Demand Side Management by using Electric Vehicles as Distributed Energy Resources

Chengzong Pang
Dept. of Electrical and Computer Engineering
Texas A&M University
College Station, USA
pangchz@neo.tamu.edu

Mladen Kezunovic
Dept. of Electrical and Computer Engineering
Texas A&M University
College Station, USA
kezunov@ece.tamu.edu

Mehrdad Ehsani
Dept. of Electrical and Computer Engineering
Texas A&M University
College Station, USA
ehsani@ece.tamu.edu

Abstract— **This paper aims at demonstrating the potential benefits of using electrical vehicles (EVs) as Distributed Energy Resources (DERs) in smart distribution system. It discusses the options of grid-to-vehicle (G2V) and vehicle-to-building (V2B) operating modes that might be used to support the power grid through demand side management (DSM) program. The V2B mode is particularly promising since it provides an option to use the energy stored in a battery in Electric Vehicles (EVs) to support the local load in the power grid during severe system loading and outages, hence alleviating the demand on the grid and its reliability requirements. The implementation and benefits of using EVs as DERs for demand-side management are discussed and demonstrated with test cases and numerical results.**

Keywords- ***Electric vehilcle, Plug-in hybrid electric vehicle, Battery electric vehicle, Distributed energy resources, Demand side management, Smart grid, Vehicle-to-building***

I. INTRODUCTION

With the development of flexible electricity markets operation under the deregulation rules and numerous distributed energy resources (DERs) connected to the electric power grid, power system became more stressed and power network security and reliability criteria became more complex. As a consequence, Smart Grid deployment has been aggressively pursued with sponsorship and involvement from government, businesses, utilities, and other stakeholders. The additional knowledge combined with advanced information technology to enhance the capability of the power grid will make the grid more secure and reliable [1]. Demand side management (DSM) is an example of various programs that utilities in North America are adopting trying to meet the emerging requirements of the smart grid.

The interest in electric vehicles (EVs), such as plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs), has increased due to their energy storage capability, low-cost smart charging, and reduced petroleum usage. Connected to the grid using a plug, EVs can charge the battery using electricity from an electric power grid, also referred to as "Grid-to-Vehicle" (G2V) operation, or discharge it to a building during the parking hours or outage, also referred to as "Vehicle-to-Grid" (V2G) operation.

Many researchers have investigated the various potential benefits and implementation issues of vehicle-to-grid (V2G) [3-11] concept. Kempton and Tomić studied the fundamentals of using PHEVs for load leveling, regulation, reserve, and other purposes [3]. They also discussed three vehicle types that can produce V2G power and the net revenue when selling V2G power to power markets [4]. Hadley and Tsvetkova analyzed the potential impacts of PHEVs/BEVs on electricity demand, supply, generation, structure, prices, and associated emission levels in 2020 and 2030 in 13 regions specified by the North American Electric Reliability Corporation (NERC) [5]. Meliopoulos, et al. considered the impacts of EVs on electric power network components [6]. Farmer, et al. describes the PHEV distribution circuit model to estimate the impact of an increasing number of EVs on transformers and underground cables within a medium voltage distribution system [7]. Han, et al. proposed the optimal V2G aggregator for frequency regulation by applying the dynamic programming algorithm to compute the optimal charging control for each vehicle [8]. Shimizu, et al. [9] and Ota, et al. [10] also discussed power system frequency control by using V2G system. Anderson, et al. performed the case studies of Plug-in hybrid electric vehicles if used by regulating power providers in Sweden and Germany [11]. Authors of this paper investigated impacts of EVs on outage management, demand side management and asset management in both G2V and V2B mode of operation [12].

This paper focuses on potential benefits of using EVs to participate in demand side management as distributed energy resources in smart distribution grid. The two modes, G2V and V2B, of utilizing EVs for demand side management control are discussed first. The implementation aspect and a case study are shown next respectively. Conclusions and references are given at the end.

II. DEMAND SIDE MANAGEMENT BY USING EVS

A. *Demand Side Managemetn (DSM)*

For electric utility, Demand Side Management is defined as “the planning, implementation, and monitoring of distribution network utility activities designed to influence customer use of electricity in ways that will produce desired changes in the load shape”, which includes peak clipping, valley filling, load shifting, strategic conservation, strategic load growth, and flexible load shape [13]. There are two components included in Demand Side Management: Energy Efficiency (EE) and Demand Response (DR). EE is designed to reduce electricity consumption during all hours of the year; DR is designed to change on-site demand for energy in intervals and associated timing of electric demand by transmitting changes in prices, load control signals or other incentives to end-users to reflect existing production and delivery costs [14]. The utility and customer cooperatively participating in DSM will provide the benefits to the customer, utility, and society as a whole, which is summarized in Table I [15]. It was implemented by changing on-site demand for energy in intervals and associated timing of electric demand by transmitting changes in prices, load control signals or other incentives to end-users to reflect existing production and delivery costs.

