**Engineering and Technology Journal e-ISSN: 2456-3358**

**Volume 10 Issue 08 August-2025, Page No.- 6397-6404**

**DOI: 10.47191/etj/v10i08.34, I.F. – 8.482**



# Efficient Electronic DC Charger for Electric Vehicle Using MATLAB

**Jabbar Shatti Jahlool[1], Majid Salal Naghmash[2], Nazar Jabbar Hussain[3]**

[1,2,3]Department of Computer Technique's Engineering, Dijlah University College, Baghdad, Iraq

**ABSTRACT:** The necessity for electric vehicle is increased in current time. Whereas the transitions to electric vehicle (EV) continue, the accelerations of this processing play a significant roles in dropping environment problem. To accelerate this transitions, charges unit should become public and charge times have to be reduce. This paper presents the direct current (DC) charger modules with its circuits topology was study in details. The electric vehicles battery is charge through DC charger for fast charging. The electric powers drives over AC to DC and DC-DC powers converter and reach the batteries. The initial stage is responsible to convert AC to DC, represent lower harmonics contents and lower reactive powers from the grids, and provide fix DC buses voltages. Though, the later tasks are charge the batteries with a controlling currents or voltages levels. The public topologies in the AC-DC converters are the neutral boost Rectifier. Though, Phase-shift Full Bridges or LLCs resonance converter is widespread on the DC-DC sides. The circuits' model for those powers stage is demonstrated in the PC platforms and obtains the systems competence of the DC chargers. The final stage is the propose ideas which presents that includes share the charging of the electric vehicles batteries among two powers converter. The suggested design result shown that the DC charge systems effectiveness increase strangely on highest outputs voltages level.

**KEYWORDS:** DC charger, DC-DCs Converter, Power Converter, Electric Vehicle, Electric Vehicles Chargers.

## I. INTRODUCTION

The acceptance and the marketing of EV are incessantly grow over the preceding decade [1]. The marketing shared of electric vehicle is 9% in 2021 and it is expects to reached 13% in 2022 and 21.7% in 2030 [2]. Comparing to conventional gas engines vehicle, there are numerous reason to buy EV. There is no CO2 emissions in the power conversions. Additionally, power sources electricity- is lesser costly than gas that use in traditional car in existing time. As EV comprise electric motor in tractions and no needs to use switch gears, there is more efficiently, comfortably, and noiseless [3 – 6]. The tractions electric motors could provide higher torques at a standstill that make EV higher dynamics and responsive. Furthermore, EV have lesser component than conventional vehicle which mean lesser maintenance and longer life. The last but not least features are regenerate brake is continually conceivable that made the EV a fuel savers without add any addition part [7-9]. The increasing in the market of EV have controlled to an increased in the markets of EVs charge station. The electric vehicles chargers markets dimension reach USD 8.8 billion and it is forecast to rise to USD 23.4 billion by 2028 with a fixed 15% CAGRs. It is stated that the quantities of open EVs chargers station are dramatic increase compare to private charger [10]. Furthermore, many study is mostly focus on increase the powers levels of free EV Chargers Station as the peoples who drives electric vehicle typically live in the city. Free EVs charger is classify into two category; ACs Chargers and DCs Fast Chargers [11-13].

Community ACs charger have generally three-phase inputs and provides up to 22 kW outputs powers. ACs charger provides ACs and needs to uses an onboard chargers to converts ACs into DCs. Consequently, the charges powers levels are restrict by onboard chargers ability [14-16]. The DCs fast charger offer DCs which straight charge the EVs batteries without use an onboard chargers. Therefore, its powers levels is only limits by chargers powers capability and batteries temperatures throughout charging process. Nowadays, the batteries charger powers limits reach about 350 kW [17-20]. Compare to ACs charging, DCs fast charger is more appropriate for public area as the charge times for every cars are limits and numerous cars user need to uses charge station [21-23]. Electric vehicles charger required higher-power and higher-frequency power converter to efficient convert's grids ACs powers to DCs powers for charge the vehicle batteries. DC faster charger have two stage in power conversions; ACs to DCs and DCs to DCs conversions. The first one goals is to get fix DCs voltages by draw lower harmonics contents ACs currents from a three-phase grids. This circuit's type is called "power factors corrections circuit [24-26].

Some application use tradition transformers and rectifiers circuit as an alternatives methods which might offer easy implementations. Though, this system is constantly larger and unwieldy. But the same goals could be implements by use AC-DCs and DC-DCs converter [27]. The above mention converter is relative high systems effectiveness and are more compacts. The second platform of the power circuits provide variables DCs voltages on the outputs [28]. In addition, the carbon emissions of traditional vehicle is amongst the big reason for the continue rises of global warming in the world [29-35]. EV (Electrical Vehicle) works to electric motors and batteries cells package. Since EV are users and eco-friendly vehicle, the transitions from internal combustions engines vehicle need to be faster and practice. Fast charge times is significant issues that will speeds up the transitions [36-45]. Though, this will causes more loads in the power systems, thus both short charging times and improved power qualities on the grids are seen as the most basic goal for EV [46-48]. DCs faster charger plays significant roles in these processing to reduce charge times to optimum condition. Because of the sizes and capacities of this system, the charge systems of EVs is locate outside the vehicles due to the higher voltages and currents. These allow the times to be reduce to 10 to 20 minute level [49-50]. The controlling and components connection systems of the network EVs is show in Figure 1.

