PalArch's Journal of Archaeology of Egypt / Egyptology

ANFIS Control Strategy for DC fast charging of micro grid connected vehicle

[1]*Akula Madhu Sree,* [2]*P.Kiran Kumar,* [3]*Velappagari Sekhar*

[1]PG scholar,Dept of EEE, Kuppam Engineering College, AP
[2]Associate Professor, Dept of EEE, Kuppam Engineering college, AP
[3]Associate Professor, Dept of EEE, Kuppam Engineering college, AP
[1]akulamadhusree@gmail.com, [2]kiran.kec123@gmail.com, [3]velappagarisekhar@gmail.com

Akula Madhu Sree, P.Kiran Kumar, Velappagari Sekhar. ANFIS Control Strategy for DC fast charging of micro grid connected vehicle--Palarch's Journal Of Archaeology Of Egypt/Egyptology 17(7), 10647-10658. ISSN 1567-214x

Keywords: V2G, ANFIS Controller, V2G-G2V

ABSTRACT

In this paper we proposes a ANFIS Control Strategy for DC fast Charging of Micro grids. ANFIS Controller gives better performance when compared along with PI, Fuzzy Logic Controller. An Appropriate framework and control frameworks must be created all together to understand this idea. Electric vehicle batteries could be utilized as potential vitality stockpiling gadgets in the micro grid, when there is excess of Grid-To-Vehicle and provides vitality back to the network V2G when it is required. Design for actualizing a V2G-G2Vframework in a miniature network utilizing level-3 type of quick charging of EVs is introduced in this paper. A miniature network test framework is demonstrated in which it contains a dc quick charging station for the interfacing of the Electric vehicles. Reproduction examines are done to show V2G-G2V power move. The simulation outcomes shows a dynamic force guideline in the miniature matrix by EV batteries through G2V-V2G methods of activity. The charging station configuration guarantees negligible consonant contortion of lattice infused current and the regulator givesgood dynamic performance in terms of dc bus voltage stability, stability and reduces harmonic distortions.

INTRODUCTION

Electric vehicle (EV) has become more competitive compared to the conventional internal combustion engine vehicle due to lower carbon dioxide emissions and rising fossil fuel price. However, EV is not widely adopted into the market due to some limitations, such as high vehicle cost, limited charging infrastructure and limited all-electric drive range [2]. In addition, the integration of EV on the power grid will lead to many challenging issues. For instance, large penetration level of EV charging will increase the power grid loading. In place of being an additional electrical load, EV battery can be used as a Power reserves. This potential leads to a new V2G concept. Apart from charging EV battery, V2G allows interaction between the EV owner sand the power utility to enable power injection into the power grid according to the predefined schedule and power rates. Interaction of EV and power grid can introduce various benefits to both the power utility and EV owners. From the perspective of power utility, V2G concept can achieve load leveling, peak load shaving, reactive power support, active power regulation, stability improvement and harmonic filtering [3]

Energy stockpiling frameworks are significant parts of a miniature network as they empower the combination of discontinuous sustainable power sources. Electric vehicle (EV) batteries can be used as successful stockpiling gadgets in miniature matrices when they are connected for charging. Most close to home transportation vehicles sit left for around 22 hours every day, during which time they speak to an inert resource. EVs might help in miniature network energy the executives by putting away energy when there is excess (Grid-To-Vehicle, G2V) and taking care of this energy back to the framework when there is interest for it (Vehicle-To-Grid). V2G applied to the overall force matrix faces a few difficulties, for example, it is muddled to control, needs huge measure of EVs and is difficult to acknowledge in momentary [1].In any case, since the UC includes whole units in a matrix, it requires a lot of tedious calculation and convoluted mathematical calculations. The all-inclusive UC with V2G makes the issue considerably more muddled, which normally prompts stochastic strategies, for example, the molecule swarm enhancement (PSO). What's more, vehicles are viewed as similarly as creating units in the all-inclusive UC and are thought to be charged from inexhaustible sources, which is ridiculous to be applied to whole vehicles. Savvy and facilitated charging of the PEVs will reduce the negative effect on the lattice. Moreover, PEVs can likewise fill in as disseminated vitality stockpiling units using the readily accessible on-board charger which would additionally profit to the utility framework [4], [5]. On-board chargers convert the air conditioner network voltage into dc, and they ordinarily have unidirectional force move ability. Utilizing a further developed geography and regulator contrasted with customary strategies accessible in the market, the installed charger can likewise gracefully control quality capacities, for example, responsive force pay (inductive or capacitive), voltage guideline, symphonious separating, and force factor amendment. These AC charging systems are limited by the power rating of the on-board charger. An additional issue is that the appointment network has not been expected for bi-directional essentialness stream. In this circumstance, there is an assessment necessity for becoming really sensible charging station plans to support V2G advancement in scaled down systems This work proposes a dc expedient blaming station establishment for V2G capacity in a smaller than usual network office. The dc transport used to interface EVs is also used for fusing a daylight based photo voltaic (PV) display into the little system.