TABLE I
DSM BENEFITS TO CUSTOMER, UTILITY AND SOCIETY [15]

Customer benefits	***Societal benefits***	***Utility benefits***
Satisfy electricity demands	Reduce environmental degradation	Lower cost of service
Reduce / stabilize costs	Conserve resources	Improved operating efficiency,
Improve value of service	Protect global environment	Flexibility of operation
Maintain/improve lifestyle and	Maximize customer welfare	Reduce capital needs

B. *Distributed Energy Resources (DERs)*

Distributed energy resources are parallel and stand-alone electric generation units located within the electric distribution system at or near the end user. DER can be beneficial to both electricity consumers and if the integration is properly engineered the electric utility [16]. The centralized electric power plants will remain the major source of electric power supply for the future. DER, however, can complement central power generation by providing incremental capacity to the utility grid or to an end user. Installing DER at or near the end user can also in some cases benefit the electric utility by avoiding or reducing the cost of transmission and distribution system upgrades. Figure 1 shows the basic applications and technologies for DER [16].

As one important technology used in configuring DER, energy storage technologies can deliver stored electricity to the electric grid or an end-user, which could be used to improve power quality by correcting voltage sags, flicker, and surges, or correct for frequency imbalances. For EVs, most of the time vehicles sit idle parked at homes, streets, parking lots, or garages. Hence EVs battery capacity can be fully utilized during such times. Therefore, EVs could serve as DER meeting energy storage property in the smart grid. On the other hand, EVs, when aggregated in sizeable numbers and capable to operate in the V2B mode, may be an attractive integral part of DER as generator.

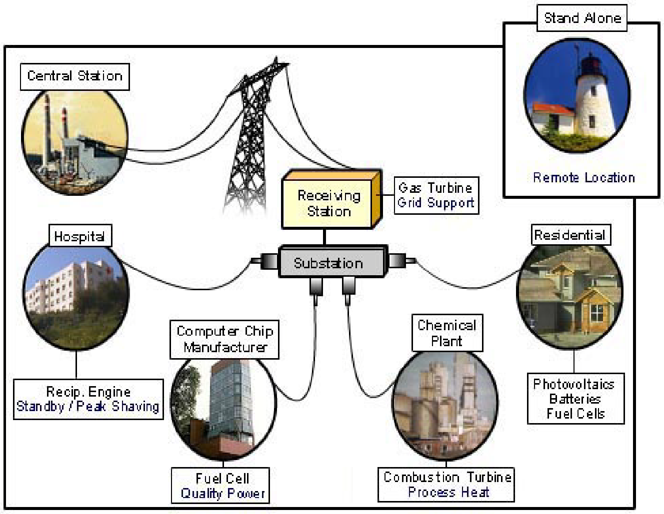

Fig. 1. Applications and technologies for DER [15].

C. *EVs Marketplace Penetration*

The penetration rate of EVs has a drastic impact on the smart grid, which is expected to continuously increase after their wide spread market introduction is made in 2011 and beyond. Multiple studies use either statistical or predictive models to determine the penetration of EVs. Hadley and Tsvetkova [5] estimate that by 2030 the market share of EVs could reach 25%. Sullivan, Salmeen, and Simon have researched the EV marketplace penetration by the agent based simulation and estimated that the market share in optimistic scenarios could reach around 20 % by 2040 [17]. N.Y. ISO published a technique report for the potential impacts of EVs on New York State’s electricity system. They assumed 25% of the fleet is PHEV by 2030 [18]. All these projections are showing that significant amount of EVs penetration is expected to occur after 20-30 years from now.

D. *Framework of using EVs for DSM*

Demand side management based on eclectic vehicles considers batteries in EVs as either generation resources or regular load for the buildings via bidirectional power transfer through energy exchange stations, such as smart garages, at certain periods of time. It could increase the flexibility of the electrical distribution system operation. Demand side management operation in customer side will improve the reliability of the distribution system, provide extra economic benefits to the vehicle owners, and reduce the home or building electricity purchase cost. Especially, when renewable energy resources, such as wind or solar, are integrated in smart grid, the batteries in EVs can function as energy storage system to reduce the influence of weather conditions. Figure 2 shows the implementation framework of using EVs as DERs for participating utility DSM program.

