



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 4, April 2024

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

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# Enhanced Power Quality Improvement by Using ANN Controller based EV Charging Station Interfaced by 3 Phase Grid

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**ABSTRACT:** Thus, the Design and Analysis of NN Controller based EV charging Station with enhanced power quality project have been executed. The NN controllers show better efficiency in power flow and voltage regulation. The NN controller productivity continually varies in the changing system conditions which increases the stability and stability of the system . The result suggests that using NN controller reduces the tuning complexity and Harmonic Distortion and performance in 6% Disturbance.

**KEYWORDS:** EV Charging station ,DC-DC Bidirectional converter,power quality,solar photovoltaic,VSC

## I. INTRODUCTION

The increasing adoption of EV's has led to growing need for changing infrastructure to support the demand but EV charging stations has relied on unidirectional power flow from the grid to the vehicles battery i.e., active power cannot flow back from the vehicle to the grid so thus limiting the potential of EVS as energy storage at sources so the bidirectional EV charging and V2G capabilities represents a significant opportunity to leverage the energy storage potential of EV batteries and contribute to the modernization of the power grid.

It uses off-board charger instead of an on-board charger as it is a more viable station for higher power applications. The control scheme uses active and reactive power references with the EV owner deciding the charging/discharging mode. The system can operate in grid connected mode and standalone mode during grid usages using the PV array to close the EV charging station can provide lag or leading reactive power compensator is needed

## II.MOTIVATION

- **Integration of renewable energy sources:**

By using ANN controllers the cs can effectively integrate with renewable energy sources like solar wind which helps in creating a sustainable and environmental friendly infrastructure

- **Improved power management**

ANN will ensure the refined charging of evs without over loading the grid and it can predict and manage the power flow which leads to better power quality and reliability of the grid system

- **Enhanced grid stability**

By the use of ANN controllers the cos can reduce to Grid distance thus enhancing the stability of the power grid

## III. OBJECTIVES

controller-based EV charging station interfaced with a 3-phase grid typically include: Optimizing Charging Operations: Utilizing ANN to efficiently manage the charging process, ensuring that EVs are charged during optimal times to reduce peak load and costs<sup>1</sup>.

Enhancing Power Quality: Improving the power quality of the grid by using ANN controllers to predict and mitigate potential disturbances caused by EV charging<sup>1</sup>. Integrating Renewable Energy: Seamlessly integrating renewable energy sources with the EV charging infrastructure to promote the use of clean energy<sup>1</sup>. Implementing V2G

Technology: Enabling Vehicle-to-Grid (V2G) capabilities to allow EVs to return energy to the grid, thereby supporting grid stability and energy management<sup>1</sup>. Supporting Smart Grid Development: Contributing to the development of smart grids by incorporating advanced technologies like ANN for better energy distribution and management<sup>2</sup>. Facilitating Microgrid Applications: Ensuring that the charging station can operate within a microgrid environment, providing stable and reliable power supply<sup>1</sup>.

#### IV. CONTRIBUTION

The main contribution of designing and analyzing a Neural Network (NN) Controller-based Electric Vehicle (EV) charging station with enhanced power quality involves integrating renewable energy sources and advanced control to improve the stability and efficiency of power delivery. Here are some key points:

Integration of Renewable Energy Sources: By incorporating renewable energy, such as solar and wind, the charging station can reduce the load on the power grid and fulfill the charging demands of EVs in an eco-friendly manner<sup>1</sup>. Advanced Control Systems: The use of a multiport converter with a detailed control system helps in stabilizing power supply, managing sudden load disturbances, and improving battery life by incorporating elements like supercapacitors<sup>1</sup>. Enhanced Power Quality: The design aims to address power quality disturbances like voltage sags and stability issues, thereby increasing the reliability of the charging infrastructure<sup>1</sup>. Efficiency and Cost-effectiveness: The use of Silicon Carbide (SiC) devices in converters has been shown to improve efficiency and reduce power loss compared to conventional Silicon (Si) devices<sup>1</sup>. These contributions are significant as they not only enhance the power quality but also pave the way for a more sustainable and reliable EV charging infrastructure.