The proposed plan allows high power bi-directional charging for EVs through off-board chargers

II. System Arrangement For V2G

The design for dc quick charging station to the execute V2G-G2V foundation in a miniature matrix is appeared in Fig .1 [4]. EV batteries are associated with the dc transport through off-board chargers. A framework associated inverter interfaces the dc transport to the utility network through a LCL channel and a stage up transformer. The significant parts of the charging station are depicted beneath. An variety of aspects should be considered when planning the circuit of the charging station. These viewpoints, from a specialized perspective, incorporate the accompanying

• Area made accessible for leaving of vehicles; this impacts the quantity of vehicles that can be put and charged.

• Estimation of the interest for quick charging openings in the area.

• Maximum charging power rate for singular vehicle.

A. Battery Charger Arrangement

For dc quick charging, the chargers are situated off-board and are encased in an EVSE. A bidirectional dc-dc converter shapes the essential structure square of an off-board charger with V2G ability. It frames the interface between EV battery framework and the dc dissemination network. The converter design is appeared in Fig. 2. It comprises of two IGBT/MOSFET switches that are constantly worked by free control signals**.**This allows a continuous bi-directional power capability.

1)Charging Mode: At the point when the upper switch (s_buck) starts working, the converter behaves as a buck converter moves down the information voltage(v_bat). Throughout the on state, current moves through the switch and the inductor to the battery.

At the point when the switch is in off state, the current draws its return way through the inductor and the diode of lower switch and closes the circuit. The voltage of the battery when the working cycle of the upper switch, is represented by:

$$V_{bat} = \mathrm{V_{dc}} * \mathrm{D} \quad (1)$$

2) Discharging Mode:

At the point when the lower switch (S boost) starts conducting, the converter goes about as a lift converter moves up the battery voltage (V batt) to the dc transport voltage(Vdc). During the on state of the switch, current keeps on moving through the inductor and finishes its circuit through the counter equal diode of the upper switch, and also with the capacitor. The net force stream for this situation is from the vehicle to the network (V2G) and the battery works in the release mode. On the off chance that the capacitor is sufficiently enormous to give a consistent dc voltage, the yield voltage during

thismethod of activity is given by the equation:

$$V_{dc} = \frac{V_{batt}}{1 - D'} \qquad (2)$$

Wher D' = duty cycle.

B. Grid Connected Inverter and LCL Filter

The matrix associated inverter (GCI) changes over the dc transport voltage into a three stage air conditioning voltage and furthermore permits the backflow of current through the counter equal diodes of the switches in every leg.

Passive LCL filters become as state of the art in harmonic reduction of grid-interfaced distributed power sources. On the one hand, the selection of the inverter side inductance is based on DC voltage, inverter modulation index, switching frequency and current total harmonic distortion.

A LCL channel is associated with the yield terminals of the inverter to reduce the harmonic and to acquire a pure sinusoidal current and voltage. The plan of action for deciding the LCL channel variables in this work is adjusted from [4].

III. CONTROL SYSTEM

A. Off-Board Charger Control

1) Constant current strategy: It is a unified control strategy equivalent to operating the battery as a current source. The output duty ratio mcc defines the boost-mode operation of the converter. A steady current control system [5] utilizing PI regulators is actualized for charge/release control of the battery charger circuit and is appeared in Fig.1. The regulator first contrasts the reference battery current and zero, so as to decide the extremity of the current sign, to settle on charging and releasing methods of activities. When the mode is chosen, the reference current is contrasted and the deliberate current and the mistake is gone through a PI regulator to create the exchanging beats for S buck/,S boost will be killed all through the charging cycle and S buck will be killed all through the releasing cycle.