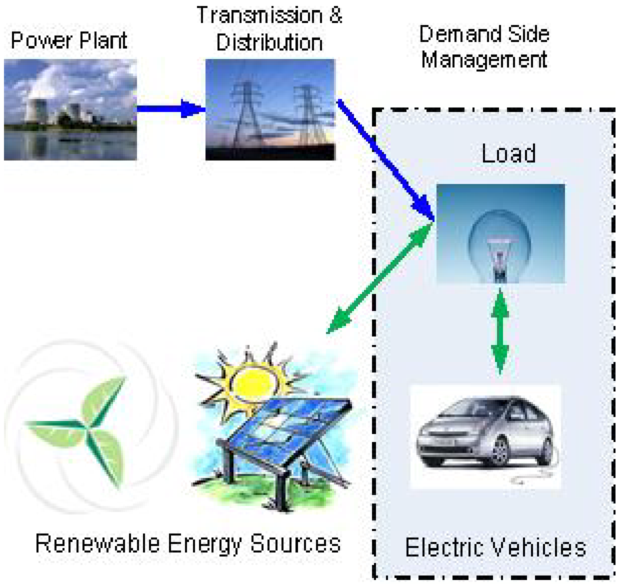

Fig. 2. Framework of using EVs for DSM.

Large business entities such as universities, shopping center, industrial parks, hospital complexes, commercial and public parking garages in a central business district (CBD) provide thousands of parking spaces for commuters and visitors. After penetrating the conventional vehicle market, owners of electric vehicles will be occupying these parking lots or parking garages, which may provide the base for an aggregated service to act as an electric power source or storage. For example, smart garage represents an interface between the transportation network and electric power systems [19]. It may provide a charging service for EV drivers, which becomes a G2V operation, and/or an energy support service for nearby buildings through the electricity power network, which may become V2B operation. For these operations, smart garage operator will communicate with independent system operator (ISO) to obtain electricity trade prices or to notify about the amount of available electricity power.

The control and communication capabilities between electric vehicles and power grid are essential to enable advanced interactions but may also be important for mitigating the impacts of very large numbers of EV charging from the grid. As increasing numbers of EVs are sold, local grid to vehicle communications broadcasting will be useful for emissions and price signaling. Two-way communications that transmit the present and desired state-of-charge (SOC), power flow, and other parameters will be useful in enabling our demand side management approach. Individual communication interface modules that support the many potential standards such as ZigBeeTM, 802.11 WiFITM, WiMaxTM, cell phone, or PLC which could be selected based on regional needs, terrain, cost, or utility preferences [12].

III. DEMAND SIDE MANAGEMENT IMPLEMETATION

A. Vehicle Assumptions

In this paper, two popular electric vehicles are selected for demonstration of V2B potential: Chevy Volt as the Plug-in Electric Vehicle (PEV) model, and Nissan Leaf as BEV model. Table II summarizes the fundamental specifications of two vehicles.

TABLE II
ELECTRIC VEHICLES BATTERY SPECIFICATIONS

Auto Model	*Weight (lb)*	*Battery Type*	*Capacity (minimum)*	*Aerodynamic Drag Coefficient*	*Charging Time*
Chevy Volt	3,781	Lithium Ion	16 kWh	0.29	6-6.5 hours (240V)
Nissan Leaf	1,521	Lithium Ion	24 kWh	0.28	7 hours (240V)

B. Charging Station Infrastructure

National Electrical Code (NEC) Article 625 [20] and the Society for Automotive Engineers (SAE) J1772 [21] provide the requirements for installation, including functional and safety requirements of electric vehicle charging infrastructure. SAE J1772 defines the electrical rating of charging methods for conductive charger coupler. Based on the available charging infrastructures, electric vehicles may be commonly charged by either AC Level 1 or AC Level 2 charging method.

Table III shows the detailed information about the different charging methods specified in North American [20, 21]. The Level 1 method uses a standard 120-VAC, 15-Amp (12 Amp useable) or 20-Amp (16 Amp useable) branch circuit that is the lowest common voltage level found in both residential and commercial buildings in the United States. Level 1 charging only provides a small amount of power (maximum of up to 1.44 kW), and results in prolonged charging time. The Level 2 method uses a 208 to 240-VAC, single-phase, up to 80-Amp branch circuit. Since the typical charging time for a 10 kWh battery pack will be 1 to 2 hours, it is the primary and preferred method for the battery electric vehicle charger for both private and public facilities. The faster charging methods are still under development. No standard for the faster charging or connector exists today. Table III shows two typical cases used for faster charging.

