电源学报
JOURNAL OF POWER SUPPLY
北大中文核心期刊
ISSN 2095-2805 CN 12-1420/TM

电源学报 ›› 2022, Vol. 20 ›› Issue (6) : 93-101. DOI: 10.13234/j.issn.2095-2805.2022.6.93
电动汽车无线充电技术专辑

含无线充电电动汽车的孤岛直流微电网运行模式研究

蓝嘉豪, 漆倬宇, 张强, 刘贤, 薛永龙, 周玮
作者信息

Research on Operation Mode of Islanding DC Microgrid with EV-Wireless Power Transfer System

LAN Jiahao, QI Zhuoyu, ZHANG Qiang, LIU Xian, XUE Yonglong, ZHOU Wei
Author information
History

摘要

为改进电动汽车充电设施的供电方式,研究了无线充电电动汽车与光储直流微电网的融合,并重点研究充电功率发生变化时微电网的能量管理策略。分别建立光伏、储能、无线充电电动汽车能量传递的数学模型,推导各部分功率、端口电压电流等的关联性,基于此设计了相应的控制器。考虑充电功率需求以及储能电池状态信息,定义微电网运行的3种模式,并提出基于功率缺额判据的能量管理策略。最后搭建实验平台,验证系统的3种运行模式均可实现充电负荷的可靠供电。当充电功率发生变动时,所设计的能量管理策略可实现模式切换,维持母线电压稳定。

Abstract

The integration of an electric vehicle-wireless power transfer（EV-WPT） system and DC microgrid with photovoltaic（PV） and energy storage（ES） is studied in this paper to improve the power supply mode of EVs charging facilities. The research focuses on the energy management strategy for microgrid when the charging power changes. The mathematical models of power transfer of PV, ES and the EV-WPT system are established, respectively. The correlations of power, port voltage and current of each unit are derived, based on which the corresponding controllers are designed. Considering the charging power demand and the state-of-charge of ES battery, three operation modes of microgrid are defined, and the energy management strategy based on the power gap criterion is proposed. Finally, an experimental platform was built, and results verified that all the three operation modes of the system can achieve a reliable power supply of charging load. When the charging power changed, the designed energy management strategy can realize mode switching and maintain the bus voltage stability.

关键词

无线电能传输 / 直流微电网 / 电动汽车 / 光伏发电

Key words

wireless power transfer （WPT） / DC microgrid / electric vehicle （EV） / photovoltaic （PV） power generation

PDF(1542 KB)

120 Accesses | 0 Citation | Detail

引用本文

导出引用

蓝嘉豪, 漆倬宇, 张强, 刘贤, 薛永龙, 周玮. 含无线充电电动汽车的孤岛直流微电网运行模式研究. *电源学报*. 2022, 20(6): 93-101 https://doi.org/10.13234/j.issn.2095-2805.2022.6.93

LAN Jiahao, QI Zhuoyu, ZHANG Qiang, LIU Xian, XUE Yonglong, ZHOU Wei. Research on Operation Mode of Islanding DC Microgrid with EV-Wireless Power Transfer System. *Journal of Power Supply*. 2022, 20(6): 93-101 https://doi.org/10.13234/j.issn.2095-2805.2022.6.93

