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Solar Energy Dependent Supercapacitor System with ANFIS Controller for Auxiliary Load of Electric Vehicles

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Abstract

Innovations are required for electric vehicles (EVs) to be lighter and more energy efficient due to the range anxiety issue. This article introduces an intelligent control of an organic structure solar supercapacitor (OSSC) for EVs to meet electrical load demands with solar renewable energy. A carbon fibre-reinforced polymer, nano zinc oxide (ZnO), and copper oxide (CuO) fillers have been used in the development of OSSC prototypes. The organic solar cell, electrical circuits, converter, controller, circuit breaker switch, and batteries were all integrated for the modelling of OSSCs. A carbon fibre (CF)-reinforced CuO-doped polymer was utilised to improve the concentration of electrons. The negative electrodes of the CF were strengthened with nano ZnO epoxy to increase the mobility of electrons as an n-type semiconductor (energy band gap 3.2–3.4 eV) and subsequently increased to 3.5 eV by adding 6% π-carbon. The electrodes of the CF were strengthened with epoxy-filled nano-CuO as a p-type semiconductor to facilitate bore/positive charging. They improve the conductivity of the OSSC. The OSSC power storage was controlled by an adaptive neuro-fuzzy intelligent system controller to meet the load demand of EVs and auxiliary battery charging. Moreover, a fully charged OSSC (solar irradiance = 1000 W/m^2) produced 561 W·h/m^2 to meet the vehicle load demand with 45 A of auxiliary battery charging current. Therefore, the OSSC can save 15% in energy efficiency and contribute to emission control. The integration of an OSSC with an EV battery can minimise the weight and capacity of the battery by 7.5% and 10%, respectively. © 2023 by the authors.

Author keywords

ANFIS; electric vehicle; renewable energy; solar energy; solar organic supercapacitor

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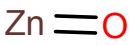

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1 Babalola, P., Atiba, O.
Solar powered cars—A review
(2021) *IOP Conf. Ser. Mater. Sci. Eng*, 1107, p. 012058. Cited 4 times.

2 Arulious Jora, A., Earlina, D., Harish, D., Sakthi Priya, P., Inba Rexy, A., Nancy Mary, J.S.
Design of solar powered electric vehicle

(2021) *Journal of Physics: Conference Series*, 2070 (1), art. no. 012105.
http://iopscience.iop.org/journal/1742-6596
doi: 10.1088/1742-6596/2070/1/012105

View at Publisher

3 Sarker, A.K., Azad, A.K., Rasul, M.G., Doppalapudi, A.T.
Prospect of Green Hydrogen Generation from Hybrid Renewable Energy Sources: A Review

(2023) *Energies*, 16 (3), art. no. 1556. Cited 6 times.
http://www.mdpi.com/journal/energies/
doi: 10.3390/en16031556

View at Publisher

4 Shah, R.M.R.A., McGordon, A., Rahman, M.M., Amor-Segan, M., Jennings, P.
Characterisation of micro turbine generator as a range extender using an automotive drive cycle for series hybrid electric vehicle application

(2021) *Applied Thermal Engineering*, 184, art. no. 116302. Cited 11 times.
http://www.journals.elsevier.com/applied-thermal-engineering/
doi: 10.1016/j.applthermaleng.2020.116302

View at Publisher

5 Allafi, W., Uddin, K., Zhang, C., Mazuir Raja Ahsan Sha, R., Marco, J.
On-line scheme for parameter estimation of nonlinear lithium ion battery equivalent circuit models using the simplified refined instrumental variable method for a modified Wiener continuous-time model

(2017) *Applied Energy*, 204, pp. 497-508. Cited 40 times.
http://www.elsevier.com/inca/publications/store/4/0/5/8/9/1/index.htt
doi: 10.1016/j.apenergy.2017.07.030

View at Publisher

6 Meng, H., Li, Y.-F.
A review on prognostics and health management (PHM) methods of lithium-ion batteries

(2019) *Renewable and Sustainable Energy Reviews*, 116, art. no. 109405. Cited 157 times.
https://www.journals.elsevier.com/renewable-and-sustainable-energy-reviews
doi: 10.1016/j.rser.2019.109405