TABLE III
ELECTRICAL RATINGS OF DIFFERENT CHARGING METHODS IN NORTH AMERICA

Charging Method	***Nominal Supply Voltage***	***Maximum Current***	***Typical Charge Time***
AC Level 1	120 V, 1-phase	12 A or 16 A	5-8 hours
AC Level 2	208 to 240 V, 1-phase	Up to 80 A	1-2 hours
AC Level 3	208 to 600 V, 3-phase	400 A	10-15 mins.
DC Charging	Up to 600 V	400 A	10-15 mins.

For smart garage with charging and discharging abilities, Level 1 and 2 will be ideal choices, since level 3 charging station will increase the power flow capacity requirement dramatically.

C. G2V Option

Without availability of significant and reliable storage of energy, maintaining grid stability and reliability under the growing electricity demand is a complex problem. Thus energy storage system is one of the major applications in support of DERs. Utilities typically use batteries to provide an uninterruptible supply of electricity to power substation switchgear and to maintain backup power systems. However, there is an interest that goes beyond these applications by performing load leveling and peak shaving with battery systems that can store and dispatch power over a period of many hours.

G2V provides the option to utilize EV's usefulness as an energy storage system. The G2V option can be used to charge electric vehicles at reduced cost when the power system load is reduced and generation capacity is abundant, such as during night time. The development of smart charging makes it feasible to implement the optimal charging to level or shift load profile curve as needed.

D. V2B Option

From the discussion above, recent research on the feasibility of V2G is based on the assumption of large-scale penetration of EVs, which is envisioned on a 15-30 year time horizon in the most optimistic scenarios. As a more near-term application of V2G, Vehicle-to-building (V2B) operation is defined as the option of exporting electrical power from a vehicle battery into a building connected to the distribution system to support loads.

Due to early adopters, the availability of electrical vehicles in major cities may create a critical mass of vehicles for aggregated use to be available 5-10 years from now. With the introduction of smart garage, which represents an interface between the transportation network and electric power system, the vehicle charging/discharging infrastructure and control system can be available widely making the proposed V2B idea viable and economically attractive.

V2B provides a good solution to implement demand side management in smart distribution system by considering those EVs as DERs [22]. In the V2B operation, the owners will plug in their vehicles during the day at their final destination for a given time frame. As an example, this may be either at their workplace (central business district) or at the place of their study (university). The destinations are assumed to be equipped with a bi-directional charger and controller. The parking facility should allow either charge or discharge mode for the car batteries when necessary. The idea for DSM is that the parking facility can offer an aggregation service for charging the batteries when the demand of a building is lower than its peak load and discharge the batteries in V2B mode to partially supply the building with electricity to reduce the peak demand during a high demand.

E. V2B based DSM Benefits

Power system utilities in North America offer a variety of load control and demand side load management programs to their clients. These programs can provide enhanced power system security and many benefits to their participants. For example, Southern California Edison (SCE) has introduced a number of demand response programs, such as Demand Bidding Program (DBP) and Critical Peak Pricing (CPP)[23].

Considering the electricity rate is lower when the vehicle batteries were charged than when the batteries are discharged, the battery storage may be used to offset high cost during the peak demand. The formulas for calculating revenue depend on the program that the V2B power resource is participated in. In this paper, a typical business customer is considered as demonstration scenario. There are three basic charges for business rate schedule are considered as an example: customer charge, energy charge, and demand charge. Consequently, the monthly total revenue r for BEVs/PHEVs based V2B operation is calculated as:

$$\begin{aligned} r = E_{ec}(r_{rc\_onpeak} - r_{rc\_midpeak}) \times t \\ + r_{tdc}(P_{\max} - P_{dsm\_\max}) \end{aligned} \tag{1}$$

where

E_{ec} : the energy shifted from On-peak time to Midpeak time (kWh);

r_{rc_onpeak} : the On-peak time energy charge rate ($/kWh);

$r_{rc\_midpeak}$: the Mid-peak time energy charge rate ($/kWh);

t : number of days in a month

r_{tdc} : the time-related demand charge ($/kW);

$P_{\max}$: the maximum On-peak power demand (kW);

$P_{dsm\_\max}$: the maximum On-peak power demand after demand-side management (kW).

