Peertechz

ENGINEERING GROUP

Trends in Computer Science and Information Technology

ISSN: 2641-3086 DOI: https://dx.doi.org/10.17352/tcsit

Opinion

Optimal integration of electric vehicles in smart grids with renewables and battery storage systems under uncertainty

Erfan Mohagheghi[1]*, Joan Gubianes Gasso[1] and Pu Li[2]

[1]MicroFuzzy GmbH, Taunusstraße 38, 80807 Munich, Germany

[2]Department of Process Optimization, Ilmenau University of Technology, Ilmenau, Germany

Received: 29 June, 2020
Accepted: 31 August, 2020
Published: 01 September, 2020

***Corresponding author:** Dr. Erfan Mohagheghi, MicroFuzzy GmbH, Taunusstraße 38, 80807 Munich, Germany, E-mail: Erfan.Mohagheghi@microfuzzy.com

https://www.peertechz.com

Check for updates

There has been a huge trend to integrate Renewable Energies (REs) and Electric Vehicles (EVs) into energy networks (Figure 1). This is mostly due to the shrinking price of their application and the increasingly strict emission policy. However, the integration of REs and EVs brings new challenges to the network operation [1]. For instance, a considerable amount of REs cannot be accommodated in the network and thus has to be curtailed due to technical limitations [2-5]. For overcoming this problem, Battery Storage Systems (BSSs) can be used to store the surplus energy and consequently increase economic benefits [4]. In addition, the storage capacity of EVs can be employed to store an amount of REs and provide it back to the grid when needed [6]. This not only balances the supply and demand but also results in decrease in network losses and improvement of voltage and frequency stability of the grid. However, BSSs and EVs lead to a dynamic power flow for the grid, which is difficult to address. In addition, considering both active and reactive power capability of the EVs and BSSs with flexible operation strategies, as well as maximizing the lifetime of the batteries [7,8] further increase the complexity of the problem. Another significant challenge lies in the fact that REs and EVs are intermittent and uncertain, i.e., their power exchange with the grid cannot be accurately forecasted and thus causes discrepancies between the forecasted and realized values. The uncertainties can lead to constraint violations and thus safety problems if not handled properly [9,10]. Therefore, the network operator has to fast update the operation strategies correspondingly, in order to operate the network economically

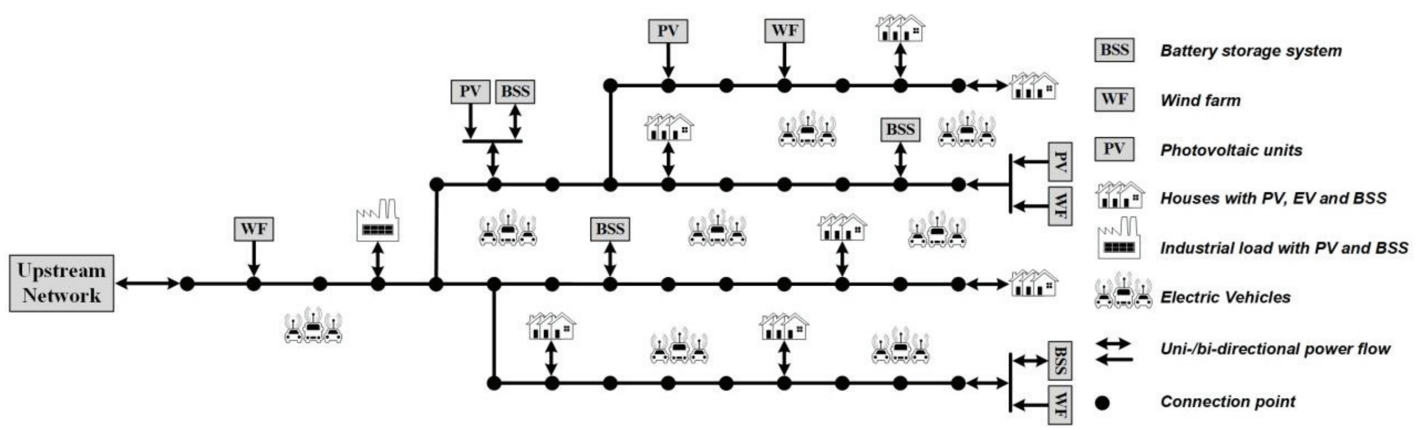

Figure 1: A smart grid with BSSs, EVs, and renewable energy generations.