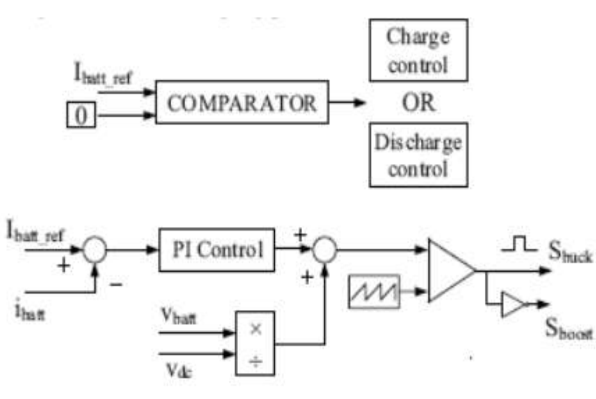


Fig. 1. Constant current control strategy for battery charger

B. Inverter Control

A cascade control in the synchronous frame is presented. It consists of outer voltage loop and inner current loop. Synchronization is performed through a phase locked loop. The conventional standard vector control using 2 ANFIS controllers and 2 PI controllers in a nested loop is appeared in Fig. 2[4].The control structure consists of two outer voltage control loops and two inner current control loops. The d-pivot external circle controls the DC transport voltage, and the internal circle controls the dynamic AC current. Because the inverter allows bidirectional power flow, increments in the dc bus voltage can be produced from negative or positive current direction and vice versa. Similarly the q-pivot external circle directs the AC voltage size by changing the responsive current, which is constrained by the q-hub internal current circle. Furthermore, dq decoupling terms ωLinv and feed-forward voltage signals are added to improve the presentation during the momentary.

IV.MICRO-GRIDTEST SYSTEM CONFIGURATION

The micro-grid test system configuration with the dc fastcharging station is as shown in Fig. 3. A 100 kW wind turbine(WT) and a 50 kW solar PV array serve as the generation sources

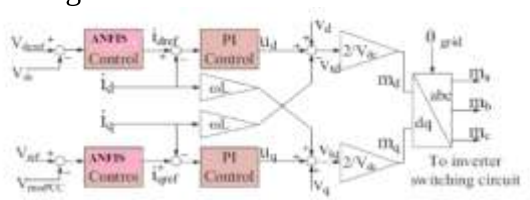


Fig. 2. Inverter control system

In the framework. The EV battery stockpiling framework comprises of 4 EV batteries associated with a 1.5 kV dc transport of the charging station through off-board chargers. The sun based PV is additionally associated with this dc transport through a lift converter which has a most extreme force point following (MPPT) regulator. The utility lattice comprises of a 25 kV conveyance feeder and a 120 kV identical transmission framework. The breeze turbine driven doubly-took care of acceptance generator is associated with the miniature network at the purpose of normal coupling (PCC). Transformers are utilized to venture up the voltages and associate the individual air conditioning frameworks to the utility lattice.

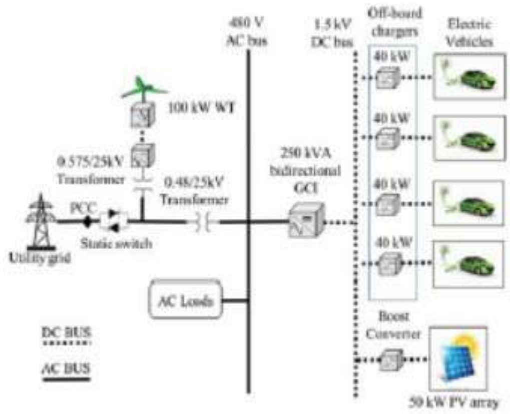


Fig. 3. Proposed microgrid test system configuration

V.ANFIS CONTROLLER

ANFIS is a hybrid system incorporating the learning abilities ofANN and excellent knowledge representation and inference capabilities of fuzzy logic (Jang 1993) that have the ability to self modify their membership function to achieve a desired performance. An adaptive network, which subsumes almost all kinds of neural network paradigms, can be adopted to interpret the fuzzy inference system. ANFIS utilizes the hybrid-learning rule and manage complex decision-making or diagnosis systems. ANFIS has been proven to be an effective tool for tuning the membership functions of fuzzy inference systems. Ibrahim (2001) proposed an ANFIS based system to learn power quality signature waveform. It was shown that adaptive fuzzy system sare very successful in learning power quality waveform. Rasli (2009), Rathina(2009) and Rathina (2010) have proposed ANFIS based systems for powerquality assessment.ANFIS is a simple data learning technique that uses a fuzzyinference system model to transform a given input into a target output. This
prediction involves membership functions, fuzzy logic operators and if-thenrules. There are two types of fuzzy system, commonly known as the Mamdani
and Sugeno models. There are five main processing stages in the ANFIS operation, including input fuzzification, application of fuzzy operators,
application method, output aggregation, and defuzzification.
ANFIS utilizes “Representation of prior knowledge into a set of constraints (network topology) to reduce the optimization search space”, from Fuzzy Systems and “adaptation of back propagation to structured network to automate FC parametric tuning”, from Neural Networks, to improve eperformance. The design objective of the fuzzy controller is to learn and
achieve good performance in the presence of disturbances and uncertainties.