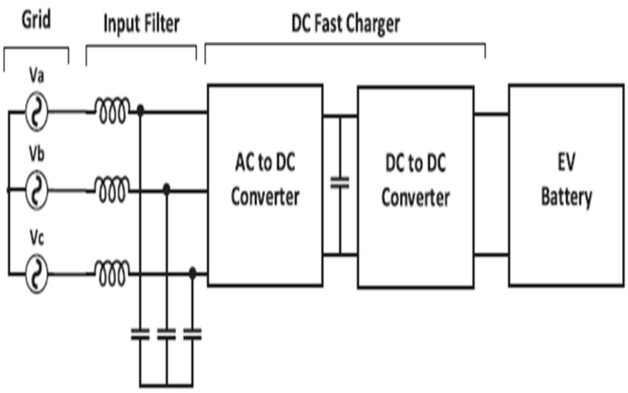



***Figure 1: Controlling and Components Connection Systems of EVs Connected to the Networks***

## II. MATERIALS AND METHODS

The proposed model of DCs faster charging stations connects with the batteries packs of a EVs illustrated in Figure 2. The key component of the model include Grids - Models the ACs supply voltages as a three-phase constant voltages sources, DC fast charge stations - Model the power electronic circuit to converts the ACs supply voltages from the grid to the DCs voltages levels that the EVs battery pack required. EVs battery pack – Models the battery pack as series of batteries cell.

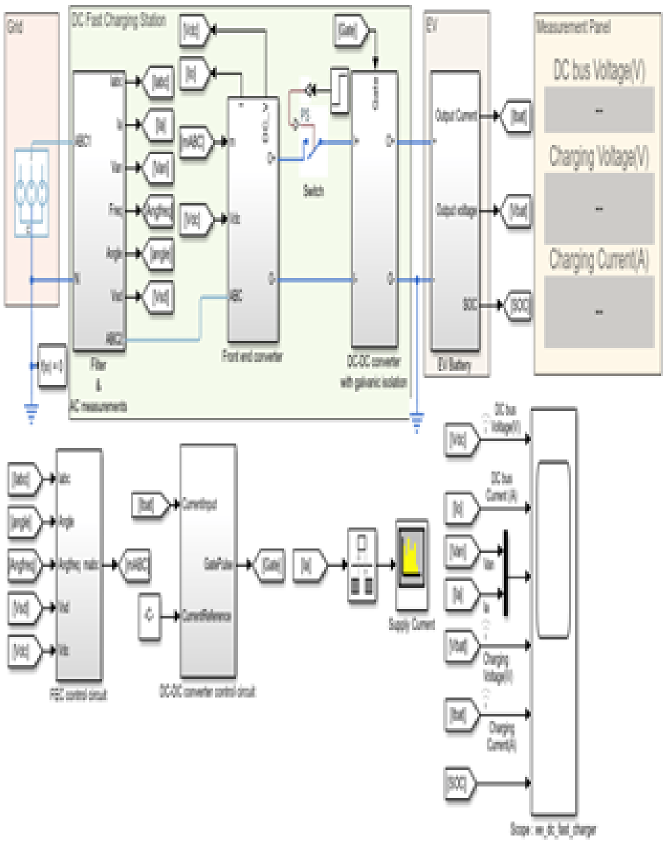



**Figure 2: Proposed EV-DC Charger Station Model in MATLAB**

The main component in EV-DC fast Charger stations in the suggested model is the filters and ACs Measurement to filters of the harmonic in the line currents and measured the three-phase supply voltages and line currents as shown in Fig. 3.

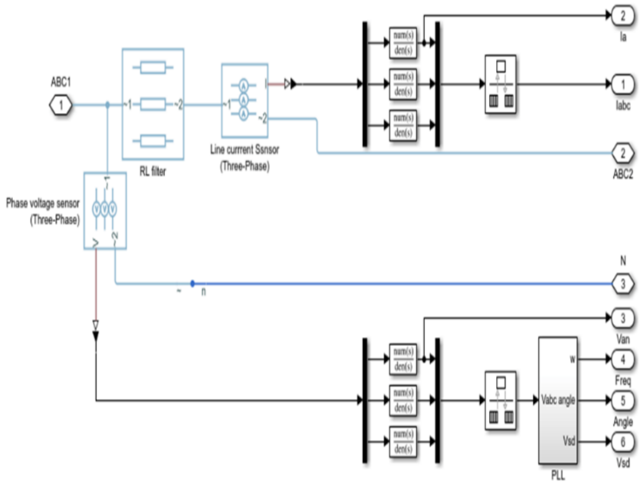


**Figure 3: Filter and AC Measurement Model**

The unity power factors (UPF) as front end converters (FEC) to controlling the outputs DCs voltages at 800 V is illustrated in Fig. 4.

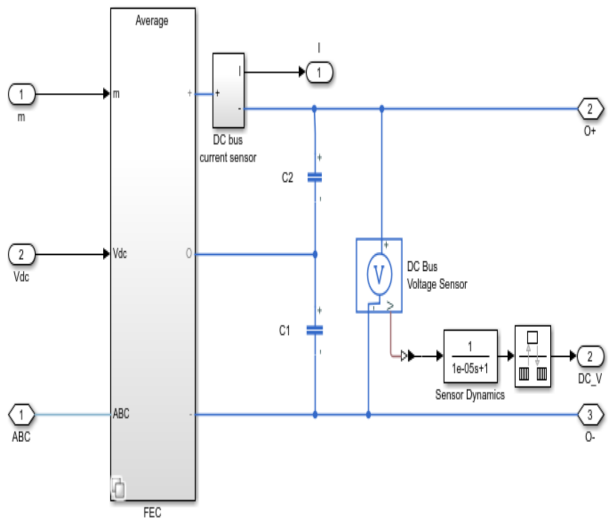



**Figure 4: Front End Converters (FEC)**

The converters circuits are modeled with three level of fidelities as show in Figs. 5(a) and 5(b) Shows the average inverter fidelity, Fig. 5(c) two levels, and Fig. 5(d) represent the three level fidelity.

