WHITEPAPER

How the Smart Grid Enables Utilities to Integrate Electric Vehicles

Executive Summary

Economic, security, and environmental pressures are driving countries around the world to electrify transportation, which currently accounts for nearly 72 percent of global oil demand. Electric vehicles (EVs)will fundamentally change how electric utilities do business and strain their existing infrastructure. Those utilities that are proactive and develop an integrated solution for their customers will be in the best position to take advantage of the opportunities that transportation electrification presents, while minimizing the potential risks.

Interest and investment in EVs are already significant. Beginning in late 2010 and continuing through 2011, more than 20 automakers will introduce battery-powered EVs or plug-in hybrid EVs. Within the United States, utilities are launching pilot EV programs, and over $30 billion dollars of both public and private investments have been made in EV-related products and projects.

Despite this momentum, a variety of business, technical, and regulatory issues must be addressed if the electrification of transportation is to succeed. Charging systems and related infrastructure must be deployed in advance of customer adoption of EVs or adoption will stall. Building out this infrastructure will take significant time, so utilities, regulators, providers of EV charging stations (also known as EV supply equipment or EVSE), and other parties must work together to streamline permitting processes, establish business and billing models, and tackle regulatory issues.

The EV community must also overcome barriers to adoption. Consumers for example, are concerned about the limited range of some EVs, potentially long charging times, the high cost of EVs and EVSEs, and the long permitting process to install an EVSE. For utilities, transportation electrification presents numerous challenges. Business models for utilities providing charging services have yet to be worked out, and will depend on how actively a utility wants to participate in the market, on their technology infrastructure, and on whether they're in a regulated or deregulated market. Three approaches are: 1) the utility owns the EVSE; 2) the utility subsidizes EVSE; or 3) EVSE as an appliance.

Even low levels of EV adoption will have a significant impact on utilities and the grid—a single EV plugged into a fast charger can double a home's peak electricity demand. Consequently, it is crucial for utilities to manage EV charging. A smart grid is the key to "smart" EV charging, providing the visibility and control needed to protect components of the distribution network, such as transformers, from being overloaded by EVs and ensure electricity generating capacity is used most efficiently. With a smart grid, utilities can manage when and how EV charging occurs while adhering to customer preferences, collect EV-specific meter data, apply specific rates for EV charging, engage consumers with information on EV charging, and collect data for greenhouse gas abatement credits.

By planning now for EVs, utilities can maximize the utilization of their infrastructure, create closer relationships with customers, and leverage EVSE communications investments for other energy initiatives. Working closely with their Public Utility (or Service) Commissions (PUC/PSCs) and other regulatory bodies, utilities can develop expedited processes for EV-related infrastructure and establish rate structures that allow them to incentivize the adoption and use of EVs. With these changes in place, transportation electrification can benefit all parties—consumers, automakers, utilities, the environment, and society as a whole.

The Emergence of the Electric Car

The next decade will bring a significant shift toward the electrification of transportation around the globe. Worldwide, more than 20 automakers plan to bring electric vehicles (EVs) to market starting in late 2010, and researchers expect sales of EVs to grow from 1 percent of the global market, or just under one million vehicles per year, to six percent by 2020.[i] This sea change in transportation applies a new urgency to a wide variety of business, technical, and regulatory issues that must be addressed if the electrification of transportation is to succeed.

EVs will fundamentally change how electric utilities do business. Although full electrification of the U.S. transportation system will take several decades, most utilities are well aware that even low levels of EV adoption can strain their existing infrastructure. Some are proactively preparing to address EV integration issues, while others will be reactively dealing with grid reliability problems as they arise.

Utilities are best positioned to manage the impact high-capacity EV charging will have on the grid. Either significant new infrastructure needs to be added to the distribution infrastructure (an EV can consume as much energy as an air-conditioned home—potentially doubling peak residential electricity demand) or these new EV loads need to be managed to avoid overlapping with existing residential usage patterns. Utilities taking an active role in planning and implementing an EV charging management solution will be well-positioned to benefit from the coming massive change in transportation.

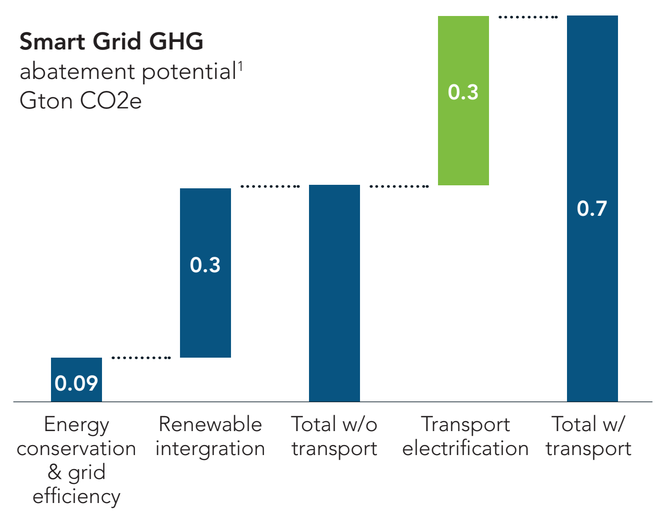
The EV Imperative

Transportation accounts for more than 30 percent of the world's energy consumption and nearly 72 percent of global oil demand. Given the volatility of oil prices over the past decade, the political instability of oil producing nations, and the environmental damage caused by internal combustion engines, governments increasingly are coming to view electric transport as essential to economic growth, energy independence, and greenhouse gas reduction.