In practical application, for the given electric vehicle, the actual maximum power from V2B is calculated as:

$$P_{vehicle} = P_{ideal} \times \eta_{\text{charger}} \times \eta_{inv} \times \eta_{other} \tag{2}$$

where

$P_{vehicle}$: the actual maximum power for V2B (kW);

P_{ideal} : the ideal maximum power from V2B, usually it is the maximum power of charging station (kW);

η_{charger} : the efficiency of charger;

η_{inv} : the electrical conversion efficiency of the DC to AC inverter;

η_{other} : other factors, such as power loss, battery self-discharge, etc.

The detail of this V2B based demand side management benefit model could be found in reference [24]. The actual revenue will be reduced with considering the charging efficiency, the conversion efficiency, power loss, battery self-discharge, etc. Assume the efficiency of charger

$\eta_{\text{charger}} = 0.9$, the conversion efficiency $\eta_{inv} = 0.93$, and $\eta_{other} = 0.9$.

IV. CASE STUDY

A. Scenario Selection and Purpose

To illustrate the role of EVs in demand side management options, one has to illustrate how EVs battery charge changes as they change their location. This leads to a need to study both temporal and special characteristics of this mobile battery load/resource as it moves in time and as a consequence changes its SoC capabilities. To make this study more useful, very specific scenarios resulting from the drive cycles in a given community (small college town) are examined. The SoC properties are then used to estimate the availability of the mobile battery to serve as either a load or resource as needed to provide benefits for the demand side management program.

B. Drive Cycles

In this paper, a university campus electricity needs are used for the case study. Under two drivers' categories, six different drive cycle scenarios are defined by considering various temporal and spatial properties:

For university faculty and staff drive cycles:

- Drive cycle #1: Home – university parking lot (9.0 mile one way);
- Drive cycle #2: University parking lot – supermarket - home (9.2 mile one way);
- Drive cycle #3: Home - university parking lot (22.5 mile one way).

For university fleet drive cycles:

- Drive cycle #4: Fleet drive cycle 1 (10 miles per day, charge overnight).
- Drive cycle #5: Fleet drive cycle 2 (20 miles per day, charge overnight).
- Drive cycle #6: Fleet drive cycle 3 (80 miles per day; charge overnight; 0-30 mile drove in electricity; 40-80 mile drove in gasoline).

The scenarios include individual vehicles and fleet; the distance for the drive cycles cover 9 miles for regular employee to 80 miles for business trip for fleet worker. Figure 3 shows an example of the drive cycle #2.

C. Battery State-of-charge Simulation

The state-of-charge (SOC) for each battery during the drive cycle was simulated. The simulation result could identify the remaining energy and the potential charging demand for each battery in any point of interest from both temporal and spatial views. In our case study, two electric vehicles are selected for demonstration of V2B potential: Chevy Volt as the Plug-in Electric Vehicle (PEV) model, and Nissan Leaf as BEV model. These two electric vehicle models are applied in the SOC simulation. Leaf is not applicable for drive cycle #6 due to its battery capacity.

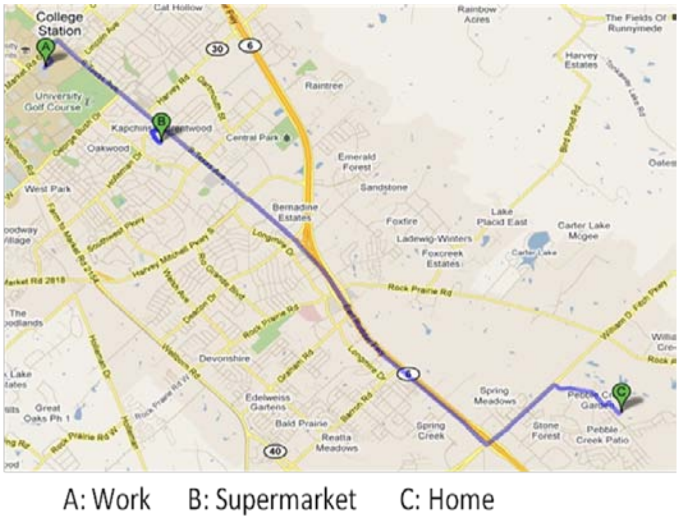

Fig. 3. Example of studied drive cycle

Figure 4 shows an example of the SOC simulation for Chevy Volt with drive cycle #1. SOC simulation for Nissan Leaf with drive cycle #2 is shown in Figure 5. The detailed method on how to simulate the EV SOC can be found in reference [25].