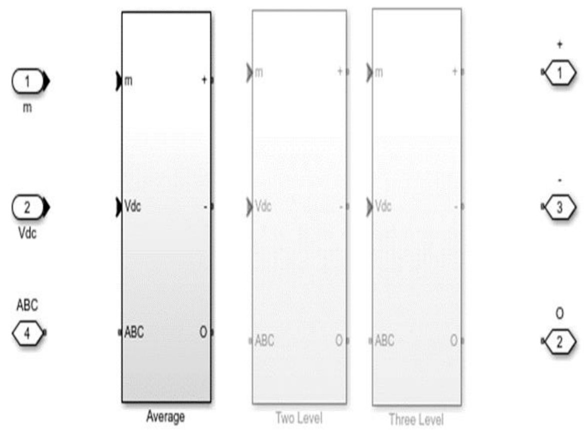
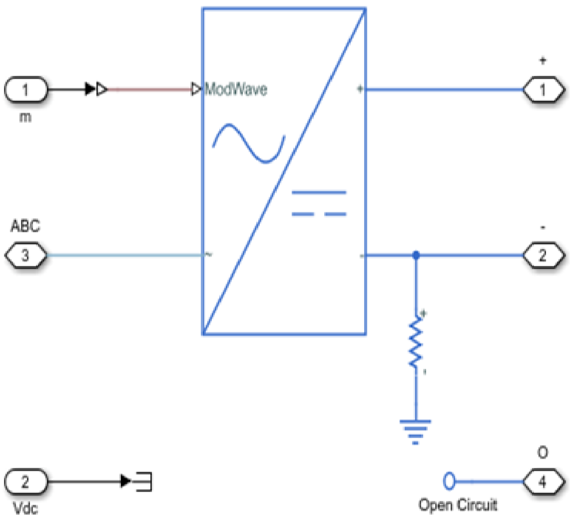
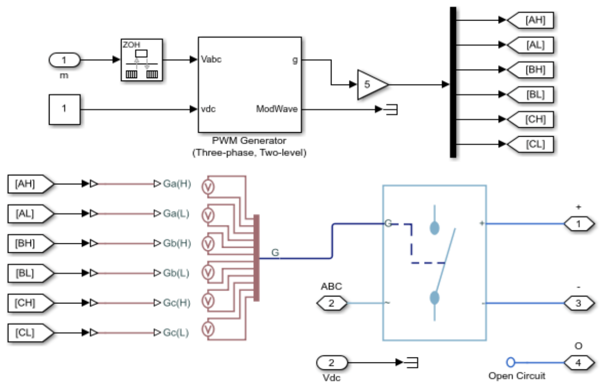


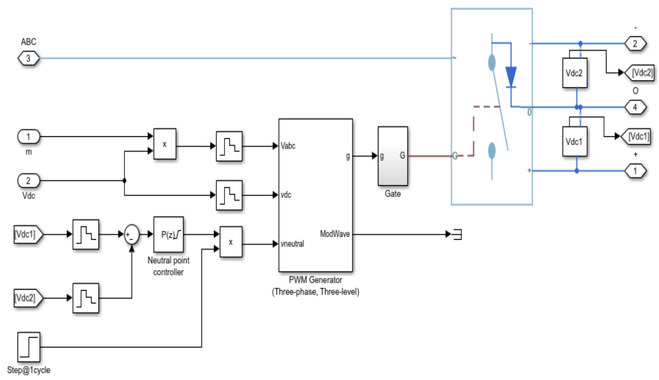

**Figure 5(a): Converters Circuits Model with Three**




*(b) Average Inverter Fidelity*




*(c) Tow Level Inverter Fidelity*




*(d) Three Level Inverter Fidelity*

The isolated DC-DC converters supply constant charge currents to the EVs batteries is highlight in Fig. 6.

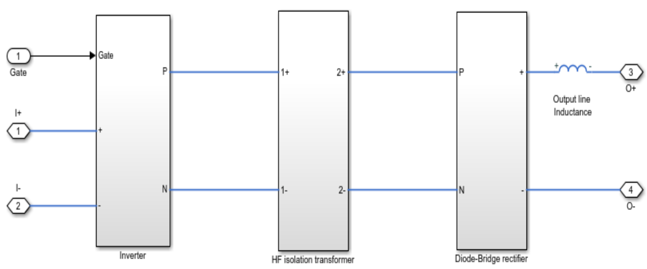



**Figure 6: Isolated DC-DC Converters**

These are the main components of the isolated DC-DC Converter as shown in Fig. 7(a), and HF Isolation Transformer is show in Fig. 7(b). The diode-bridge rectifiers used in this model is illustrated in Fig. 7(c).