Three factors, in particular, are driving the United States and other countries toward transportation electrification:

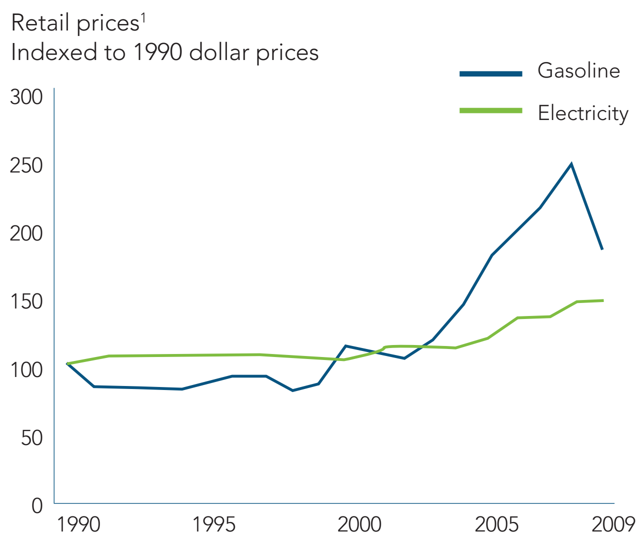
High and volatile oil prices: Oil prices have been highly volatile over the past decade, rising from roughly $25 per barrel in 2000 to $75 in 2006 and soaring to an all-time high of $147 per barrel in 2008 before settling back to around $80 in early 2010. Naturally, gasoline prices have fluctuated widely as well. In addition, every recession over the past 35 years has been preceded by or occurred concurrently with an oil price spike. In contrast, electricity prices have been relatively stable with the price per MegaWatt hour (MWh) tracking between $50 and $75 and retail rates rising an average of less than 2 percent per year.

EV Greenhouse Gas Abatement Potential



[1]Transport electrification involves charging EVs from renewable energy sources. Source: Silver Spring Networks ("Connecting Smart Grid and Climate Change", 2009)

Volatile and Rising Oil Prices



[1] Annual gasoline prices based on straight average of 'Weekly U.S. Regular All Formulations Retail Gasoline Prices (Cents per Gallon)', normalized to 1990 average. Annual electricity prices based on US total electric industry dollar revenues from the Residential sector divided by US total electric industry Watt-hour sales to the Residential sector. Source: EIA

Energy independence and security: Growing worldwide competition for oil creates economic risks for the United States, with China's oil demand growing at double digit growth rates to over 8 million barrels per day (versus the US's 20mm bpd consumption). Dependence on imports from volatile Middle Eastern, African, and South American countries creates concerns over security and oil availability. Securing foreign oil supplies exacts a high price according to the RAND Corp., whose research suggests that between 12 and 15 percent of the U.S. defense budget, or some $67 to $83 billion annually,ii is spent patrolling oil transit routes and protecting infrastructure in hostile regions to ensure a continued flow of oil.

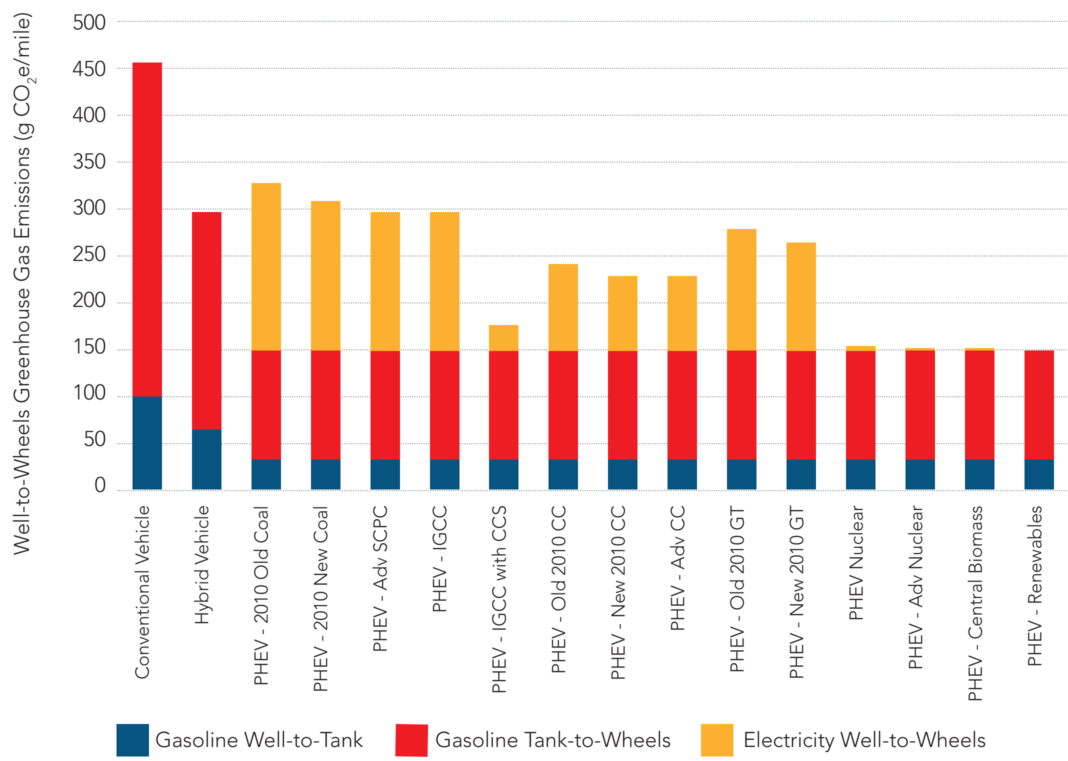
Environmental benefits: According to the U.S. Department of Energy (DOE), transportation is the largest emitter of carbon dioxide in the United States, accounting for roughly one third of all CO2 emissions. Inherently clean electric motors are more than three times as efficient as gasoline engines; transport electrification will cut greenhouse gases significantly. The environmental advantages of electric transport are such that even if EVs were initially powered by electricity generated solely from today's relatively dirty coal power plants, EVs would still reduce carbon emissions compared to gas-based vehicles, according to a study by the Natural Resources Defense Council and Electric Power Research Institute.[iii]