上一篇 下一篇

参考文献

[1] Chu S Y, Cui X, Zan X, et al.Transfer-power measurement using a non-contact method for fair and accurate metering of wireless power transfer in electric vehicles[J]. IEEE Tra-nsactions on Power Electronics, 2022, 37(2): 1244-1271.
[2] 柳君波, 徐向阳, 李思雯. 中国电力行业的全周期碳足迹[J]. 中国人口·资源与环境, 2022, 32(1): 31-41.
Liu Junbo, Xu Xiangyang, Li Siwen.Lifecycle carbon footprint analysis of China's power industry[J]. China Popu-lation, Resources and Environment, 2022, 32(1): 31-41 (in Chinese).
[3] 张朱浩伯, 徐德鸿, Philip T K, 等. 一种高偏移容限的无线电能传输系统设计[J]. 电源学报, 2021, 19(1): 155-164.
Zhang Zhuhaobo, Xu Dehong, Philip T K, et al.Design of a wireless power transfer system with high misalignment tolerance[J]. Journal of Power Supply, 2021, 19(1): 155-164 (in Chinese).
[4] Li Zhongqi, Li Jing, Li Shangyou, et al.Design and opti-mization of asymmetric and reverse series coil structure for obtaining quasi-constant mutual inductance in dynamic wir-eless charging system for electric vehicles[J]. IEEE Trans-actions on Vehicular Technology, 2022, 71(3): 2560-2572.
[5] Yenil V, Cetin S.Load independent constant current and constant voltage control of LCC-series compensated wireless EV charger[J]. IEEE Transactions on Power Electronics, 2022, 37(7): 8701-8712.
[6] Yang Bin, Chen Yang, Ruan Wenjun, et al.Current stress optimization for double-sided CLLLC topology-based IPT system with constant output current tolerating pad misalignments[J]. IEEE Transactions on Industry Applications, 2022, 58(1): 1032-1043.
[7] Wu Lihao, Zhang Bo, Jiang Yanwei, et al.A robust parity-time-symmetric WPT system with extended constant-power range for cordless kitchen appliances[J]. IEEE Transactions on Industry Applications, 2022, 58(1): 1179-1189.
[8] Zhou Wei, Gao Qiao, He Lixin, et al.Design of CPT system with multiple constant output voltage pickups using inverse hybrid parameters of capacitive coupler[J]. IEEE Transactions on Industry Applications, 2022, 58(1): 1061-1070.
[9] Zhong Wenxing, Zhang Siyuan, Chen Min, et al.Reconfigurable resonant topology linking two-, three-, and four-coil modes for WPT with large coupling range and fixed frequency[J]. IEEE Transactions on Power Electronics, 2022, 37(7): 8713-8725.
[10] Chung H- M, Li W- T, Yuen C, et al.Electric vehicle charge scheduling mechanism to maximize cost efficiency and user convenience[J]. IEEE Transactions on Smart Grid, 2019, 10(3): 3020-3030.
[11] 苗中磊, 蔡逢煌, 王群兴, 等. 分布式直流微电网分级控制技术综述[J]. 电源学报, 2019, 17(6): 115-127.
Miao Zhonglei, Cai Fenghuang, Wang Qunxing, et al.Review of hierarchical control of distributed DC microgrid[J]. Journal of Power Supply, 2019, 17(6): 115-127 (in Chinese).
[12] 郁家麟, 肖龙海, 胡舟, 等. 微电网含非线性与不平衡负荷时的混合储能系统功率分配策略研究[J]. 电源学报, 2020, 18(2): 43-54.
Yu Jialin, Xiao Longhai, Hu Zhou, et al.Research on power allocation strategy for hybrid energy storage system in microgrids under nonlinear and unbalanced loads[J]. Journal of Power Supply, 2020, 18(2): 43-54 (in Chinese).
[13] 郑凯元, 杜文娟, 王海风. 混联多微电网系统动态交互作用及稳定性分析[J]. 中国电机工程学报, 2021, 41(16): 5552-5568.
Zheng Kaiyuan, Du Wenjuan, Wang Haifeng.Analysis on dynamic interactions and stability of hybrid multi-micro grids[J]. Proceedings of the CSEE, 2021, 41(16): 5552-5568 (in Chinese).
[14] 肖朝霞, 刘杰. 基于微网的电动汽车无线充电系统研究[J]. 电工技术学报, 2015, 30(S1): 231-236.
Xiao Zhaoxia, Liu Jie.The research of electric vehicles wireless charging system based on micro-grid[J]. Transactions of China Electrotechnical Society, 2015, 30(S1): 231-236 (in Chinese).
[15] 周玮, 蓝嘉豪, 麦瑞坤, 等. 无线充电电动汽车V2G模式下光储直流微电网能量管理策略[J]. 电工技术学报, 2022, 37(1): 82-91.
Zhou Wei, Lan Jiahao, Mai Ruikun, et al.Research on power management strategy of DC microgrid with photovoltaic, energy storage and EV-wireless power transfer in V2G mode[J]. Transactions of China Electrotechnical Society, 2022, 37(1): 82-91 (in Chinese).
[16] 张胜楠, 王海云, 王茹. 双向无线电能传输系统在V2G中的控制策略研究[J/OL]. 电源学报, (2022-03-18)[2022-04-25], http://kns.cnki.net/kcms/detail/12.1420. TM.20220317.1807.004.html
Zhang Shengnan, Wang Haiyun, Wang Ru. Research on control strategy of bidirectional wireless power transmission system in V2G[J/OL]. Journal of Power Supply, (2022-03-18)[2022-04-25], http://kns.cnki.net/kcms/detail/12.1420.TM.20220317.1807.004.html (in Chinese).
[17] Wang Lei, Madawala U K, Wong M C.A wireless vehicle-to-grid-to-home power interface with an adaptive DC link[J]. IEEE Journal of Emerging and Selected Topics in Power Electronics, 2021, 9(2): 2373-2383.
[18] Zeng Rong, Galigekere V P, Onar O C, et al.Grid integration and impact analysis of high-power dynamic wireless charging system in distribution network[J]. IEEE Access, 2021, 9: 6746-6755.
[19] Ahmed J, Salam Z.An enhanced adaptive P &O MPPT for fast and efficient tracking under varying environmental conditions[J]. IEEE Transactions on Sustainable Energy, 2018, 9(3): 1487-1496.

基金

国家自然科学基金资助项目（51907170）；四川省科技计划资助项目（2021YFH0039）