Study of Vehicle-to-Grid Technology

Abhiram Kadavakollu
Student
EEE Department
Chaitanya Bharathi Institute of Technology(CBIT), Hyderabad, Telangana, India
Kabhiram16@gmail.com

Naveen Amanchi
Student
EEE Department
Chaitanya Bharathi Institute of Technology(CBIT), Hyderabad, Telangana, India
amanchinaveen200@gmail.com

Abstract:
The everlasting need of power leads to increase in demand for power sources of high energy density and stability for emergent electrical vehicles and portable electronic devices, rechargeable batteries have attracted extensive interests. Among the emerging battery technologies, With the increasing pollution level and environmental threats, the 21st century is moving towards green and sustainable like plug-in hybrid electric vehicles. They have vast scope and capabilities of energy storage. This feature of vehicles is making them to utilize for energy storage and distribute/sell it during 'peak' demand. The vehicle to grid (V2G) technology with some improvement may present a promising solution for future energy problems. The features, applications and advantages of V2G are presented here, along with the challenges to implement it. Many programs by automotive industries, power generation units and government of different countries are being performed to make V2G technology viable for future use

Keywords : *vehicle to grid; automotive and power generation units; renewable energy integration; plug-in hybrid vehicle; battery.*

INTRODUCTION

Increasing pollution level and global warming are the major areas of concern as the era head deeper into the current century. Emissions of greenhouse gases, carbon dioxide (CO2), carbon monoxide (CO), nitrogen oxides (NOx) and unburned hydrocarbons (HCs) in large amount have caused environmental pollution and global warming. A lot of these emissions are caused for the fulfilment of the basic human requirements such as electricity production, transportation, industrial and commercial purposes. 23 present of total CO2 emissions in the world are caused by the transport sector which is 87 present in India. The modern transport sector relies on the internal combustion engine based vehicles which use petroleum to propel the vehicle and emit toxic gases; ultimately causing harm to the environment and human life.

Eventually, there has been a search for a more efficient and clean vehicle. Due to the continuous decreasing level of fuel and energy resources, hybrid and plug-in hybrid electric (PHEVs) vehicles are in the spotlight for quite a while now. They are being seen as the future of transportation with combustible fuel resources depleting fast.

Most of the customer-owned vehicles stay parked more often than they are driven. This offers an opportunity to utilize their stored energy while they are idle. Since the ESS on board in an electric vehicle allow two way power flow, they can be used to take power from or supply power to a connected grid. The Vehicle-to-Grid (V2G) concept stands on this principle. It describes a system in which plug-in electric vehicles communicate with the power grid when not in use and provide power to the grid during peak power requirements and get charged from the grid during off peak hours.
The fundamental idea is to set up an exchange system between the grid and a vehicle with electrical energy storage capabilities to benefit both the parties involved .

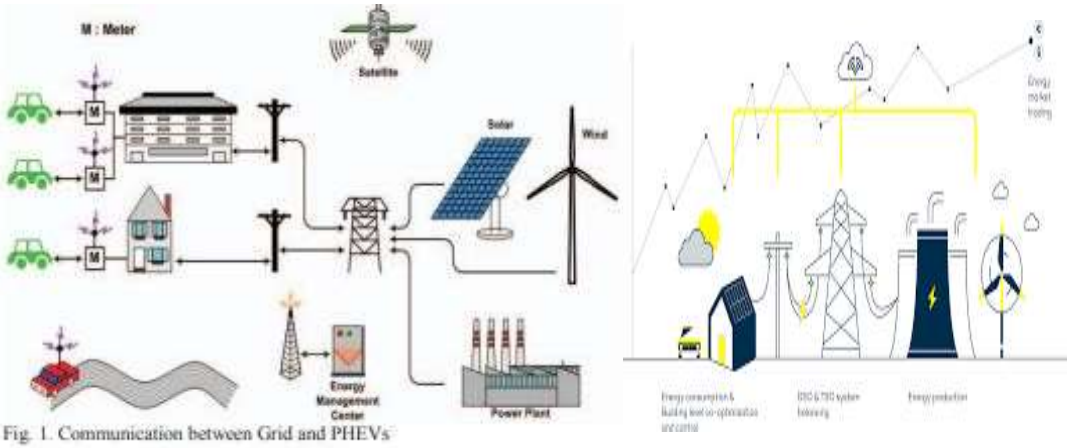


Fig. 1. Communication between Grid and PHEVs

Understanding concept of Vehicle to grid:

Vehicle to grid (V2G) technology can be defined as a system in which there is a capability to control, bi-directional flow of electric energy between a vehicle and the electrical grid. Vehicle to grid (V2G) technology can be defined as a system in which there is a capability to control, bi-directional flow of electric energy between a vehicle and the electrical grid. It has been calculated that 92% of the total vehicles remain parked even during the peak hours . When a vehicle is not being operated, the on- board battery is connected to a nearby electrical grid via appropriate communication devices. The idea is to use the power from the idle vehicles to provide load-shedding and peak shaving and many other functions. The vehicle batteries can be fully charged during low-demand hours and the flow can be reversed at any time according to the requirements. This can be fulfilled by utilizing the concept of 'smart grid' which is an electricity network capable of processing the information, manages the electricity flow to fulfil the end users varying power demand and is able to provide communication between generation sources and end users. This concept works on the balance the 'off-peak' and 'peak' demand. The Vehicle can get charged during off-peak hours and can sell it back to the grid during peak hours.

METHODOLOGY

Electrical benefits in V2G:

The stored battery energy can be used to provide power to help balance loads by charging at the night when the demand is low (valley filling) and providing power to the grid when the demand is high (peak shaving). Peak shaving also provides additional advantages such as reduction of a variety of unwanted factors like line losses, delay transmission, transmission congestion, etc. It also helps in reducing the stressed operation of a power system, thus adding to its longevity in terms of lasting. This leads to avoid heavy investments in installing peaking power plants. Power regulation authorities have a good ability of predicting the peak loads (mostly during summers due to the load of the ACs). Using the hybrid vehicles as a distributed storage acts as a robust alternative to expensive and capital demanding 'peaking plant' generators. Generally power-seeking bodies purchase electrical energy through long term contracts with generation companies or from spot electricity markets in the short run. Peak load periods, see the highest electricity prices. Peak shaving applications of PHEV fleet, reduces the cost of electricity during peak periods. The money saved in the case can be used to further propel the utilities of PHEVs investing in research facilities and expanding their horizon. The average benefits from the V2G participation of an EV is estimated to range from $392 to $561 annually per vehicle . Thus PHEVs offer the power system with a flexible, controllable load and could provide load levelling during off peak periods.

Integration of renewable energy source with V2G:

One of the major problems associated with harnessing renewable energy resources is its storage. Energy storage has long been a subject of research within the electric community as it would take advantage of low cost periods of generation. Added storage would become a resource for the voltage regulation needs discussed previously. The remote and challenging locations also act as barriers to the procurement of energy. Solar energy peaks around 1 pm, whereas wind energy peaks overnight around 4.30 am . The standard model for the peak electricity demand predicts highest demand between 4 and 8 p.m. The peak, is thus shifted from the optimal hours of the solar/wind generation capacities leading to major problems in integrating renewable energy resources. Wind curtailment also remains a big issue in harnessing wind energy. Sometimes the energy generation overloads the grid and some turbines are then shut down or temporarily impaired. The most important role for V2G may ultimately be in emerging power markets to support renewable energy.

Building Spinning Reserves:

Spinning reserves are known as the extra generating capacity that is made available by switching on additional generators already connected to the grid. This additional power supply is made available within a short time from the time of request. However, the capital costs of these reserves are higher. V2G integration solves this issue by meeting sudden demands for power. Connecting vehicles to the grid can go a long way in eliminating the need of maintaining spinning reserves. At any factory or workstation, where there are possibilities of sudden requirements of peak power, the vehicles which could be of the employees would remain connected to the grid and can be called upon to provide the additional power supplies. This creates a win-win situation for both the workplace and the employees. The employees can get their vehicles charged back during non-peak times and can also be paid a particular amount for the usage of the vehicle . Thus, V2G can indeed provide a solution to reduce the need of spinning reserves.