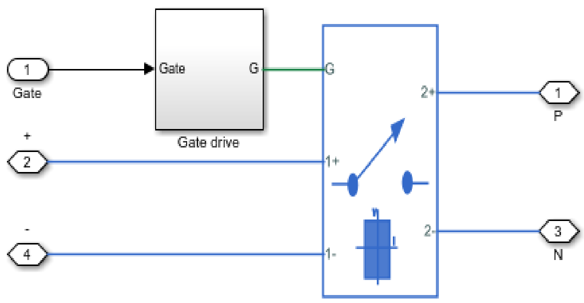
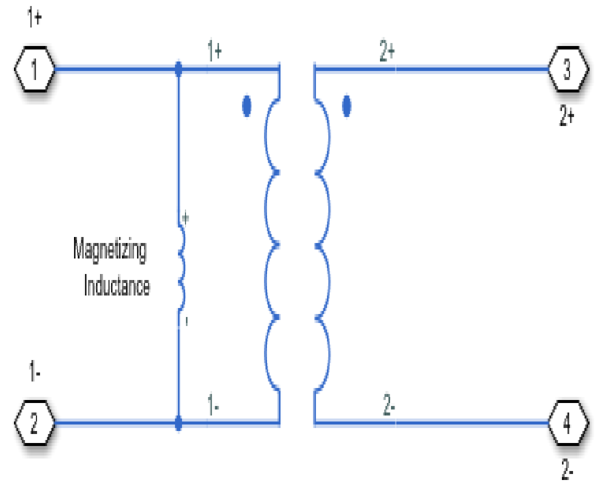
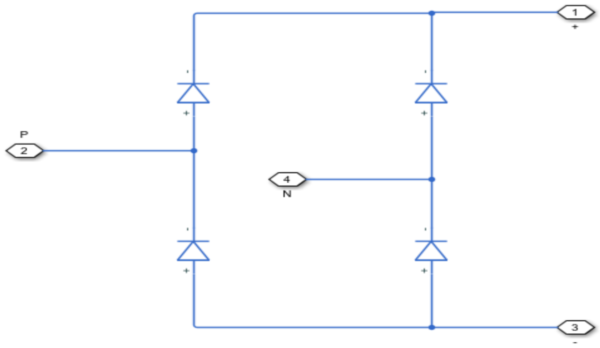



**Figure 7(a): Main Components of the Isolated DC-DC Converter**




*(b) Isolation Transformer*



*(c) Diode-Bridge Rectifiers*

The EVs battery pack model cells is connects in series and the sensor to measures the battery terminals voltages and outputs currents as show in Fig. 8.

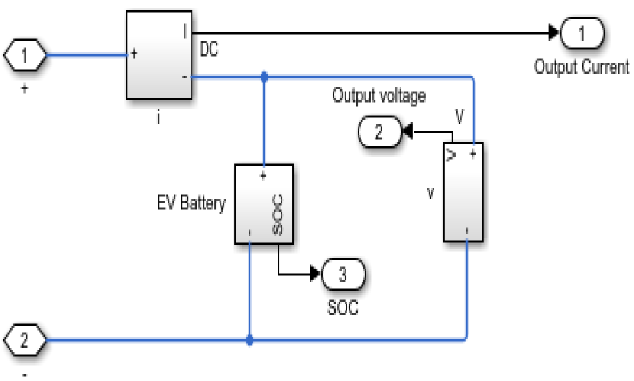



**Figure 8: EV Battery Model**

**III. SIMULATION RESULTS**

After the model was running in MATLAB, the plots show in Fig. 9 demonstrated the DC bus voltages and currents, battery terminals voltages, and charge currents.

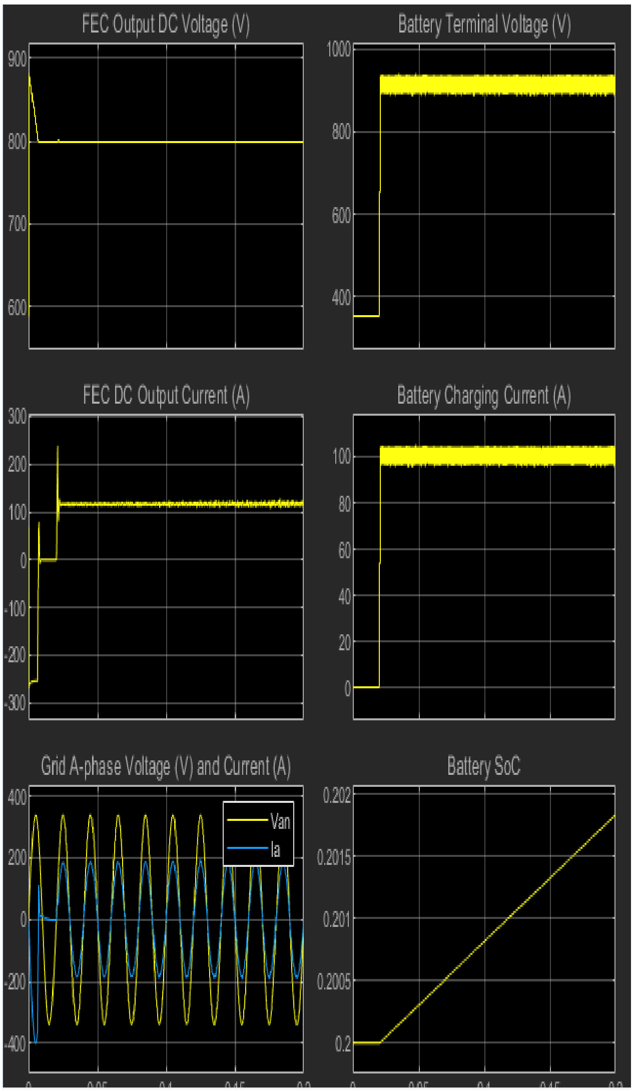



**Figure 9: DC bus voltages and currents, battery terminals voltages, and charge currents.**

The fast-charge units needs DCs connections and control the DCs connections are significant required. There is numerous different DCs bar voltages controlling scheme. This controlling scheme is wide use include Master slave and droops controlling mapping. In DC bars controlling strategies and model, recommend to notice the article in [51] in details. The voltages of DCs connections are adjusts rendering to main voltages.