#### V. LITERATURE REVIEW

[1] M. Shatnawi, K. B. Ari, K. Alshamsi, M. Alhammadi and O. Alamoodi, In this paper, the authors introduce a novel approach to charging electric vehicles (EVs) using hybrid renewable energy sources like wind generators and photovoltaic modules. They highlight the limitations of current EV recharging mechanisms, which rely on dedicated recharging stations and can impact long-distance travel. To address this, they propose an automated charging mechanism (ACM) that autonomously recharges EV battery packs, eliminating the need to wait for recharging and thereby extending travel distances.

The ACM is developed using a MATLAB-Simulink model. The authors conduct experiments to measure the output voltage of wind turbines under various speed scenarios and analyse the performance of solar photovoltaic systems at different irradiance levels. They also study the ACM's behaviour under different load conditions, focusing on metrics such as total harmonic distortion (THD) of output current and voltage, efficiency, and vehicle coverage distance.

To demonstrate the ACM's effectiveness, the authors compare it with commercial charging mechanisms across different EV brands. Simulation results indicate that the ACM satisfactorily recharges EV batteries without relying on traditional recharging stations. They argue that automatic recharging can boost EV usage, leading to a reduction in fossil fuel vehicles and associated CO<sub>2</sub> and CO-related emissions. Ultimately, the authors believe that their proposed method can decrease overall travel time and promote greater EV adoption.

[2] P. P. Nachankar, H. M. Suryawanshi, P. Chaturvedi, D. D. Atkar, C. L. Narayana, and D. Govind, "Electric vehicle fast charger based multiport bi-directional dc-dc interface for grid integration," Amid the growth of environmental and energy concerns, electric vehicles are one of the potential solution for reduction of carbon emission. All-electric green energy objectives depend primarily on standardization of electric vehicle service equipment (EVSE),



associated protocols, smart chargers, and battery technology. However, a generic methodology for EVSE to charge the wide variety of electric vehicle is unavailable. Hence in this paper off-board unidirectional conductive type DC fast charger for light and heavy electric vehicle was proposed. The proposed system requires adaptive for charging of light as well as heavy electric vehicle. The proposed charger is structured

[3]K.Sahoo, A.Pattanaik,A. K. Dey and T. K. Mohapatra, “A new method of battery charging and motor controlling of an electric vehicle: EV, “entire system has two major divisions, those are EV charger and motor controller, that arrangement of battery acting as load or a source and the motor P acting is driving purpose. It has a two separate both charging and motor control the identical highly efficient DC-DC converters named as TA converter which is nothing but Buck-Boost by nature. charging the battery it is necessary to make charging process effective. Microcontroller employ control all parameter of EV in all conditions when the what a it had.

[4]P.Rehlaender,F.Schafmeister,andJ.Böcker, “Automotive on-board dc-dc converters must cover a wide input and output voltage range that is a function of the state of charge of both, the input and the output battery. The conventional two-stage power transfer solution offers a first-stage non-isolated dc-dc converter which sets an input voltage for the galvanic isolated second-stage dc-dc converter. The second-stage dc-dc-converter shall be regulated back to its optimum operating point. This is achievable with a single stage interleaved LLC resonant converter of 3.6 kW, which is introduced in this paper.”

[5]B. B. Quispe, G. de A. e Melo, R. Cardim, and J. M. de S. Ribeiro, “ A single-phase bidirectional plug-in electric vehicle charger with reactive power support feature ,” In this paper presents the design of a single-phase bidirectional plug-in electric vehicle charger for charging/discharging the vehicle’s battery. The charging system operates in all four quadrants of the active-reactive power plane , therefore, providing reactive power support service to the utility grid. The proposed charger is comprised of two cascaded power stages: a full-bridge inverter and a coupled-inductor bidirectional Cuk converter . The charging control system is a hybrid one and consists of a set of PI controllers and a Takagi-Sugeno -T-S- fuzzy controller. The goal of this control system is to supply the charger with the reference measured for the active and reactive power, according to the smart grid environment.

## VI. METHODOLOGY

All-electric cars are known as battery electric vehicles use an electric motor instead of an internal combustion engine. The vehicle runs on electricity from rechargeable storage batteries, also known as a large traction battery pack, and must be charged up by plugging into a wall outlet or charging equipment referred to the electric vehicle supply equipment . Since it only runs on electricity, the vehicle has no tailpipe, does not emit exhaust, and cannot contain a liquid fuel tank. It also does not have a fuel pump or fuel line to emit toxins.