Developing Backup Systems:

The energy from the vehicle can be used for personal emergency power requirements of the owner as well. When there is an outage of power, the vehicle can be connected to the uninterruptible power supply unit of the house and most appliances with not very high ratings

of power can be run. The Toyota Prius can produce at least three kilowatts of continuous power, which is adequate to maintain a home's basic function. Thus a home's basic functions can be quite easily met with a Plug
In hybrid vehicle(PHEV)

CONCLUSION:

The applications of V2G are vast and provides a wide array of possibilities for reliable power generation and storage. V2G also promises a more sustained approach where the environment is also a major concern. However, it still faces a lot of criticism. The major reasons for this criticism are high initial cost, lack of government subsidy, resistance to change, be the people and manufacturers. The view of most people can be considered as narrow and negligent as they are only looking at the initial situation, they are ignoring the future prospects of V2G. The recent projects in the V2G implementation have shown promising results and encouraged further research in the field. As and when more durable batteries and cost efficient grid lines become common, V2G will become a widespread phenomenon. Until then the views of people and manufacturers must be monitored. Lastly, a widespread propagation of the V2G idea, its prospects and opportunities by the governments of developing and developed countries will make the path of V2G implementation much easier. And definitely, smart grid technologies have the latency to meet up the future power demand, which will support V2G.

REFERENCES:

Journal Articles

[1] United stataes environmental protection Agency, "Sources of greenhouse gas emissions", (as accessed on 9/10/2014).
[2] A. Panday and H. O. Bansal, "Green Transportation: Need, Technology and Challenges", Int. J. Global Energy Issues, Inderscience publishers, Vol. 37, No. 5/6, pp. 304-318.
[3] A. Briones, J. Francfort, P. Heitmann, M. Shey, S. Shey and J. Smart,"Vehicle-to-grid (V2G) power flow regulations and building codes review by the AVTA", INL/EXT-12-26853, September 2012.
[4] A. Ashouri, M. J. Benz and L. Guzzella, "Comparing control strategies for EV and PHEV fleets providing regulation ancillary services", 2012 IEEE Int.Conf.Control Applications,Dubrovnik, Croatia, October 3-5,2012, pp. 739 - 744.
[5] R. Sioshansi and P. Denholm, "The value of plug-in hybrid electric vehicles as grid resources", Energy Journal , vol. 31, no. 3, paper no.01/2010.
[6] A. B. Rolufs, "Kansas City Plug-In Electric Vehicle Demonstration Project", Missouri Transportation Institute, Missouri university of science and engineering.
[7] W. Kempton, J. Tomic, S. Letendre, A. Brooks and T. Lipman, "Vehicleto-grid power: battery, hybrid, and fuel cell vehicles as resources for distributed electric power in California", UCD-ITS-RR-01-03, June 2001.
[8] T. Morgan, "Smart grids and electric vehicles: Made for each other?",Summit Int.Transport Forum, on Seamless Transport: Making Connections, Leipzig, Germany, 2-4 may 2012, discussion paper no.2012-02, OECD.
[9]M. Ehsani, M. Falahi and S. Lotfifard, "Vehicle to Grid Services: Potential and Applications." Energies, vol. 5, no. 10: 4076-4090, 2012.

[10] M. E. Chehaly,O. Saadeh, C. Martinez and G. Joos, “Advantages and applications of vehicle to grid mode of operation in plug-in hybrid electric vehicles”, IEEE Electrical Power & Energy Conf., Montreal, QC, 22-23 Oct. 2009, pp. 1 - 6.
[11]W. Kempton and V. Udo, Ken Huber, K. Komara, S. Letendre, S. Baker,D. Brunner and N. Pearre, “A test of vehicle-to-grid (v2g) for energystorage and frequency regulation in the PJM system”, nov. 2008.