In this work, DC connections voltages could be regulate independent of the main voltages. These arrangements could be make rendering to the ration of the cut voltages of batteries and modulations indexes of chargers. A stabilizer of the DCs bars with the inverters outputs connections depend on the sizes of the capacitors, which continue its fluctuation in the DC currents values. This fluctuations could be higher as a larger numbers of EVs charger that connects to the bars. Due to these reasons, the capacitors values has to be higher. It is suitable to uses the equal presented from calculation in order to catch the suitable DCs capacitors values. The concentrated value at the voltage and current values of the definite DC charge levels are the references value of the voltage and current value in the batteries. The reasons for the assignments of this value is due the specify EVs not exceeded the extreme powers values. The formula of calculate the powers of EVs is:

$$P_{EA} = V_{maks}\ x\ I_{maks} \quad (1)$$

The equity of the below formula is the DC bars capacitors values and DCs bars voltages which could be make as:

$$V_{dc} \leq \frac{V_{min}}{m_{min}} \quad (2)$$

$$C_{dc} = \frac{Ax2xnxTx\Delta Gxcos\emptyset}{(V_{dc})^2 x\Delta V} \quad (3)$$

Where
A is apparent Powers, ΔG is the Powers Change Ranges, ΔV is the Voltages Ranges, $V_{dc}$ is the Dc bars Voltages, cos φ is the Power Factors, and T is the Periods for ACs Voltages.

### *A. Battery Chargers*

Double-side DCs/DCs converters collection play a significant roles in the charging system of EV. Furthermost current bi-direction DCs/DCs converter is characterize thru currents or voltages supply from one side. The currents in double side transducer should transports to both side. Meanwhile there are no powers keys that work in this method, the one ways powers keys like MOSFETs or IGBTs must be chosen in parallel with the diodes. The batteries characteristic to be designated in powers systems models to be calculates is important. This parameter must be revise rendering to the wanted results as there will be a batteries in the systems that will draws the powers as a loads. The EVs batteries parameter is explained in Table 1.

**Table I: EV BATTERY PARAMETERS**

| Description | Value reference |
|---|---|
| Battery Technology | Lithium ion |
| Soc | %50 |
| Battery Capacity | 35 kWh |
| $M_{min}$ | 0.125 |
| Series Resistance ($R_{series}$) | 0.0175 Ω |
| Transient Resistance ($R_{transient}$) | 0.254 Ω |
| Transient Capacitor ($C_{transient}$) | 8.1 F |
| Battery Inductance ($L_b$) | 0.002 H |
| Open Circuit Voltage ($V_{oc}$) | 400 V |
| Minimum Battery Voltage ($V_{min\ bat}$) | 200 V |
| Control Loop | CC/CV(constant current/ constant voltage |

Inputs and outputs parameter of the proposed models in SIMULINK is listed in Table 2. Providing that these parameter is indoors the scopes of the standard, many value could be designated for the models to be considered and simulations could be performs.

**Table II. SIMULATIONS INPUTS PARAMETER FOR PROPOSED MODELS**

| Description | Value |
|---|---|
| THD(total harmonic distortion current) | %5-30 |
| RAF(reduction factor) | %20 |
| $N_{(slot)}$ | 10 |
| PEA(power of electric vehicle) | 90 Kw |
| $K_{load}$ (overload factor) | 1.1 |
| cos ϕ (power factor) | 0.95 |
| T(period for AC voltage) | 0.02sn |
| N | 0.5 |
| $F_{sf}$(switch frequency) | 5 kHz |
| Three phase short circuit level | 1200 MVA |
| Phase-phase voltage ($V_{rms}$) | 20 Kv |
| X/R ratio | 8 |
| Frequency | 50 Hz |
| Primer voltage | 20 Kv |
| Seconder voltage | 800 V |
| Frequency | 50 Hz |
| Winding connection | Δ - Yg |

This approach works the best in guidance of fellow researchers. In this the authors continuously receives or asks inputs from their fellows. It enriches the information pool of your paper with expert comments or up gradations. And the researcher feels confident about their work and takes a jump to start the paper writing.

### *B. Use of Simulation software*

There are numbers of software available which can mimic the process involved in your research work and can produce the possible result. One of such type of software is Matlab. You can readily find M-files related to your research work on internet or in some cases these can require few modifications. Once these M-files are uploaded in software, you can get the simulated results of your paper and it easiest the process of paper writing.
As by adopting the above practices all major constructs of a research paper can be written and together compiled to form a complete research ready for Peer review.

## CONCLUSIONS

Growing environment problem in current time, transformations in power system and digitalize world is the issue that affects the transitions to EV the furthermost. Hence one of utmost issue in the transitions to EV is the integrations of charge unit into the grids. DCs faster charge unit comes to the front because of the requisite for higher powers as the charge times need to be short for EV to be favored. In this work, DCs faster charge units for EV have been demonstrated in MATLAB environments.