The Pacific Northwest National Laboratory (PNNL) reported that approximately 160 million vehicles in the United States could be powered solely from existing off-peak generating capacityiv, meaning many utilities could initially support EV charging without adding generating capacity. The environmental benefits of EVs are even more pronounced since most utilities today use a mix of renewable and non-renewable energy sources to generate electricity. Excess—and expensive to store—nocturnal wind power is a growing natural source for charging EVs before the morning commute.

EV Momentum is Growing

Interest and investment in EVs continues to grow with automakers, consumers, utilities, investors, and new enterprises focused on different aspects of the market and supply chain.

EPRI/NRDC – GHG Emission by Vehicle and Fuel Type



Year 2010 comparison of PHEV 20 GHG emissions when charged entirely with electricity from specific power plant technologies (12,000 miles driven per year).

Automakers: Beginning in late 2010 and continuing through 2011, more than 20 automakers will introduce battery-powered EVs (BEVs) or plug-in hybrid electric vehicles (PHEVs) that combine an electric motor with an internal combustion engine (ICE). Among the first to market will be Nissan with the 100-mile range, all-electric LEAF, and Chevrolet with its Volt, a PHEV that can travel up to 40 miles on battery charge only and an additional 300 miles on its gasoline-powered engine.

Consumers: Research shows pent-up demand for EVs exists; early adopters could easily outstrip the available supply of EVs in the short term. Nissan, for example, already has 56,000 pre-release orders for the LEAF as of March 2010. A study conducted by New York City found that as many as 21 percent of car owners would be early adopters of EVs and that by 2015, between 14 and 16 percent of all new vehicles purchased by city residents could be EVs.[iv]

Utilities: Across the country, utilities are launching a variety of pilot EV programs and working with Public Utility Commissions (PUCs) and Public Service Commissions (PSCs) to address both technical and regulatory issues to help smooth EV deployments. In California, for example, the CPUC has been leading efforts to bring together all stakeholders, including utilities, automakers, charging station companies, and environmental groups to facilitate transition to electric transportation. In some cases, utilities are leading by example. FPL Group, Inc. and Duke

Energy have committed to transition their fleets of more than 10,000 company cars and trucks to plug-in hybrid or all-electric vehicles by 2020. The conversion is expected to reduce greenhouse gas emissions by more than 125,000 metric tons over the next 10 years. The Sacramento Municipal Utility District (SMUD) has secured DOE funding to integrate 100 EVSEs into its smart grid as part of its Smart Grid Investment Grant.

Public and private investors: The Energy Independence and Security Act of 2007 (EISA) authorized $25 billion in loans for automakers and suppliers to establish or reequip plants to produce EV components; in 2009, roughly $8 billion was awarded to Ford, Nissan, and Tesla. In addition, the American Recovery and Reinvestment Act (ARRA) of 2009 authorized additional funding for EVs, including $5 billion in grants for fuel-efficient and electric transportation.

New enterprises: Private investors are also pouring millions into EVSE start-ups. For example, venture capitalists gave Coulomb Technologies, a developer of EV charging station infrastructure, $14 million in funding in February 2010, while EVSE provider Better Place secured a hefty $350 million of new equity financing in January 2010, and in 2008, Tesla Motors, a new auto manufacturer focused on EVs, secured $40 million in private financing.

Challenges to EV Adoption: Consumer Concerns

To succeed as an industry, the EV community—including automakers, utilities, EVSE providers, and government agencies such as PUCs and city agencies—must overcome a number of barriers to adoption. One major hurdle is the integration of charging stations into the electric grid. Consumers driving their EV away from a dealership won't find charging stations, which are critical to timely charging, on numerous street corners as they do today with gas stations.

