Learning Based Optimization (TLBO) tuned PI controller.

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