In the demonstrating, the powers upcoming from the networks create DC buses lines via the ACs/DCs converters. The DCs buses lines represent the phase require for charged the EV. Wholly EV to be connects to the chargers will draw the powers from the DCs buses. The numbers of EV to be connects to the grids increased day by day, the fluctuation on the DCs buses will increased also. To keeps this fluctuation at an assured levels, add the capacitors is required to keeps the fluctuation at the wanted levels. Protection the fluctuation at a confident levels has shown more active result are achieved in EVs chargers. The proposed models strategy in this work support fast charge of 10 EV at DCs levels-2 and support 200 kV main voltages, 800 V transformers outputs voltages, 1.5 kV DCs buses voltages.

To keeps the mention value at the stated level, controlling design is require. The chargers charge the EVs batteries by use the powers it receive from the DCs buses. The section that will controlled this processing is the batteries charging controllers. The inverters take the powers from the grids and feed the DCs buses after ACs/DCs conversions which controlling the inverters controllers. When the result is examine, the batteries voltages values fit into the fully charges voltages values determine within the frameworks of the nominal parameter enter into the batteries. The voltages increase continuous up to this levels and ensure that the currents is kept constant. In these method, higher currents will supports fast charge. Therefore, it has been determine that with the developments of controlling strategy, higher-speeds charge will be smooth. It is suggested to carrying out study by examine the powers qualities on the grids while charge process at higher speed.

## ACKNOWLEDGMENT

The author expresses his thanks and gratitude to Dijlah University College, especially the Department of Computer Engineering Technology, for its facilities and support.

## REFERENCES

1. R Khezri, A Mahmoudi, H Aki "Optimal planning of solar photovoltaic and battery storage systems for grid-connected residential sector" Review, challenges and new perspectives. Renew. Sustain. Energy Rev. Vol. 153 pp. 111763 January 2022, https://doi.org/10.1016/j.rser.2021.111763
2. P.H.A. Barra a, W.C. decarvalho, T.S. Menezes, R.A/.S Fernandes, D.V. Coury "A review on wind power smoothing using high-power energy storage systems" Renew. Sustain. Energy Rev., Vol. 137, pp. 110455, March 2021, https://doi.org/10.1016/j.rser.2020.110455
3. J. Morfeldt, S.d. Kurland, D.J.A Johansson "Carbon footprint impacts of banning cars with internal combustion engines" Transp. Res. Part D Transp. Environ, Vol. 95, pp. 102807, May 2021, , doi: 10.1016/j.trd.2021.102807
4. K. Forrest, M.M. Kinnon, B. Tarroja, S. Samuelsen "Estimating the technical feasibility of fuel cell and battery electric vehicles for the medium and heavy duty sectors in California" Appl. Energy, Vol. 276, No. 9, pp. 115439, 2020, doi: 10.1016/j.apenergy.2020.115439
5. H.S Das, M.M. Rahman, S. Li, C.W. Tan, "Electric vehicles standards, charging infrastructure, and impact on grid integration" A technological review. Renew. Sustain. Energy Rev., Vol. 120, pp. 109618, March 2020, https://doi.org/10.1016/j.rser.2019.109618
6. R. Challa, D. Kamath, A. Anctil, "A.Well-to-wheel greenhouse gas emissions of electric versus combustion vehicles" Journal of Environmental Management, Vol. 308, pp. 114592, 15 April 2022, https://doi.org/10.1016/j.jenvman.2022.114592
7. M. Gustafsson, N. Svensson, M. Eklund, B.F. Möller, "Well-to-wheel climate performance of gas and electric vehicles in Europe" Transp. Res. Part D: Transp. Environ. Vol. 97, pp.102911, August 2021, https://doi.org/10.1016/j.trd.2021.102911
8. H. Krueger, A. Cruden, "Integration of electric vehicle user charging preferences into Vehicle-to-Grid aggregator control" Energy Rep. Vol. 6, pp. 86-95, 2020, doi: 10.1016/j.egyr.2020.02.031
9. B. Al-Hanahi, I. Ahmad, D. Habibi, M. A. S. Masoum, "Charging Infrastructure for Commercial Electric Vehicles" Challenges and FutureWorks. IEEE Access, Vol. 9, pp. 121476–121492,
10. O. Gönül, A.C. Duman, O. Güler, "Electric vehicles and charging infrastructure in Turkey" An overview. Renew. Sustain. Energy Rev., Vol. 143, pp. 110913, 2021, https://doi.org/10.1016/j.rser.2021.110913
11. R.R. Kumar, A. Chakraborty, P. Mandal "Promoting electric vehicle adoption " Who should invest in charging infrastructure? Transp. Res. Part E Logist. Transp. Rev., Vol. 149, pp 102295, 2021, https://doi.org/10.1016/j.tre.2021.102295
12. M. Greaker "Optimal regulatory policies for charging of electric vehicles" Transp. Res. Part D Transp. Environ., Vol. 79, No. 4, pp 102922, 2021, doi: 10.1016/j.trd.2021.102922
13. D. Ziegler, N. Abdelkafi, "Business models for electric vehicles" Literature review and key insights. J. Clean. Prod. Vol. 330, No. 1, pp. 129803, January 2022, https://doi.org/10.1016/j.jclepro.2021.129803
14. V. Azarova, J.J. Cohen, A. Kollmann, J. Reichl "The potential for community financed electric

vehicle charging infrastructure" Transp. Res. Part D Transp. Environ.Vol. 88, pp. 102541, November 2020, https://doi.org/10.1016/j.trd.2020.102541