View at Publisher

7 Kim, Y.-M., Lee, J.-H., Kim, S.-J., Favrat, D.

Potential and evolution of compressed air energy storage: Energy and exergy analyses

(2012) *Entropy*, 14 (8), pp. 1501-1521. Cited 144 times.
http://www.mdpi.com/1099-4300/14/8/1501/pdf
doi: 10.3390/e14081501

View at Publisher

8 Bezerra Menezes Leite, H., Zareipour, H.

Six Days Ahead Forecasting of Energy Production of Small Behind-the-Meter Solar Sites

(2023) *Energies*, 16 (3), art. no. 1533. Cited 3 times.
http://www.mdpi.com/journal/energies/
doi: 10.3390/en16031533

View at Publisher

9 Parveen, N., Ansari, S.A., Ansari, M.Z., Ansari, M.O.

Manganese oxide as an effective electrode material for energy storage: a review (Open Access)

(2022) *Environmental Chemistry Letters*, 20 (1), pp. 283-309. Cited 26 times.
http://springerlink.metapress.com/app/home/journal.asp?wasp=d86tgdwvtg0yvw9gvkwp&referrer=parent&backto=browsepublicationsresults,140,541;
doi: 10.1007/s10311-021-01316-6

View at Publisher

10 Rahman, A., Rashid, M., Mohiuddin, A.K.M., Hawlader, M.N.A.
Nano-Battery Technology for Ev-Hev Panel: A Pioneering Study
(2015) *IIUM Eng. J*, 16, pp. 57-68. Cited 3 times.

11 Chen, H., Lu, F., Guo, F.

Power management system design for small size solar-electric vehicle (Open Access)

(2012) *Conference Proceedings - 2012 IEEE 7th International Power Electronics and Motion Control Conference - ECCE Asia, IPEMC 2012*, 4, art. no. 6259281, pp. 2658-2662. Cited 9 times.
ISBN: 978-145772086-4
doi: 10.1109/IPEMC.2012.6259281

View at Publisher

12 Li, Z., Khajepour, A., Song, J.

A comprehensive review of the key technologies for pure electric vehicles

(2019) *Energy*, 182, pp. 824-839. Cited 246 times.
https://www.journals.elsevier.com/energy
doi: 10.1016/j.energy.2019.06.077

View at Publisher

13 Ganji, B., Kouzani, A.Z.

A study on look-ahead control and energy management strategies in hybrid electric vehicles

(2010) *2010 8th IEEE International Conference on Control and Automation, ICCA 2010*, art. no. 5524178, pp. 388-392. Cited 25 times.
ISBN: 978-142445195-1
doi: 10.1109/ICCA.2010.5524178

View at Publisher

14 Raja Ahsan Shah, R.M., Jones, R.P., Cheng, C., Picarelli, A., Abd Aziz, A.R., Al Qubeissi, M.

Model-based energy path analysis of tip-in event in a 2wd vehicle with range-extender electric powertrain architecture (Open Access)

(2021) *Energies*, 14 (18), art. no. 5696.
https://www.mdpi.com/1996-1073/14/18/5696/pdf
doi: 10.3390/en14185696

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15 Liu, Z., Wang, Y., Feng, J.

Vehicle-type strategies for manufacturer's car sharing (Open Access)

(2022) *Kybernetes*. Cited 26 times.
http://www.emeraldinsight.com/info/journals/k/k.jsp
doi: 10.1108/K-11-2021-1095

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16 Clement, K., Haesen, E., Driesen, J.

Coordinated charging of multiple plug-in hybrid electric vehicles in residential distribution grids (Open Access)

(2009) *2009 IEEE/PES Power Systems Conference and Exposition, PSCE 2009*, art. no. 4839973. Cited 314 times.
ISBN: 978-142443811-2
doi: 10.1109/PSCE.2009.4839973

View at Publisher

17 Sawant, S., Ahsan Shah, R.M.R., Rahman, M., Abd Aziz, A.R., Smith, S., Jumahat, A.

System modelling of an electric two-wheeled vehicle for energy management optimization study (Open Access)

(2021) *Evergreen*, 8 (3), pp. 642-650. Cited 4 times.
http://www.tj.kyushu-u.ac.jp/evergreen/contents/EG2021-8_3_content/642-650.html
doi: 10.5109/4491656

