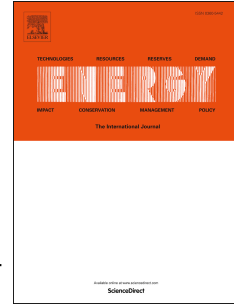


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An optimal versatile control approach for plug-in electric vehicles to integrate renewable energy sources and smart grids

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1 An optimal versatile control approach for plug-in electric 2 vehicles to integrate renewable energy sources and smart grids

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9 **Highlights:**

- 10 • Optimization problems are solved to size and site smart parking lots of electric vehicles.
- 11 • The effectiveness of the proposed algorithm is compared to other reported algorithms.
- 12 • An adaptive intelligent control strategy with V2G and G2V applicability is proposed.
- 13 • A global optimal solution is guaranteed with the proposed model.

14 **Abstract**

15 This study proposes a practical solution to deal with challenges of integrating renewable
16 energy sources and electric vehicles into the electric grid, considering generation source
17 intermittency and energy usage inconsistency, via a new adaptive intelligent controller. The
18 present research describes a smart grid consisting of power plants and distributed generation,
19 fueled via photovoltaic panels and wind turbines, and augmented with electric vehicles as power
20 storage devices. Employing a parking lot to deal with challenges such as low penetration of the
21 electric vehicles embedded with Vehicle-to-Grid functionalities encounters two difficulties:
22 where they should be installed, and modeling of bi-directional power flow between electric
23 vehicles, the grid, and the distributed generation system. In this regard, a nonlinear multi-
24 objective problem is designed and solved via employing the Non-dominated Sorting Genetic
25 Algorithm-II, and the forward and backward substitution method. In addition, Newton-Raphson
26 Power Flow is adopted and modified to calculate the power flow of the distribution network. The
27 results related to optimal placement and sizing of hybrid renewable energy systems show that
28 bus 16 of the studied grid is the best place to integrate a parking lot – equipped with 117
29 photovoltaic and 10 wind turbine units - to the tested IEEE-26 buses. Furthermore, this study
30 suggests that the aforementioned grid could employ a complex versatile control unit able to

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