15. R.K. Kaufmann, D. Newberry, C. Xin, S. Gopal "Feedbacks among electric vehicle adoption, charging, and the cost and installation of rooftop solar photovoltaics" Nat. Energy, Vol. 6, No. 2, pp. 143-149, 2021, doi: 10.1038/s41560-020-00746-w
16. S. LaMonaca, L. Ryan, "The state of play in electric vehicle charging services" A review of infrastructure provision, players, and policies. Renew. Sustain. Energy Rev., Vol. 154, pp. 111733, February 2022, doi: 10.1016/j.rser.2021.111733
17. G. Rajendran, C.A. Vaithilingam, N. Misron, K. Naidu, M.R. Ahmed, "A comprehensive review on system architecture and international standards for electric vehicle charging stations" Journal of Energy Storage, Vol. 42, pp. 103099, October 2021, https://doi.org/10.1016/j.est.2021.103099
18. W Wei, S. Ramakrishnan, A.Z. Needell, J.E. Trancik, "Personal vehicle electrification and charging solutions for high-energy days" Nature Energy, Vol. 6, No. 1, pp. 105-114, January 2021, doi: 10.1038/s41560-020-00752-y
19. S. Pemberton, A. Nobajas, R. Waller, "Rapid charging provision, multiplicity and battery electric vehicle (BEV) mobility in the UK" Journal of Transport Geography, Vol. 95, pp. 103137, 2021, https://doi.org/10.1016/j.jtrangeo.2021.103137
20. D. Yang, N.J.S. Sarma, M.F. Hyland, R. Jayakrishnan, "Dynamic modeling and real-time management of a system of EV fast-charging stations" Transp. Res. Part C Emerg. Technol. Vol. 128, pp 103186, 2021. https://doi.org/10.1016/j.trc.2021.103186
21. M. Muratori, E. Elgqvist, D. Cutler, J. Eichman, S. Salisbury,Z. Fuller, J. Smart, "Technology solutions to mitigate electricity cost for electric vehicle DC fast charging" Appl. Energy, vol. 242, pp. 515-423, 15 May 2019. https://doi.org/10.1016/j.apenergy.2019.03.061
22. N. Wassiliadis, J. Schneider, A. Frank, L. Wildfeuer, X. Lin, A. Jossen, M. Lienkamp, "Review of fast charging strategies for lithium-ion battery systems and their applicability for battery electric vehicles" J. Energy Storage, vol. 44, pp. 103306, 2021. https://doi.org/10.1016/j.est.2021.103306
23. S. Habib, M.M Khan, F. Abbas, A. Ali, Faiz, M.T.; Ehsan, F.; Tang, H. "Contemporary trends in power electronics converters for charging solutions of electric vehicles" CSEE J. Power Energy System, vol. 6, no. 6, pp. 911-929, 2020. http://restpublisher.com/book-series/daai/
24. M.R. Khalid, I.A. Khan, S. Hameed, M.S.J. Asghar, J.S. Ro, "A Comprehensive Review on Structural Topologies, Power Levels, Energy Storage Systems, and Standards for Electric Vehicle Charging Stations and Their Impacts on Grid" IEEE Access, vol. 9, pp. 128069–128094, 2021. doi: 10.1109/ACCESS.2021.3112189
25. M.O. Metais, O. Jouini, Y. Perez, J. Berrada, E. Suomalainen, "Too much or not enough? Planning electric vehicle charging infrastructure" A review of modeling options. Renew. Sustain. Energy Rev. vol. 153, pp. 111719, 2022. https://doi.org/10.1016/j.rser.2021.111719
26. Y. Zhao, Z. Wang, Z.J.M. Shen, F. Sun, "Data-driven framework for large-scale prediction of charging energy in electric vehicles" Appl. Energy, vol. 282, pp. 116175, 2020. https://doi.org/10.1016/j.apenergy.2020.116175
27. W. Li, H. Cui, T. Nemeth, J. Jansen, C. Ünlübayir, Z. Wei, X. Feng, X. Han, M. Ouyang, H. Dai, et al. "Cloud-based health-conscious energy management of hybrid battery systems in electric vehicles with deep reinforcement learning" Appl. Energy, vol. 293, pp. 116977, 2021. https://doi.org/10.1016/j.apenergy.2021.116977
28. Y. Lu, K. Li, X. Han, X. Feng, Z. Chu, L. Lu, P. Huang, Z. Zhang, Y. Zhang, F. Yin, et al. "A method of cell-to-cell variation evaluation for battery packs in electric vehicles with charging cloud data" eTransportation, vol. 6, pp. 100077, 2020, https://doi.org/10.1016/j.etran.2020.100077
29. A. Ouali, Y. Goude,P. Massart, J.M. Poggi, H.A. Yan, "A review of electric vehicle load open data and models" Energies, vol14, no. 8, pp. 22-23, 2021, https://doi.org/10.3390/en14082233
30. A.L. Sørensen,K.B. Lindberg, I. Sartori, I. Andresen, " Residential electric vehicle charging datasets from apartment buildings" Data Br. 2021, 36, 107105. Doi:10.1016/j.dib.2021.107105
31. M. Lahariya, D.F. Benoit, C. Develder, "Synthetic data generator for electric vehicle charging sessions: Modeling and evaluation using real-world data" Energies 2020, vol. 13, pp. 2-18, 4211.
32. F.M. Andersen, H.K Jacobsen, P.A. Gunkel, "Hourly charging profiles for electric vehicles and their effect on the aggregated consumption profile in Denmark" Int. J. Electr. Power Energy Syst. 2021, 130, 106900.
33. Q. Xing, Z. Chen, Z. Zhang, R. Wang, T. Zhang, "Modelling driving and charging behaviours of electric vehicles using a data-driven approach combined with behavioural economics theory" Journal of Cleaner. Production. Vol. 324, pp. 129243, 2021, https://doi.org/10.1016/j.jclepro.2021.129243