The design of membership functions is done by the ANFIS batch learning technique, which amounts to tune a FIS with back propagation algorithm based on a collection of input–output data pairs.
Generally, ANFIS is a multilayer feed forward network in which each node performs a particular function (node function) on incoming signals.
For simplicity, we consider two inputs 'x' and 'y' and one output 'z '. Suppose that the rule base contains two fuzzy if-then rules of Takagi and Sugeno type
(Jang 1993):
Rule 1: IF x is A1 and y is B1 THEN f1=P1x+Q1y+R1
Rule 2: IF x is A2 and y is B2 THEN f2=P2x+Q2y+R2 (3.1)

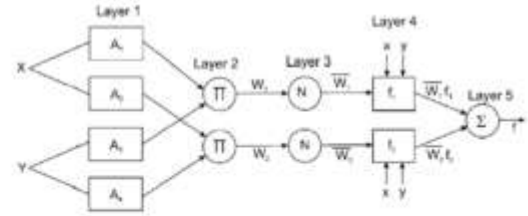
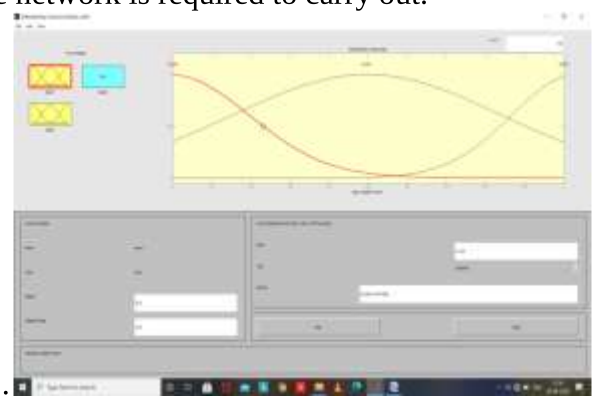
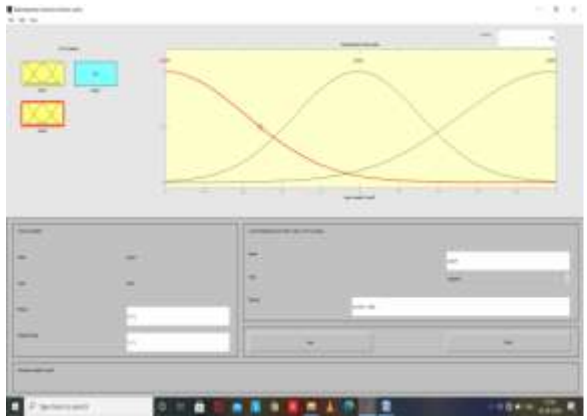


Figure 4. ANFIS Architecture

The ANFIS architecture is a five layer feed forward network as shown in Figure. An adaptive network (Jang 1993) is a multilayer feed forward network in which each node performs a particular function (node
function) on incoming signals as well as a set of parameters pertaining to this node. The formulas for the node functions may vary from node to node, and
the choice of each node function depends on the overall input-output function which the adaptive network is required to carry out.