Among the consumer challenges that must be addressed are:

High cost: Depending on the battery size, EVs can be more expensive than vehicles with traditional gas engines. Hybrid EVs, including PHEVs, are more expensive than gas-powered vehicles because they have both an electric motor and an internal combustion engine. McKinsey & Co. estimates that by 2015 a PHEV with a range of 40 miles will cost $11,800 more than a standard car with a gas-fueled internal combustion engine, while an EV with a range of 100 miles will cost $24,100 more.[v]

Aggressive initial pricing by automakers and government subsidies will help bridge the initial gap. U.S. buyers are currently eligible for up to $7,500 in federal tax credits, which are scheduled to start phasing out as each manufacturer sells 200,000 EVs. China plans to cover $8,800 of the cost of each EV purchased for more than a dozen of its large-city government and taxi fleets. Also, automakers are aggressively pricing initial models to make EVs cost competitive. For example, Nissan announced its all-electric LEAF with a base price of $32,780 in the United States, which translates to $25,280 to buyers after tax credits. Similarly, Mitsubishi announced its i-MiEV all-electric vehicle will be priced at less than $30,000 in the United States, presumably to compete with the LEAF. While subsidies and aggressive pricing will definitely help jump-start the market for EVs, they are not sustainable in the long term.

Potentially long charging times: It can take from half an hour to a day or more to charge EVs, depending on battery capacity, state of charge, and the type of charging infrastructure or EVSE used. Three levels of charging technologies are being developed, supplying different amounts of power. AC Level 1 (L1) charging and Level 2 (L2) EVSEs are designed for use in individual residences, multi-dwelling units, and similar structures.

With L1 charging, the consumer plugs into a traditional 110 volt plug at 12A amps (A), charging at 1.3kW. L1 charging is relatively slow; a Nissan LEAF could take ~16-18 hours to charge depending on the battery's initial state of charge. The Chevy Volt, with 8 kWh of its 16 kWh battery used, is specified to take roughly 6 hours to charge at L1.

Typically, Level 2 EVSEs need to be permanently mounted and wired to an electrical panel at 220 volts, the circuits used for many electric clothes driers, electric ovens, and well pumps. L2 is specified at between 208 and 240 volts and will charge between 12 and 80A, though most vehicles are being designed to accept L2 charge at no more than 30A, representing 6.6kW. The Nissan LEAF, with a 24 kWh battery pack, is expected to take 3 to 8 hours to charge with a 240V supply.

EV Charging Times

		Time to charge[2]	
Charger type	Capacity[1] (kW)	Chevy Volt (8kWh)	Nissan LEAF (24kWh)
AC Level 1	1.3	~6 hrs	~16-18 hrs
AC Level 2	3.3	~3 hrs	6-8 hrs
	6.6	~1.5 hrs	~3 hrs
DC Fast Charger	~60	<10 min	~30 min

[1] Assumes – AC Level1 : 110V @ 12A; AC Level 2: 220V @ 15A, 30A; DC Fast Charger 420V @ 150A

[2] Assumes 8kWh of Chevy Volt's 16kWh used. Chevy specifies 6 hours and 3 hours for Levels 1 and 2 respectively. Nissan specifies 16-18 hours for Level 1, 8 hours for Level 2 (depending on amperage) and 26 minutes to charge to 80% at a quick charge station.

Source: GM-Volt.com; NissanUSA.com; US DOE PHEV Charging Infrastructure Review 2008

DC Fast Charging is designed for commercial installations, such as commercial charging stations (think gas station equivalents), and these devices charge the battery using direct current. This technology and market is in its infancy, and few DC fast chargers are available in the United States. These chargers will likely range from 30 to 250 kW, with the goal of a complete charge in less than 10 minutes at 420V and up to 150 amps. A DC fast charger operating at 60 kW could fully charge a 24 kWh battery, such as that found in the Nissan LEAF, in approximately 30 minutes.

Range anxiety: Because of the lack of public rapid charging infrastructure, anxiety about being stranded is a concern for potential EV buyers. However, studies of drivers who already have EVs show that most commute within the range of their planned EV or are otherwise able to avoid public charging.v Vehicles such as the Nissan LEAF and BMW MiniE can travel 100 miles before recharging, sufficient range to satisfy most people's typical driving habits according to research done by the PHEV Center at the University of California, Davis.[vi]

Many EVs can go only a limited distance, such as 40 miles, before recharging. While this range is sufficient for the 80 percent of Americans who commute fewer than 40 miles per day, research by Frost & Sullivan[vii] indicates that drivers have a strong preference for range-extended PHEVs like the Volt.