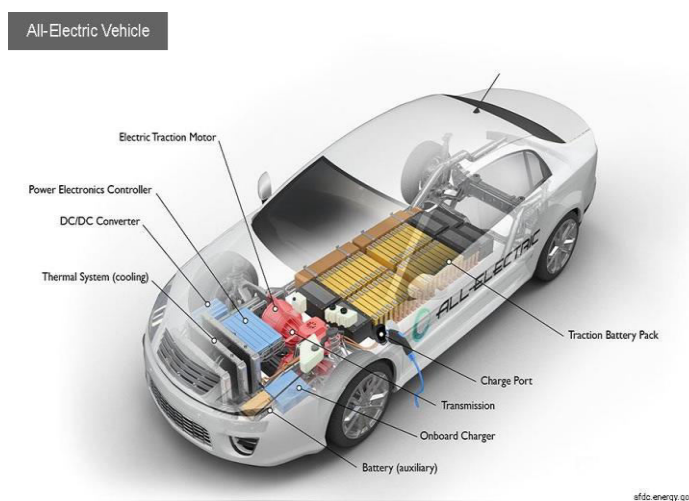


Fig 1:Electric vehicle

Solar energy generation relies on the photovoltaic effect exhibited by certain materials. When these materials,

typically semiconductor compounds, are exposed to sunlight, they generate an electric current. This effect occurs when sunlight interacts with a combination of two thin layers of semiconductor materials. One layer in this combination has a depleted number of electrons. When sunlight strikes this layer, photons are absorbed, causing electrons to become excited and move to the other layer. This movement creates a charge difference between the layers, resulting in a small potential difference.

## VII. PROPOSED SYSTEM

Neural network, whether biological or artificial, A comprises interconnected neurons or nodes. In the modern context, we often refer to artificial neural networks (ANNs), which are built with artificial neurons. In this setup, the connections between neurons are represented as weights. A positive weight indicates an excitatory connection, while negative values signify inhibitory connections. Each input is multiplied by a weight and then aggregated. This process, termed a linear combination, leads to an output. To control the output's magnitude, an activation function is applied. Typically, the desired output falls within a specific range such as 0 to 1. Artificial neural networks find utility in various fields, including predictive modelling, adaptive control, and tasks where training with datasets is feasible. Remarkably, these networks can exhibit self-learning, drawing insights from intricate and seemingly disparate data sets, thus acquiring knowledge through experience without direct human intervention.

Initially, research primarily focused on the electrical properties of neurons. However, in recent years, there has been a significant emphasis on investigating the impact of neuromodulators like dopamine, acetylcholine, and serotonin on behavior and learning. This exploration represents a crucial area of study.

Biophysical models, such as the BCM theory, have played a pivotal role in deciphering the mechanisms underlying synaptic plasticity. These models have found application not only in neuroscience but also in computer science, offering valuable insights into learning processes.

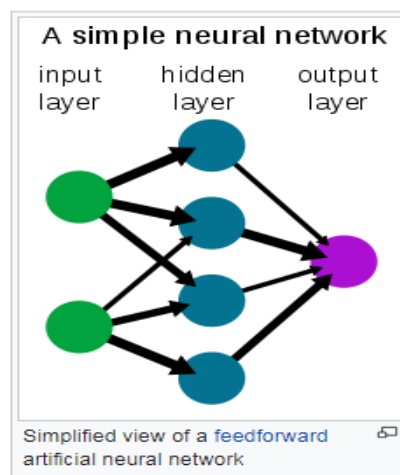


Fig 2. Neural network

## VIII. RESULT AND DISCUSSION

In the upgraded Power Quality Improvement project, the traditional PI controller previously used in the PV-based EV Charging Station connected to a Three-Phase Grid has been substituted with a Neural Network (NN) controller. This NN controller showcases remarkable performance, surpassing that of the PI controller by efficiently managing power flow and regulating voltage.