5.Error



6. Change in error

7.ANFIS Structure

VI. Simulation Results

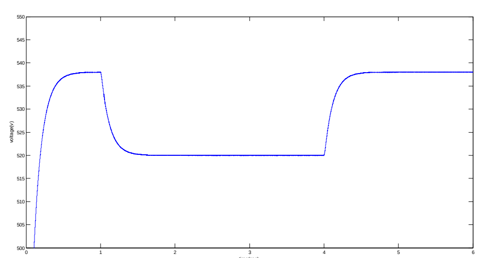


Fig 8.Voltage of EV1 battery during V2G operation

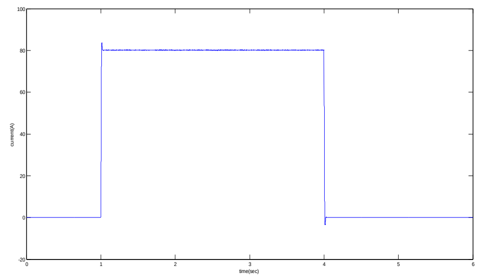


Fig.9.Current of EV1battery during V2G operation

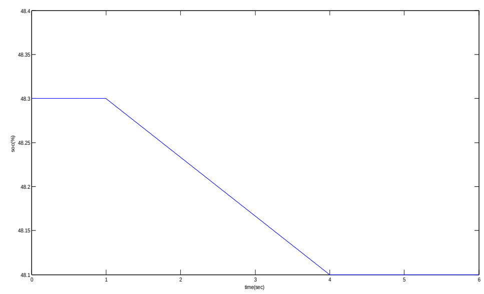


Fig.10. State of charge(SOC) of EV1 battery during V2G operation

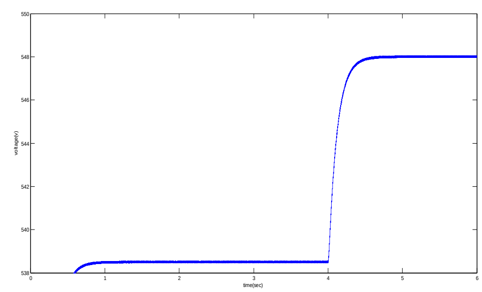


Fig.11.Voltage of EV2 battery during G2V operation

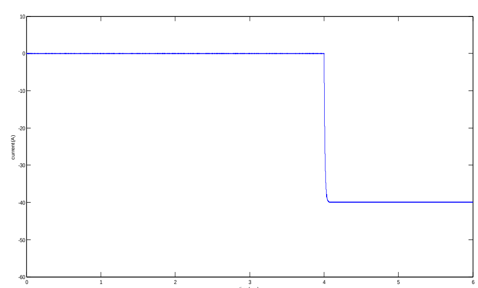


Fig.12.Current of EV2 battery during G2Voperation

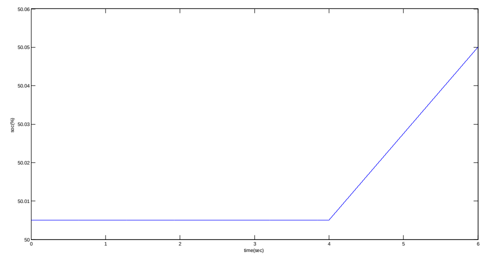


Fig.13.SOC of EV2battery during G2Voperation

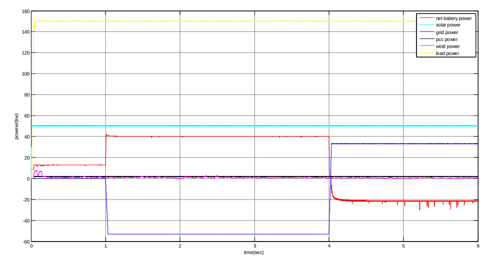
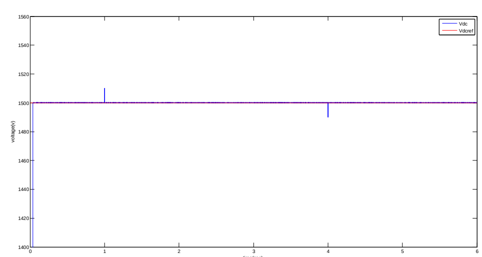


Fig.14Dynamic force profile of different segments in the framework

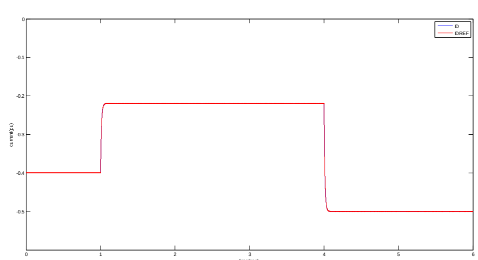
The dynamic force commitment from different segments of framework is appeared in Fig.14.The lattice power changes to oblige the force moved by the EVs. The negative extremity of the framework power from 1s to 4s shows that the force is being taken care of to the matrix from the vehicle. The adjustment in extremity of lattice power at 4s shows that the force is provided by the matrix for charging the vehicle battery.