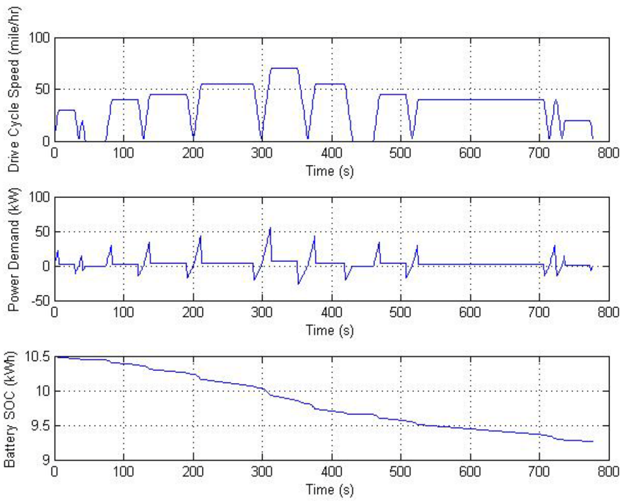

Fig. 4. Case study for SOC simulation of Chevy Volt.

D. Case Study

With the SOC simulation results for the six drive cycle scenarios, the aggregator will know the capacity of each EV in either G2V option (charging) or V2B option (discharging). The strategy for optimal participation in utility DSM could be obtained by considering the SOC simulation results and the requirements for DSM applications. For peak load shaving, the aggregator will use the remaining energy based on the SOC simulation results to provide V2B services. For load shifting, when EVs are on site, the aggregator can charge the batteries during the morning hours (lower electricity price) and drain the batteries during afternoon hours (higher electricity price).

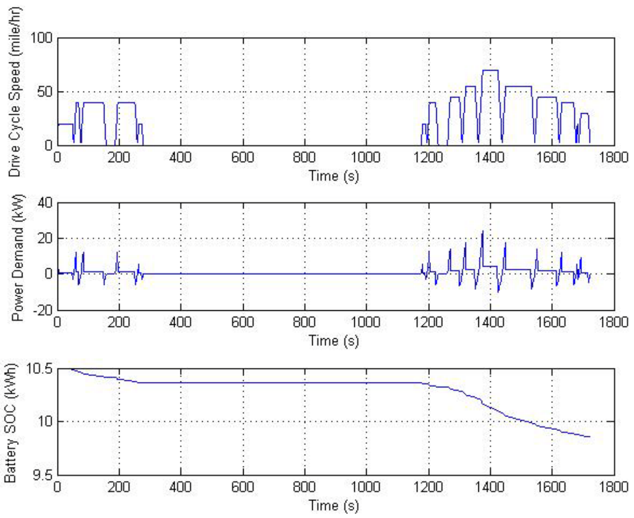

Fig. 5. Case study for SOC simulation of Nissan Leaf.

With no doubt, the necessary amount of battery energy has to be assured to let the owner of EV have sufficient SOC in their battery storage to meet the driving cycle to return home. This lower boundary is set as 4.0 kWh for generally considering the charging/discharging SOC patterns, or each individual can set their own lower boundary based on his drive profile. With the available AC Level 2 charging stations, EVs batteries can be charged to full capacity in less than 1 hour. Faster charging stations (AC Level 3 or DC charging) can finish the charging process in 30 minutes.

For most utilities, peak demand is based on geographic location and season. Some utilities are winter peaking with highest loads generated by electric space heat and water heating in the evening hours. Some utilities are summer peaking with highest loads generated by air conditioning. Thus, demand side management using V2B is very different for different utilities based on the various scenarios. But by these EVs as DERs and applying peak load shaving and load shifting, the utility and customer cooperatively participating in DSM will provide the benefits to the customer, utility, and society as a whole.

Figure 6 shows the case study result of one demand side management application – load shifting, by using EVs based V2B operation mode. The load curve was changed by shifting the afternoon peak load to the morning off-peak load when charging and discharging the EVs. The electric vehicle discharging covers a larger area than the charging. The extra energy is coming from night time charging at home with reduced cost.

Figure 7 shows the case study result of another demand side management application – peak load shaving, by using EVs based V2B operation mode. By discharging EVs batteries, the peak load in the load curve was decreased to lower level. Since each battery will be only charged and discharged once as its regular routine, the charging cycles for these batteries do not increase, which indicates the battery capital cost in implementing V2B based demand side management is low.

