Big Savings from Vehicle-Grid Integration (VGI)

The U.S. electrical grid lacks the ability to store energy. Battery-powered electric cars could store excess energy from the grid, and return it as needed.



Grid operators can use EV batteries to smooth "peak" highs and "valley" lows in energy demand and avoid use of expensive polluting peaker plants.

\$150 million per year in avoided emissions costs for California alone and up to \$3 billion in emissions savings nationwide

> Electric car owners are paid by utilities for allowing vehicle batteries to be used as energy storage for the grid, helping keep the grid stable and meet utilities' operating reserves.

\$300-\$1000/vehicle/year

saved by consumers and 15-25% cheaper fueling costs

EV battery storage can buffer peak demand and reduce energy losses, preventing damage or excessive wear of expensive transformers and wires. Fewer transformers are needed, even as demand grows.

\$300 million to \$1.6 billion in annual grid system value

Sources used in calculations: • Acha, S. Green, T. C., Shah, N. (2010). Effects of Optimised Plug-in Hybrid Vehicle Charging Strategies on Electric Distribution Network Losses. IEEE 2010. • Caramanis, M. (2009). Management of Electric Vehicle Charging to Mitigate Renewable Generation Intermittency and Distribution Network Congestion. IEEE Conference on Decision and Control. http://www.bu.edu/pcms/caramanis/CDCpaperDeco9.pdf • Goransson, L. et al. (2010). Integration of plug-in hybrid electric vehicles in a regional wind-thermal power system. Energy Policy, 38. • Kim, E. L. et al. (2012). Carbitrage: Utility Integration of Electric Vehicles and the Smart Grid. The Electricity Journal, 25 (2). • Peterson, S. B. et al. (2010). The economics of using plug-in hybrid electric vehicle battery packs for grid storage. Journal of Power Sources, 195 (8). • PG&E (2014). Plug-in electric vehicle fueling cost calculator. http://www.pge.com/cgi-bin/ pevcalculator/PEV • Valentine, K. et al. (2011). Intelligent electric vehicle charging: rethinking the valley-fill. Journal of Power Systems with demand response and wind power. Energy Policy, 39. • Zhu et al. (2011). Modeling of the Cost of EV Battery Wear due to V2G Application in Power Systems. IEEE Transactions on Energy Conversions, 26 (4). • Eyer, J., Corey, G. (2010). Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide. Sandia Report SAND2010-0815 • Calculations: www.chargemanager.com/vgi-calcs.html







Energy from rooftop solar can be stored in EV batteries, instead of being fed into the grid. EV owners can use this "free" fuel for driving or as a supply of home energy.

Up to **\$1000/vehicle/year** saved by consumers



EV owners can schedule charging to occur when renewable energy is most plentiful. This helps the grid stay balanced, green, and safe.

Up to **\$4 billion** in annual benefits for renewable energy