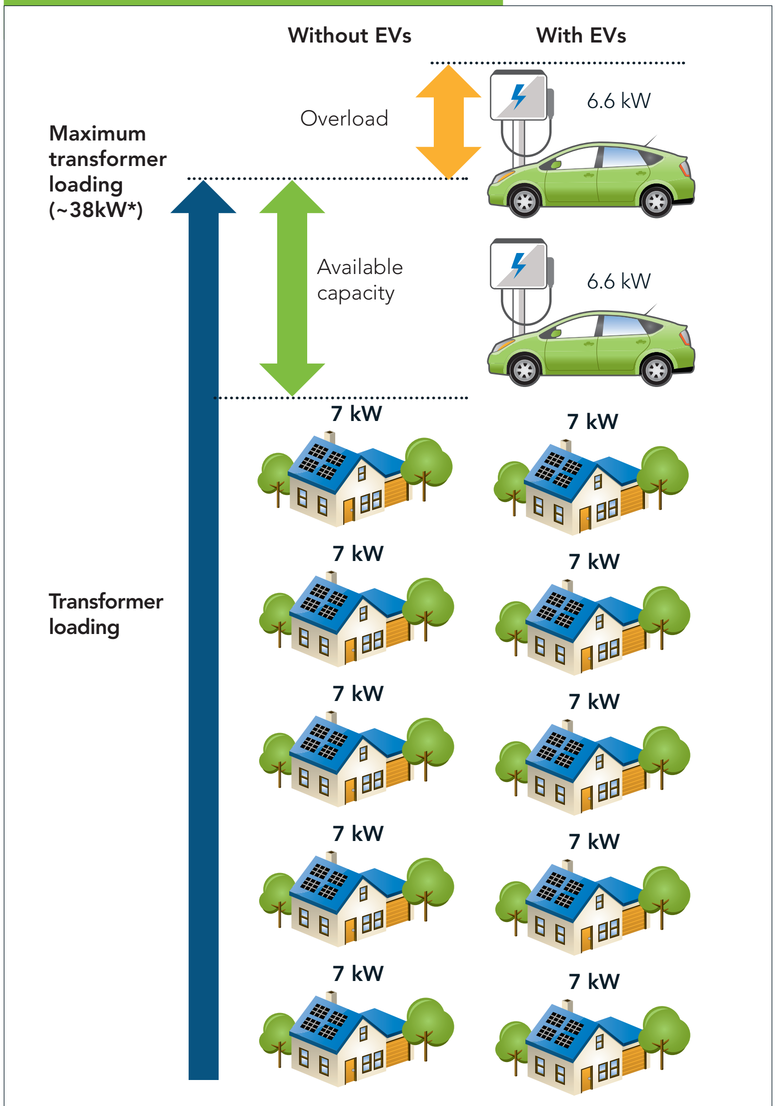
Long permitting process for L2 chargers: Consumers are used to buying a car and driving it home. Consumers will demand the convenience of the faster L2 chargers, which require permits and must be installed by a licensed electrician. With L2 EVSEs, they may wait one or two months before their charger is installed at their home. Obtaining a permit may involve both the city and local utility, which must be informed about the additional power requirements. Coulomb CEO Richard Lowenthal has said that it took a month to get a charging station in his Santa Barbara, CA, home, which he noted "is a little long." Waits up to three months for permits are common. Relying on the ~16 hour charging times of L1 charging could potentially halt the adoption of EVs for American consumers.

High costs of charging infrastructure: Consumers who want L2 charging will need to cover the $1,500 to $4,000 cost of the EVSE charging station itself, as well as the cost of installing such stations in their garage or car park. Installation cost estimates range from $500 to $2,500, depending on whether a residence requires an electrical service panel upgrade, which will be common in older homes.

Utility Challenges with EVSE integration

For utilities, the move to electrify transportation presents a wide range of challenges. Some of the key concerns include:

Potential Transformer Overloading



* Assuming a transformer rating of 37.5kVA and unity power factor

High costs of upfront infrastructure: While consumers will bear the cost of installing residential EVSE, utilities will be responsible for the other related EV infrastructure costs. These costs include upgrades to distribution circuits, as equipment such as transformers, substations, and extra line capacity are needed to support the increased load from EVSEs. Since L2 chargers draw an electricity load equivalent to a house (a L2 load is 6.6 kW vs. approximately 7 kW for a typical residence), utilities will need to invest in updating distribution networks and potentially add generation and transmission capacity.

Peak load impacts of uncontrolled charging: Perhaps the most serious concern utilities have is controlling when EVSE load is applied to their grid. A high percentage of consumers will instinctively charge their EVs when they get home from work; the absence of load management would likely have a de-stabilizing effect on the grid.

Local distribution system impacts from clustering of EVs: Researchers and industry experts who have analyzed current demographics of hybrid vehicle owners anticipate that EV early adopters will emerge in neighborhood clusters. Utilities must be prepared for multiple customers on the same transformer wishing to charge their EVs overnight. Just one or two active L2 chargers could overload a transformer, creating reliability problems. For example, using data from Electric Power Research Institute, Silver Spring Networks estimates that if two customers on the same transformer plugged in L2 chargers (at 6.6 kW each) during a peak time, their load could exceed the emergency rating of roughly 40 percent of today's distribution transformers.[vi]

Administrative impacts: Regardless of who installs, operates, or owns charging infrastructure, utilities must be included in the permitting process so they can plan and budget for the necessary network upgrades. If service panel upgrades are required for L2 EVSE installation, the consumer will not be able to install the EVSE until the utility has ensured the grid is capable of supporting the additional demand. This process will place an additional administrative burden on utilities and creates significant pressure on them to avoid being a bottleneck to EV adoption.

Billing issues: Business models for providing charging services have yet to be worked out. For example, how will utilities be compensated for the power used by charging stations that are owned and operated by third parties? What happens when a drivercharges at a public station? How can a utility keep track of which resident in an apartment complex plugged into a charging station and bill them accordingly? Will utilities need to develop transfer pricing agreements, like cell phone operators did, to accommodate "roaming" and/or develop parking meter-like pay stations to accommodate the 50-cent or $1.00 transactions per battery charge?