Citation: Mohagheghi E, Gasso JG, Li P (2020) Optimal integration of electric vehicles in smart grids with renewables and battery storage systems under uncertainty. Trends Comput Sci Inf Technol 5(1): 048-049. DOI: https://dx.doi.org/10.17352/tcsit.000021

and safely, i.e., online optimal operation strategies for the whole system are needed [11-16]. Mathematically, it is a task to solve a real-time dynamic active-reactive optimal power flow (RT-DAR-OPF) problem with a huge number of mixed-integer decision variables [16]. The optimization problem aims at minimizing the total grid operation costs and expended life costs of BSSs, while maximizing the benefits for RE and EV owners. Therefore, developing a solution framework for RT-DAR-OPF is of utmost importance for ensuring both optimality and feasibility in the operation of smart grids with BSSs under uncertain EV and RE exchange. The most challenging issue hereby is that a large-scale dynamic stochastic mixed-integer nonlinear programming (MINLP) problem has to be solved in real-time [16]. A multi-phase multi-time-scale solution framework provides a way to solve this complicated optimization problem. As a result, the operation strategies by the online optimization will financially motivate the network operator and energy prosumers to interact optimally in the grid, while satisfying all technical constraints.

References

1. Lopes JAP, Soares FJ, Almeida PMR (2010) Integration of electric vehicles in the electric power system. Proceedings of the IEEE 99: 168-183. Link: https://bit.ly/3hKfpkN

2. Bird L, Cochran J, Wang X (2014) Wind and solar energy curtailment: experience and practices in the United States. US National Renewable Energy Laboratory, NREL/TP-6A20-60983 3. Link: https://bit.ly/2EUlZq4

3. Dolan MJ, Davidson EM, Kockar I, Ault GW, McArthur SD (2014) Reducing distributed generator curtailment through active power flow management. IEEE Transactions on Smart Grid 5: 149-157. Link: https://bit.ly/3lAJrtl

4. Gabash A, Li P (2012) Active-reactive optimal power flow in distribution networks with embedded generation and battery storage. IEEE Transactions on Power Systems 27: 2026-2035. Link: https://bit.ly/2EUrAg7

5. Mohagheghi E, Gabash A, Li P (2015) A study of uncertain wind power in active-reactive optimal power flow. Power and Energy Student Summit (PESS) 2015, January 13th-14th, Dortmund Germany. Link: https://bit.ly/3hXdcCN

6. Zheng Y, Niu S, Shang Y, Shao Z, Jian L (2019) Integrating plug-in electric vehicles into power grids: A comprehensive review on power interaction mode, scheduling methodology and mathematical foundation. Renewable and Sustainable Energy Reviews 112: 424-439. Link: https://bit.ly/2QEyxVl

7. Alramlawi M, Gabash A, Mohagheghi E, Li P (2018) Optimal operation of hybrid PV-battery system considering grid scheduled blackouts and battery lifetime. Solar Energy 161: 125-137. Link: https://bit.ly/3gGXry3

8. Alramlawi M, Mohagheghi E, Li P (2019) Predictive active-reactive optimal power dispatch in PV-battery-diesel microgrid considering reactive power and battery lifetime costs. Solar Energy 193: 529-544. Link: https://bit.ly/3b5CGLm

9. Zhang H, Li P (2011) Chance Constrained Programming for Optimal Power Flow Under Uncertainty. Power Systems, IEEE Transactions on 26: 2417-2424. Link: https://bit.ly/31I17eF

10. Mohagheghi E, Geletu A, Bremser N, Alramlawi M, Gabash A, et al. (2018) Chance Constrained Optimal Power Flow Using the Inner-Outer Approximation Approach. 2018 IEEE International Conference on Environment and Electrical Engineering and 2018 IEEE Industrial and Commercial Power Systems Europe (EEEIC/I&CPS Europe) IEEE 1-6. Link: https://bit.ly/2YN3qeU

11. Mohagheghi E, Gabash A, Li P (2016) Real-time optimal power flow under wind energy penetration-Part I: Approach. In IEEE 16th International Conference on Environment and Electrical Engineering (EEEIC). IEEE 1-6. Link: https://bit.ly/34MYvhN

12. Mohagheghi E, Gabash A, Li P (2017) A Framework for Real-Time Optimal Power Flow under Wind Energy Penetration. Energies 10: 535. Link: https://bit.ly/2YHETHM

13. Mohagheghi E, Alramlawi M, Gabash A, Li P (2018) A survey of real-time optimal power flow. Energies 11: 3142. Link: https://bit.ly/3hFSZB5

14. Mohagheghi E, Gabash A, Alramlawi M, Li P (2018) Real-time optimal power flow with reactive power dispatch of wind stations using a reconciliation algorithm. Renewable Energy 126: 509-523. Link: https://bit.ly/34DjxPT

15. Mohagheghi E (2019) Real-Time Optimization of Energy Networks with Battery Storage Systems under Uncertain Wind Power Penetration. Technische Universität Ilmenau. Link: https://bit.ly/2QyFJm4

16. Mohagheghi E, Alramlawi M, Gabash A, Blaabjerg F, Li P (2020) Real-time active-reactive optimal power flow with flexible operation of battery storage systems. Energies 13: 1697. Link: https://bit.ly/3lrak2S

Citation: Mohagheghi E, Gasso JG, Li P (2020) Optimal integration of electric vehicles in smart grids with renewables and battery storage systems under uncertainty. Trends Comput Sci Inf Technol 5(1): 048-049. DOI: https://dx.doi.org/10.17352/tcsit.000021