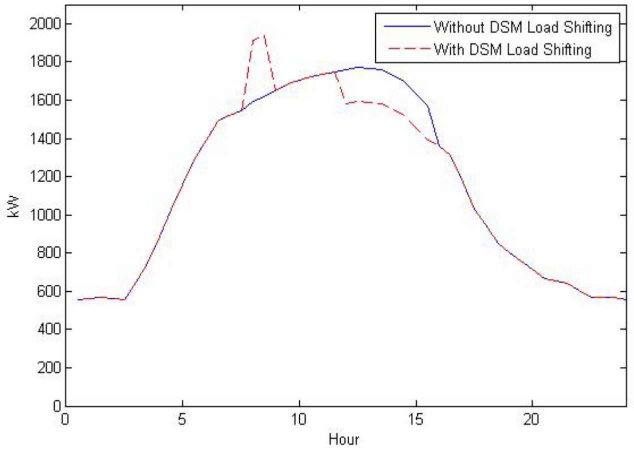

Fig. 6. Case study of load shifting.

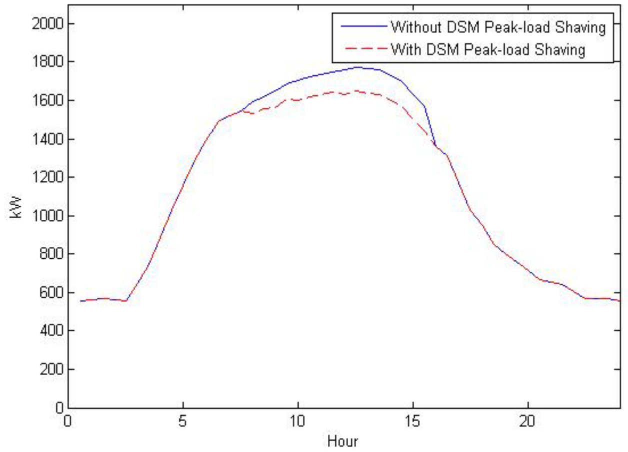

Fig. 7. Case study of peak load shaving.

V. CONCLUSIONS

This paper discusses the potential benefits of using EVs as DER that can serve as controllable load or generation in a power system as needed. It is concluded that EVs could play a major role in the distribution system DSM program by serving in G2V as well as V2B mode if aggregated. Based on the discussions presented in this paper, the following conclusions can be drawn:

- The use of EVs battery as DER provides opportunities for the charging/discharging operating modes leading to the control flexibility necessary for DSM operation;

- The load shifting and peak load shaving strategy using controlled EV charging/discharging can reduce on-peak load demand and energy consumption, which will reduce the electricity purchase cost for the customer and vehicle owner;
- Case studies of SoC calculation demonstrate the feasibility of the proposed demand side management concept, which suggest that with enough available EVs, the aggregated batteries could be used to support the electricity demand of a typical building and create revenue.

REFERENCES

[1] DOE, “Smart Grid System Report,” U.S. Department of Energy, July 2009. [Online]. Available: http://www.oe.energy.gov/DocumentsandMedia/SGSRMain_090707_lowres.pdf

[2] J. Axsen and K. S. Kurani, "The early US market for PHEVs: Anticipating consumer awareness, recharge potential, design priorities and energy impacts," Institute of Transportation Studies, University of California, Davis, 2008.

[3] W. Kempton and J. Tomić, "Vehicle-to-grid Implementation: from stabilizing the grid to supporting large-scale renewable energy". Journal of Power Source, Vol. 144, no. 1, pp. 280-294, 2005.

[4] W. Kempton and J. Tomić, “Vehicle-to-grid power fundamentals: Calculating capacity and net revenue,” Journal of Power Source, vol. 144, no. 1, pp. 268-279, 2005.

[5] S. W. Hadley and A. Tsvetkova, "Potential impacts of plug-in hybrid electric vehicles on regional power generation," Oak Ridge National Laboratory, Oak Ridge, TN, ORNL/TM-2007/150, Jan. 2008.

[6] S. Meliopoulos, J. Meisel, G. Cokkinides, and T. Overbye, “Power System Level Impacts of Plug-In Hybrid Vehicles”, PSerc Project T34 Final Report #09-12, Oct. 2009. [Online]. Available: http://www.pserc.wisc.edu/documents/publications/reports/2009_reports

[7] C. Farmer, P. Hines, J. Dowds, and S. Blumsack, "Modeling the Impact of Increasing PHEV Loads on the Distribution Infrastructure," in System Sciences (HICSS), 2010 43rd Hawaii International Conference on, 2010, pp. 1-10.