Rules regarding who is or is not a utility and who owns what part of the electricity infrastructure vary between regulated and deregulated markets, further complicating EVSE integration issues. In addition, the emergence of charging providers who own EVSEs and re-sell electricity for charging raises the issue of whether these companies will be regulated under state PUC/PSCs.

Embracing Opportunity

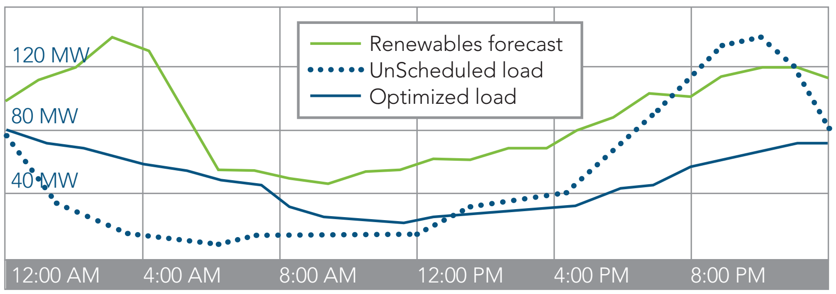
While the electrification of the transportation sector poses numerous challenges, it also presents utilities with a significant opportunity. Since only utilities can mitigate the impact of charging stations on the grid, by planning now for EVs, utilities can maximize the utilization of their infrastructure, create closer relationships with customers, and leverage EVSE communications investments for other energy initiatives. Those that don't prepare to integrate EVSE into their distribution network risk being a bottleneck for EV adoption and will find themselves with an over-taxed grid and the potential for reliability issues.

Maximizing utilization of infrastructure

Utilities are gaining experience today with the tools and techniques that will be required to control the inevitable increase in demand for electricity that even early EV adoption will bring. Pilots involving price incentives to consumers have resulted in significant peak shifting; off-peak EV charging will be critical to enabling utilities to shift peak demand and defer capacity upgrades to their distribution network. In the future, creating an active load through EV charging can help utilities integrate renewable energy sources and avoid having to build new peak generating capacity, acting like energy storage without actually needing to overcome the challenges of drawing power from batteries.

Transport electrification also boosts electricity sales, which can help utilities reduce the rate impact of bringing renewable energy sources online and implementing efficiency programs by helping utilities lower the amortization of their fixed costs of infrastructure. By slowing the pace of rate increases, the United States can achieve its energy goals without overly burdening consumers. And by anticipating L2 EVSE installations, utilities can put processes in place to cut administrative overhead and streamline permitting, as well as take the lead in defining billing models.

Creating Active Load to Increase Renewable Generation



When utilities are able to shift load, they can take better advantage of generation from alternative energy sources. In this graph, the optimized load (the solid blue line) better follows the forecasted wind availability (the green line), avoiding the peak that would occur without scheduling EV load (the dotted blue line).

Creating closer customer relationships

Transportation electrification presents an opportunity for utilities to have greater contact with customers, creating a stronger relationship. Not only will utilities enable vehicle "fueling" through EV charging, they'll also be able to communicate greenhouse gas reductions and energy savings to customers (and regulators) through web portals and monthly bills, empowering customers as partners in energy efficiency.

Reducing greenhouse gases

By proactively working to support EVSEs, utilities can play a major role in cutting GHG emissions. It's likely that future legislation will levy limitations on carbon emissions; utilities that actively support EVSE will be well positioned to manage the impact and help determine the proper allocation of GHG credits.
Leveraging EVSE communications for other energy initiatives

Utilities that want to derive the benefits of measuring the electricity used for EVs will need revenue grade metering and communications to the EVSE. With these capabilities, the utility can measure EVSE usage and quantify GHG savings, effectively manage the electricity flow by enrolling customer in a demand response (DR) program, and offer customers special rates for EVSE charging.

The Business of EV Charging

No clear-cut business model has yet emerged for how utilities will support EVs. What approach a given utility takes will depend on how actively they want to participate in the market, their technology infrastructure, and whether they're in a regulated or deregulated market. Three possible approaches for residential charging include:

I – Utility owns the EVSE: In this model, the utility is responsible for installing and maintaining the EVSE, which is metered, managed, and secured as part of a smart grid. Consumers provide charging schedule preferences and allow the utility to determine when charging occurs in return for providing the EVSE and/or specialized rates.

II – Utility subsidizes EVSE: In this model the consumer or a third party owns the EVSE itself while utilities would likely own the EVSE smart meter and the communications network linking to it. The utility would provide incentives, such as rebates, for customers to install a smart grid-connected EVSE, an approach akin to utilities providing rebates for devices such as air conditioners as part of demand response (DR) programs, in exchange for some rights to control charging a certain number of times during the year.

Benefits	Challenges
Utility gains maximum opportunity to manage EV integration	Participant bias (Owners of EVs receive more benefits than non-EV owners)
Utility has visibility into and better ability to plan for distribution impacts and system upgrades	Utility must maintain EVSE in homes or garages, which presents access and maintenance issues
Utility can influence charging given consumer schedule preferences	Consumer must allow utility to influence charging schedule
Utility can likely claim GHG credits	Utility may earn less revenue from lower, EV-specific rate programs
Utility can offer rate programs that reduce costs to consumers	
Utility may be able to build a rate case to cover the capital costs of EVSEs (investor-owned utilities only)	

III –EVSE as an appliance: With this approach, consumers own the EVSE itself and would hire contractors for installation. The EVSE would be metered through the residence's existing meter unless the utility opted to install an EVSE-specific meter.