34. K. Chaudhari, N.K. Kandasamy, A. Krishnan, A. Ukil, H.B. Gooi, "Agent-based aggregated behavior modeling for electric vehicle charging load" IEEE Trans. Ind. Inform, vol. 15, pp. 856-868, 2019, doi: 10.1109/TII.2018.2823321
35. C. Crozier, T. Morstyn, M. McCulloch, "Capturing diversity in electric vehicle charging behaviour for network capacity estimation" Transp. Res. Part D Transp. Environ. 2021, 93, 102762. doi: 10.1016/j.trd.2021.102762
36. S.I. Spencer, Z. Fu, E.A. Iosifidou, T.E. Lipman, "Evaluating smart charging strategies using real-world data from optimized plugin electric vehicles" Transp. Res. Part D Transp. Environ. 2021, 100, 103023.
37. A. Amin, W.U.K Tareen, M. Usman, H. Ali,I. Bari, B. Horan, S. Mekhilef, M. Asif, S. Ahmed, A. Mahmood, et al. "A review of optimal charging strategy for electric vehicles under dynamic pricing schemes in the distribution charging network" Sustainability 2020, 12, 10160.
38. B. Bibak, H.T. Mo˘gulkoç, "comprehensive analysis of Vehicle to Grid (V2G) systems and scholarly literature on the application of such systems" Renew. Energy Focus 2021, 36, 1–20.
39. T.U. Solanke, V.K. Ramachandaramurthy, J.Y. Yong, J. Pasupuleti, P. Kasinathan, A. Rajagopalan, "A review of strategic charging–discharging control of grid-connected electric vehicles" J. Energy Storage 2020, 28, 101193.
40. B. Tarroja, E. Hittinger, "The value of consumer acceptance of controlled electric vehicle charging in a decarbonizing grid" The case of California. Energy, vol. 229, pp. 120691 , 2021, https://doi.org/10.1016/j.energy.2021.120691
41. R. Tu, Y. Gai, B. Farooq, D. Posen, M. Hatzopoulou, "Electric vehicle charging optimization to minimize marginal greenhouse gas emissions from power generation" Appl. Energy 2020, 277, 115517.
42. F. Knobloch, S.V. Hanssen, A. Lam, H. Pollitt, P. Salas, U. Chewpreecha, M.A.J Huijbregts, J.F. Mercure, "Net emission reductions from electric cars and heat pumps in 59 world regions over time" Nat. Sustain. 2020, 3, 437–447.
43. S. Powell, E.C. Kara, R. Sevlian, G.V. Cezar, S. Kiliccote, R. Rajagopal, "Controlled workplace charging of electric vehicles " The impact of rate schedules on transformer aging. Appl. Energy 2020, 276, 115352.
44. G. Guidi, S. D'Arco, K. Nishikawa, J.A. Suul, "Load Balancing of a Modular Multilevel Grid-Interface Converter for Transformer- Less Large-Scale Wireless Electric Vehicle Charging Infrastructure" IEEE J. Emerg. Sel. Top. Power Electron. Vol. 9, no. 4, pp. 4587–4605, 2021, doi: 10.1109/JESTPE.2020.3043211
45. H.R .Sayarshad, V. Mahmoodian, "An intelligent method for dynamic distribution of electric taxi batteries between charging and swapping stations" Sustain. Cities Soc. 2021, 65, 102605.
46. G. A. Gyamfi, H. Song, B. Obuobi, E. Nketiah, H. Wang, D. Cudjoe, "Who will adopt? Investigating the adoption intention for battery swap technology for electric vehicles. Renew " Sustain. Energy Rev. 2022, 156, 111979.
47. S. Zu, L. Sun, "Research on location planning of urban charging stations and battery-swapping stations for electric vehicles" Energy Rep. 2022, 8, 508–522.
48. S. Sachan, S. Deb, S.N. Singh, "Different charging infrastructures along with smart charging strategies for electric vehicles" Sustain. Cities Soc.vol. 60, pp. 102238,2020, https://doi.org/10.1016/j.scs.2020.102238
49. Y. Zhang, X. Liu, W. Wei, T. Peng, G. Hong, C. Meng, "Mobile charging: A novel charging system for electric vehicles in urban areas" Appl. Energy,vol. 18, pp. 115648, 2020, https://doi.org/10.1016/j.apenergy.2020.115648
50. V. Moghaddam, I. Ahmad, D. Habibi, M.A.S. Masoum, "Dispatch management of portable charging stations in electric vehicle networks" eTransportation, vol, 8, pp. 100-112, 2021, https://doi.org/10.1016/j.etran.2021.100112
51. P. Karlsson, J. Svensson, "DC bus voltage control for a distributed power system" IEEE Transactions On Power Electronics, vok. 18, no. 6, pp. 1405-1412, 2003, doi: 10.1109/TPEL.2003.818872