Optimal Charging Algorithms for Vehicle-to-Grid

This device offers a bidirectional power flow for charging electric vehicles. An algorithm is implemented and can return an optimal charging profile to the EV when parked. The algorithms allow service bids from different companies, focus on profiles to fit resources, and more efficient energy management.

What is the Problem?

Electric vehicles offer many benefits over traditional internal combustion engine (ICE) vehicles such as lower operating costs and the potential to run on locally produced renewable energy. However, mass adoption of EVs is not without its challenges; the public charging infrastructure is in its infancy. One proposed way to aid in addressing these challenges is vehicle-to-grid (V2G), the provision of energy and ancillary services from an EV to the electricity grid. This helps to address the increasing need for large scale energy storage, as utilities explore the adoption of renewable sources of energy.

Most studies have focused on bidirectional power flow for V2G, where there are serious challenges for its adoption. In order to pump energy back into the grid, additional hardware that is not currently included in EVs is required. Also, anti-islanding protection and other interconnection issues must be addressed. Additionally, there is increased cycling wear on the battery, and consumers may also be resistant to allowing the utility to pull energy from their batteries. Coupled with economic factors of the energy market, there is a need for solutions beyond simply the installation of two-way hardware.

What is the Solution?

This innovation is an algorithm for optimal bidirectional flow between a vehicle and a power grid. These algorithms are to be implemented by an aggregator which is a participant in energy markets. The aggregator communicates between the utility system and all of the participating EVs. Based on the battery state of charge of each EV, and the time that EVs will remain parked, the algorithms return the optimal charging profile for each EV as well as ancillary services bids from the aggregator to the energy market. The optimal charging profiles are those that maximize profits to the aggregators, utility system benefits, and customer economy. These algorithms can be adjusted to include optional system load and price level constraints which may be set by utilities and customers.

What is the Competitive Advantage?

Technology ID

BDP 8670

Category

Cleantech/Energy Efficiency
Selection of Available Technologies

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Mass unregulated charging of EVs can cause energy shortages in the power grid, and similarly the strain of intermittent renewable energy sources on the power grid necessitates increased energy storage capacity. With a potential solution of V2G bidirectional power flow, energy must be pumped back into the grid, which requires unavailable hardware and customers will likely be resistant to adopt this technique. These algorithms can provide a charging profile for each EV, allowing for service bids from different companies, allowing companies to focus on profiles that fit their resources, enabling more efficient energy management.

Patent Information:

US9209623B1

References

1. Eric Sortomme, Mohamed A. El-Shrkawi(40513) , https://ieeexplore.ieee.org/document/5661888, IEEE Transactions on Smart Grid, 2