Benefits	Challenges
No direct EVSE costs, less responsibility for utilities	Utility would likely not be able to claim greenhouse gas credits
	Utility has less visibility into or ability to plan for distribution impacts and system upgrades
	Requires separate meter infrastructure to support EV-specific rates
	Besides rates, no ability to directly manage EV charging to benefit grid integration

In de-regulated markets, it is unclear which party is best suited to manage or own EVSE and its integration into the electric grid. Without proper planning, the distribution utility will be left with the responsibility to ensure sufficient infrastructure to support EV electric demand.

Regardless of the approach a utility takes to EVSE integration, or whether that utility is operating in a regulated or de-regulated market, policy and regulation initiatives will be needed to support EVs. Numerous issues remain to be addressed. For example, will utility investments in EVSE or related infrastructure be recoverable in rates? Will unplanned distribution system upgrades be recoverable? In situations where third-party EV billing networks provide EVSE infrastructure, such as models from Coulomb and Better Place, will these providers sell electricity and be regulated as utilities?

How the Smart Grid Enables Smart Charging

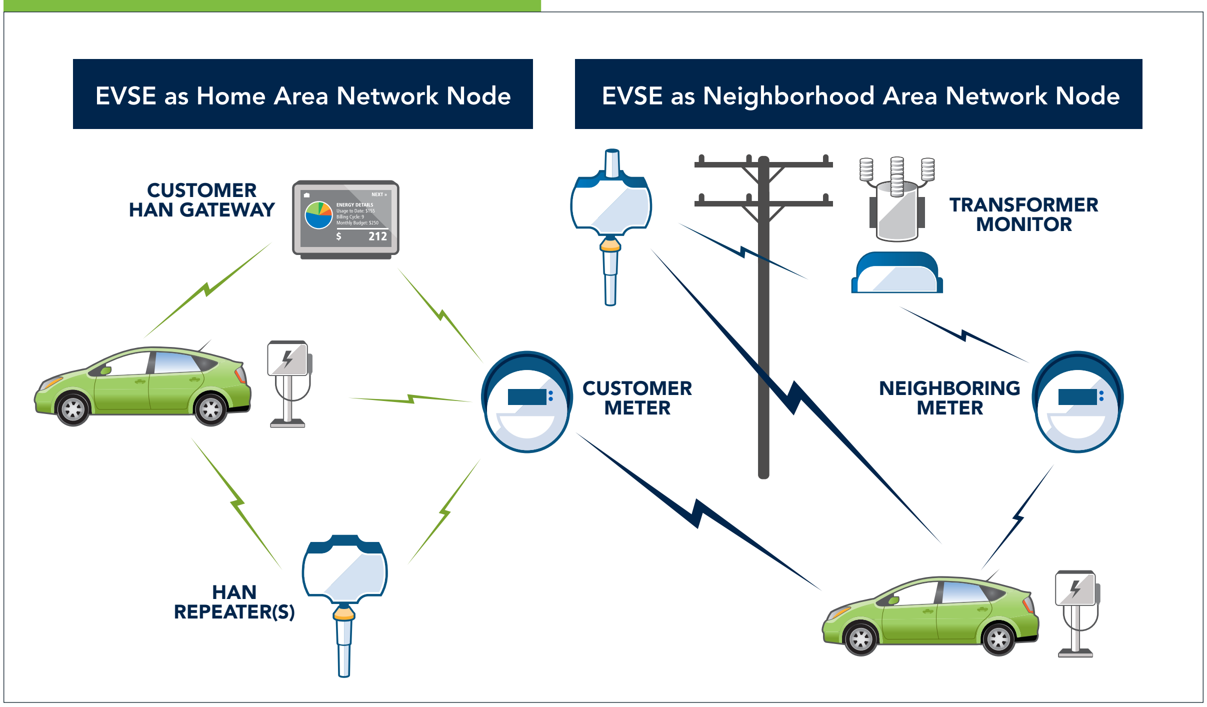
It is clear that even low levels of EV adoption can have a significant impact on a utility and its network. Smart grid technology can help utilities manage this impact by enabling smarter charging. By providing intelligent monitoring and communications capabilities to an electricity network, a smart grid gives utilities much greater control over all aspects of operations, from generation and distribution to metering and billing. As a result, utilities can carefully manage when and how EV charging occurs, collect EV-specific meter data, apply specific rates for EV charging, implement DR programs, engage consumers with information on EV charging status and bill impacts, and collect data for greenhouse gas credits.

For a smart grid solution to effectively support smart charging, it must provide the following capabilities:

Robust, reliable and secure connectivity: Robust connectivity to the home EVSE charger is vital for remote support and can eliminate unnecessary on-site service calls. For example, if a customer is having a problem with an EVSE device, a utility with a good communications infrastructure can remotely troubleshoot the device and advise customers on actions to take without making a home visit.