View at Publisher

18 Kötz, R., Carlen, M.

Principles and applications of electrochemical capacitors

(2000) *Electrochimica Acta*, 45 (15-16), pp. 2483-2498. Cited 4171 times.
http://www.journals.elsevier.com/electrochimica-acta/
doi: 10.1016/S0013-4686(00)00354-6

View at Publisher

19 Burke, A.

Ultracapacitors: Why, how, and where is the technology

(2000) *Journal of Power Sources*, 91 (1), pp. 37-50. Cited 2642 times.
doi: 10.1016/S0378-7753(00)00485-7

View at Publisher

20 Geim, A.K., Novoselov, K.S.

The rise of graphene (Open Access)

(2007) *Nature Materials*, 6 (3), pp. 183-191. Cited 34072 times.
doi: 10.1038/nmat1849

View at Publisher

21 McDonough, J.R., Choi, J.W., Yang, Y., La Mantia, F., Zhang, Y., Cui, Y.

Carbon nanofiber supercapacitors with large areal capacitances

(2009) *Applied Physics Letters*, 95 (24), art. no. 243109. Cited 114 times.
doi: 10.1063/1.3273864

View at Publisher

22 Xu, N., Riley, J.

Nonlinear analysis of a classical system: The double-layer capacitor (Open Access)

(2011) *Electrochemistry Communications*, 13 (10), pp. 1077-1081. Cited 46 times.
doi: 10.1016/j.elecom.2011.07.003

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23 Gow, J.A., Manning, C.D.

Development of a photovoltaic array model for use in power-electronics simulation studies (Open Access)

(1999) *IEE Proceedings: Electric Power Applications*, 146 (2), pp. 193-200. Cited 891 times.
doi: 10.1049/ip-epa:19990116

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24 Huang, B., Deng, H.-X., Lee, H., Yoon, M., Sumpter, B.G., Liu, F., Smith, S.C., (...), Wei, S.-H.

Exceptional optoelectronic properties of hydrogenated bilayer silicene (Open Access)

(2014) *Physical Review X*, 4 (2), art. no. 021029. Cited 88 times.
http://journals.aps.org/prx/pdf/10.1103/PhysRevX.4.021029
doi: 10.1103/PhysRevX.4.021029

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25 Andersen, T.R., Dam, H.F., Hösel, M., Helgesen, M., Carlé, J.E., Larsen-Olsen, T.T., Gevorgyan, S.A., (...), Krebs, F.C.

Scalable, ambient atmosphere roll-to-roll manufacture of encapsulated large area, flexible organic tandem solar cell modules (Open Access)

(2014) *Energy and Environmental Science*, 7 (9), pp. 2925-2933. Cited 247 times.
http://www.rsc.org/Publishing/Journals/EE/About.asp
doi: 10.1039/c4ee01223b

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26 Bagher, A.M.
Comparison of Organic Solar Cells and Inorganic Solar Cells
(2014) *Int. J. Renew. Sustain. Energy*, 3, p. 53. Cited 69 times.

27 Singh, U., Rizwan, M.

Analysis of fuzzy logic, ANN and ANFIS based models for the forecasting of wind power

(2018) *2018 2nd IEEE International Conference on Power Electronics, Intelligent Control and Energy Systems, ICPEICES 2018*, art. no. 8897445, pp. 1-7. Cited 6 times.
http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=8892714
ISBN: 978-153866625-8
doi: 10.1109/ICPEICES.2018.8897445

View at Publisher

28 Yang, G.R., Wang, X.-J.

Artificial Neural Networks for Neuroscientists: A Primer (Open Access)

(2020) *Neuron*, 107 (6), pp. 1048-1070. Cited 73 times.
http://www.cell.com/neuron/home
doi: 10.1016/j.neuron.2020.09.005

View at Publisher

29 Jang, J.-S.R.

ANFIS: Adaptive-Network-Based Fuzzy Inference System

(1993) *IEEE Transactions on Systems, Man and Cybernetics*, 23 (3), pp. 665-685. Cited 13129 times.
doi: 10.1109/21.256541

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