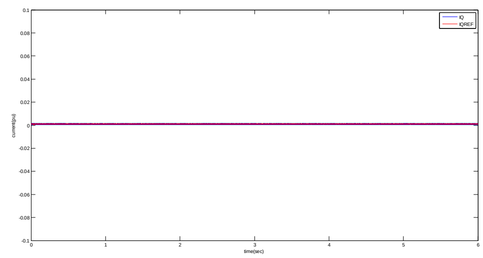
.

Fig. 15.Variation in dc bus voltage

Fig.15.shows the variation in dc bus voltage regulated at 1500V by using voltage current loop controller.



(a)



(b)
Fig 16.Reference currents tracking by inverter controller

This in turn is achieved by the inner current control looptracking the changed d-axis reference current q_axis reference currents as shown in Fig.16

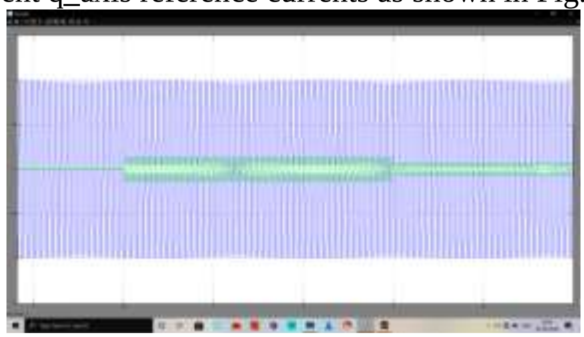


Fig. 17.Grid voltage and grid injected current during V2G-G2V operation

Total harmonic distortion (THD) analysis is done on the grid injected current and the result is appeared in Fig.17

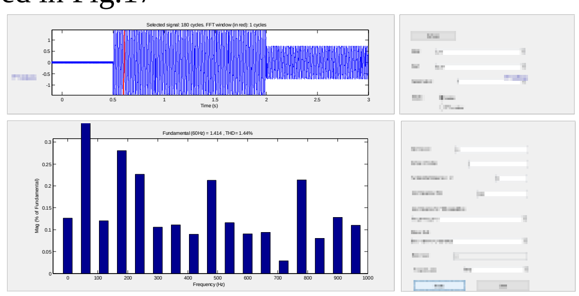


Fig.18. Harmonic spectrum and THD of grid-injected current

The THD of grid injected current is obtained as 1.44% and is achieved by the judicious design of LCL filter in fig.18

VI. CONCLUSION

This paper proposes a ANFIS Control Strategy for DC quick charging of miniature lattice associated vehicle. A dc quick accusing station of off-board chargers and a lattice associated inverter is intended to interface EVs to the micro grid. The control framework intended for this force electronic interface permits bi-directional force move among EVs and the network. The reenactment results show a smooth force move between the EVs and the framework, and the nature of network infused current from the EVs clings to the significant norms. ANFIS regulator gives a decent unique presentation as far as dc transport voltage steadiness and in following the changed dynamic force reference. The proposed V2G framework can be used for a few different administrations like responsive force control lessens the consonant bending, diminishes the consistent state mistakes and recurrence guideline.

REFERENCES

[1] C. Shumei, L. Xiaofei, T. Dewen, Z. Qianfan, and S. Liwei, “The construction and simulation of V2G system in micro-grid,” in Proceedings of the International Conference on Electrical Machines and Systems, ICEMS 2011, 2011, pp. 1–4.

[2] S. Han, S. Han, and K. Sezaki, “Development of an optimal vehicle-togrid aggregator for frequency regulation,” IEEE Trans. Smart Grid, vol. 1, no. 1, pp. 65–72, 2010.

[3] M. C. Kisacikoglu, M. Kesler, and L. M. Tolbert, “Single-phase on-board bidirectional PEV charger for V2G reactive power operation,” IEEE Trans. Smart Grid, vol. 6, no. 2, pp. 767–775, 2015.

[4] A. Arancibia and K. Strunz, “Modeling of an electric vehicle charging station for fast DC charging,” in Proceedings of the IEEE International Electric Vehicle Conference (IEVC), 2012, pp. 1–6.

[5] K. M. Tan, V. K. Ramachandaramurthy, and J. Y. Yong, “Bidirectional battery charger for electric vehicle,” in 2014 IEEE Innovative Smart Grid Technologies - Asia, ISGT ASIA 2014, 2014, pp. 406–411.