Utilities have the option of communicating with the EVSE over the Neighborhood Area Network (NAN) or Home Area Network (HAN). Compared to HAN, NAN connectivity offers the same security as other utility meters; better range and propagation characteristics (the signal needs to get into a garage or car port, for example), eliminating the need for HAN repeaters; peer-to-peer communications between the EVSE and other smart grid devices, ensuring multiple communications paths for higher reliability; robust device monitoring; and remote upgrade capabilities.

Two Connectivity Options for EVSEs



Demand Side Management (DSM) infrastructure: Utility back offices must be able to support, integrate, and optimize EV charge management as part of an integrated DSM operation. This approach requires systems that not only manage EV charging but also optimize it against other Demand Response programs and tie to utility energy procurement and dispatch. Tying to the electric grid topology can also enable enhanced reliability of the grid by conducting localized management of charging for individual neighborhoods, such as coordinating the load on particular electric circuits.

Distributed intelligence: The smart grid makes it possible to embed intelligence and communications into devices in the electricity generation and distribution chain, allowing for comprehensive management of EV charging. For example, outfitting transformers with monitors, software, and communications could allow these devices to communicate directly with EVSEs. As a result, a transformer could control when the connected EVs charge and avoid being overloaded and failing.

EV smart charging ties to nearly every element of the smart grid, enabling utilities to achieve greater benefits when managing EVs over a common smart grid platform:

Advanced Metering Infrastructure (AMI) integration: Incorporating a separate or submeter in an EVSE and having a back-end AMI system capable of supporting EVSE meters allows a utility to break out EV charging from the primary meter and seamlessly bill for EV charging at a separate rate. AMI integration also makes it easy for utilities to track and report EV charging usage for greenhouse gas credits. In addition, utilities can use AMI data to predict local reliability issues. For example, prior to installing an EVSE, a utility can compare the peak electric demand of all houses on a single transformer, add the EVSE demand, and determine whether the transformer will need to be replaced or upgraded. Separate EVSE metering can better differentiate EV charging loads from normal loads, which aids in managing EV loads and in forecasting future demand.

Demand Response (DR) integration: The smart grid enables DR programs so that a utility can shape the electricity load by turning down thermostats or air conditioners, for example, or stopping and starting EV charging as needed. A smart grid solution that integrates EV load management with other DR load controls allows a utility to fully optimize the demand side of the electricity equation to manage electricity supply requirements.

Distribution Automation (DA) integration: Integrating EVSE with Distribution Automation gives utilities greater flexibility in managing the reliable delivery of electricity, including the planning or expansion of circuits to accommodate EV demand. EVSE-DA integration also helps utilities maintain power quality as they increase renewable electricity generation.

Coordinate with generation: By managing EV charging, utilities are able to reduce peak demand impacts, optimize intermittent renewable generation such as wind, and coordinate that generation with EV charging.

Utilities that begin planning to support smart charging now will avoid disruption of their network and have greater visibility into and control over any needed infrastructure upgrades. By installing a robust smart grid infrastructure, utilities can take an active role in managing EV charging and benefit from the shift to transport electrification.

Winning with Electric Vehicles

Significant economic, security, and environmental motivations are driving the world toward transportation electrification. To ensure as smooth a transition as possible, all parties in the EV ecosystem—including consumers, regulators, politicians, automakers, EVSE providers, smart grid solution providers, and utilities—must act.

Charging systems and related infrastructure must be deployed in advance of customer adoption of EVs or adoption will stall. Building out this infrastructure will take significant time, so regulators, utilities, EVSE providers, and other parties must work together to remove roadblocks by streamlining permitting processes, establishing billing models, and tackling regulatory and other issues.

Even low levels of EV adoption will have significant impact on a utility. Those utilities that are proactive and develop an integrated solution for their customers will be in the best position to take advantage of the opportunities that transportation electrification presents. Communication and cooperation among departments within a utility, including the EV, Smart Grid, IT, Energy Procurement, and Distribution Planning groups, is critical to defining and executing a successful EV charging strategy.

Likewise, utilities need to work closely with their PUCs and other regulatory bodies to develop expedited siting, permitting, and other processes for EV-related infrastructure and to establish rate structures that can allow utilities to subsidize infrastructure costs for managing EV charging. With these changes in place, utilities and regulators can create a "win-win" situation for utilities and their customers, ensuring that transportation electrification benefits all parties—consumers, automakers, utilities, the environment, and society as a whole.

[i] John Voelcker, "Market Projections for EVs and Hybrids," http://www.just-auto.com/article.aspx?id=99082

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About Silver Spring Networks

Silver Spring Networks is a leading networking platform and solutions provider for smart energy networks. Our pioneering IPv6 networking platform, with 16.5 million Silver Spring enabled devices delivered, is connecting utilities to homes and business throughout the world with the goal of achieving greater energy efficiency for the planet. Silver Spring's innovative solutions enable utilities to gain operational efficiencies, improve grid reliability, and empower consumers to monitor and manage energy consumption. Silver Spring Networks is used by major utilities around the globe including Baltimore Gas & Electric, CitiPower & Powercor, Commonwealth Edison, CPS Energy, Florida Power & Light, Jemena Electricity Networks Limited, Pacific Gas & Electric, Pepco Holdings, Inc., and Progress Energy, among others. For more information please visit **www.silverspringnet.com**.

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