By leveraging intelligent learning capabilities, the NN controller adjusts seamlessly to changing system dynamics, thereby bolstering system stability and optimizing efficiency. The outcomes of this upgrade demonstrate substantial

enhancements in grid integration, a noticeable decrease in harmonic distortions, and an overall enhancement in power quality.

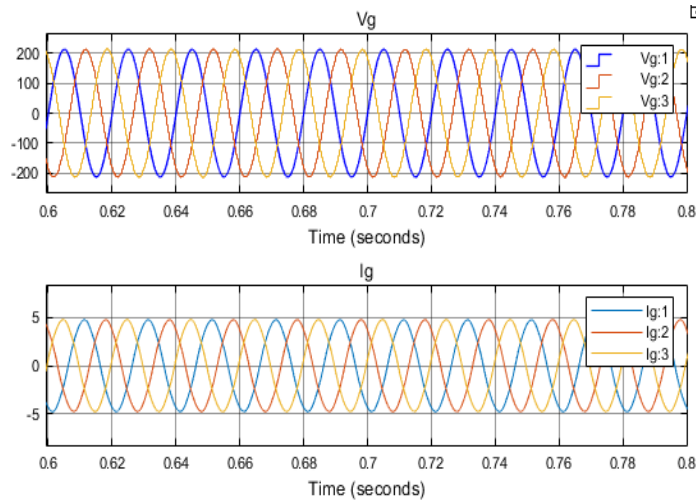


Fig 3. Grid side voltage and current

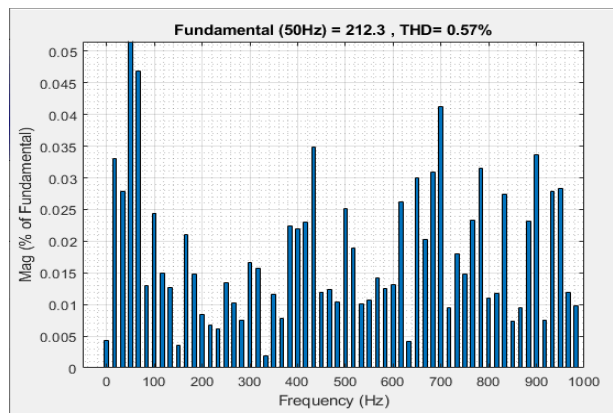


Fig 4. THD of Vga

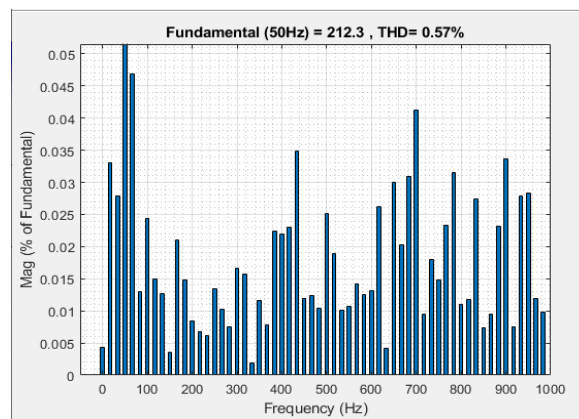


Fig 5. THD of Vgb

## IX.CONCLUSION

In this project, a Neural Network (NN) Controller has been designed and analyzed for an Electric Vehicle (EV) charging station aimed at enhancing power quality. This charging station is versatile, capable of operating independently while charging EV batteries using power generated from a Photovoltaic (PV) array. Additionally, it can interface with the utility grid, supplying excess power to it.

One notable feature of the charging station is its ability to compensate for reactive power, thereby improving grid power quality. It serves multiple purposes, including harmonics current compensation, EV battery charging/discharging control, and simultaneous EV battery charging alongside harmonics current compensation or discharging. The charging station's control mechanism ensures reliable operation even under unbalanced grid voltages, with grid current total harmonic distortion reduced to below 5%, as recommended by the IEEE-519 standard. To evaluate system performance and enhance power quality, a comparative analysis is conducted between the traditional Proportional-Integral (PI) Controller and the proposed NN Controller. The simulation is carried out using Matlab/Simulink 2018a Software, revealing that the NN Controller outperforms the PI Controller by achieving better reduction of total harmonic distortion (THD).

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