[8] S. Han, S. Han, K. Sezaki, "Development of an Optimal Vehicle-to-Grid Aggregator for Frequency Regulation," Smart Grid, IEEE Transactions on, vol. 1, pp. 65-72, 2010.

[9] K. Shimizu, et al., "Load Frequency Control in power system using Vehicle-to-Grid system considering the customer convenience of Electric Vehicles," in Power System Technology (POWERCON), 2010 International Conference on, 2010, pp. 1-8.

[10] Y. Ota, et al., "Effect of autonomous distributed vehicle-to-grid (V2G) on power system frequency control," in Industrial and Information Systems (ICIIS), 2010 International Conference on, 2010, pp. 481-485.

[11] S. L. Andersson, A.K. Elofsson, M.D. Galus, L. Goransson, S. Karlsson, F. Johnsson, G. Andersson, “Plug-in hybrid electric vehicles as regulating power providers: Case studies of Sweden and Germany,” Energy Policy, vol. 38, no. 6, pp. 2751-2762, June 2010.

[12] M. Kezunovic, R. Baldick, and I. Damnjanovic, “PHEVs as Dynamically Configurable Dispersed Energy Storage”, PSerc Project T40 Final Report #11-03, Aug. 2011. [Online]. Available: http://www.pserc.wisc.edu/research/public_reports/td.aspx

[13] C. W. Gellings, “The concept of demand-side management for electric utilities,” Proceedings of the IEEE, vol. 73, no. 10, pp. 1468-1470, 1985.

[14] NERC, "Data Collection for Demand-Side Management for quantifying its influence on reliability: Results and Recommendations," North American electric Reliability Corporation, Princeton, NJ, Dec. 2007. [Online]. Available: http://www.nerc.com/docs/pc/drdtf/NERC_DSMTF_Report_040308.pdf

[15] IIEC, “Demand side management best practices guidebook or pacific island power utilites,” International Institute for Energy Conservation, July 2006. [Online]. Available: www.sidsnet.org/docshare/other/20070110DSMBestpractices.pdf

[16] The California Energy Commission, “California distributed energy reseource guide,” [Online]. Available: http://www.energy.ca.gov/distgen/background/background.html

[17] J. L. Sullivan, I. T. Salmeen, and C.P.Simon, “PHEV marketplace penetration: An agent based simulation,” University of Michigan, Ann Arbor, Transportation Research Institute. UMTRI-2009-32, July 2009.

[18] N. Y. ISO, "Alternate route: Electrifying the transportation sector," New York ISO, NY, Tech. Report, June 2009. [online] Available: http://www.nyiso.com/public/webdocs/newsroom/press_releases/2009/Alternate_Route_NYISO_PHEV_Paper_062909.pdf

[19] S. Kim and I. Damnjanovic, “Smart Garage Projects: Optimizing for Vehicle-to-Grid Operations”, presented at the Transportation Research Board 89th Annual Meeting, Washington DC, Jan. 10-14th, 2010.

[20] Mark W. Earley, Jeffrey S. Sargent, Joseph V. Sheehan, and E. William Buss, “National Electrical Code (NEC) Handbook, 2008 Edition,” Quincy, MA : National Fire Protection Association, 2008.

[21] SAE Recommended Practice for Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charger Coupler, SAE Standard J1772, Jan. 2010.

[22] C. Pang, P. Dutta, S. Kim, M. Kezunovic,I. Damnjanovic "PHEVs as Dynamically Configurable Dispersed Energy Storage for V2B Uses in the Smart Grid ," MedPower 2010, Cyprus, November, 2010.

[23] Southern California Edison. [Online]. Available: http://www.sce.com/business/rates/business-rates.htm

[24] C. Pang, P. Dutta, M. Kezunovic, “BEVs/PHEVs as Dispersed Energy Storage for V2B Uses in the Smart Grid,” IEEE Transactions on Smart Grid, Special Issue on Transportation Electrification and Vehicle-to-Grid Applications, December 2011.

[25] A. E. Halvaii and M. Ehsani, "Computer aided design tool for electric, hybrid electric and plug-in hybrid electric vehicles," Vehicle Power and Propulsion Conference (VPPC), 2011 IEEE , vol., no., pp.1-6, 6-9 Sept. 2011.