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The shift to electric vehicles

Putting consumers in the driver's seat

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By Kalman Gyimesi and Ravi Viswanathan

The world seems poised for an electric vehicle (EV) rebirth as issues ranging from environmental concerns to fluctuating oil prices continue to push consumers toward alternatives to combustion engines. Today's EV, however, is beyond anything nineteenth century drivers could imagine. From intelligent driving to proactive service and remote vehicle access, EVs can offer the safety and convenience today's consumers crave. To push drivers toward "plugging in," however, automakers must better educate them, as well as offer a uniquely "connected" driving experience. Equally important, they must embrace innovative business models and partnerships.

At the beginning of the twentieth century, more automobiles in the United States were powered by electricity than by gasoline.[1] By 1900, the electric vehicle was a common fixture on U.S. roads, representing approximately one-third of all cars in New York City, Boston and Chicago. Of the 4,192 cars produced in the United States that year, 28 percent were powered by electricity.[2]

However, the need for longer travel ranges, desire for a more affordable fuel source and lack of a reliable power infrastructure soon led to the dominance of the gas-powered internal combustion engine.[3] A century later, a new set of concerns are driving a move away from gasoline back to electricity as a source for automotive power.

As the auto industry works to reduce carbon emissions, many car owners are increasingly concerned with volatile – and rising – petroleum costs. As a result, a growing number of consumers are considering alternatives to internal combustion engine (ICE) vehicles. In addition, governments worldwide are implementing incentive programs in an attempt to push drivers toward electric and other alternatively powered vehicles.[4]

However, hurdles to the adoption of electric vehicles (EVs) remain, with concerns primarily centered on price and vehicle range. To further understand these hurdles and gauge consumer and industry attitudes about EVs, we coupled interviews with executives from both leading and emerging automotive companies with a survey of consumers who rely on cars as their primary transportation mode (see sidebar: Research methodology).

Through our survey, we discovered that average consumers seem to appreciate the sustainability benefits of driving an electric vehicle. However, they aren't particularly interested in paying a higher premium to purchase one. In addition, they have concerns regarding total miles per battery charge – despite the fact that today's electric cars can typically handle the average driver's daily needs without needing to recharge.[5]

Our study also revealed another potential roadblock that can certainly be addressed by the industry – the simple fact that many consumers don't know enough about electric vehicles.

Even those who consider themselves knowledgeable have misconceptions. The good news for those interested in driving EV adoption is that there *is* substantial interest in electric vehicles. In fact, one fifth of drivers are either "very likely" or "likely" to consider purchasing an electric-only vehicle when shopping for a new car. This is particularly notable since close to half of drivers acknowledge they know little to nothing about electric vehicles. With sustained and comprehensive education campaigns, automakers could potentially increase this pool of buyers.

While consumer education is important, automakers must also rely on innovation to help drive EV adoption. We suggest they tap into the innovative technology inherent in the vehicle itself to enhance the driver's experience through various connected features. In addition, the industry must be aggressive in developing new business models while forging new partnerships to build the infrastructure necessary for widespread EV adoption.

Specifically, we believe the auto industry should focus on three key efforts:

- Educate consumers about electric vehicle ownership, shifting focus from environmental aspects toward the vehicle's viability and benefits.
- Rely on technology to help differentiate the consumer experience based on connected features embedded throughout the vehicle and its surroundings.
- Foster business innovation by leveraging a vast array of creative partnerships with entities outside the current industry ecosystem.

Research methodology

This paper is based on insights from automotive industry executive interviews and consumer survey responses, as well as secondary research on electric vehicles. The 125 executive interviews were conducted as part of a prior IBM Institute for Business value study on mobility, "Advancing mobility: The new frontier of smarter transportation."[6] Our new study focuses specifically on the executives' responses relating to alternatively powered vehicles.

Separate from the mobility study, we conducted a consumer survey of 1,716 U.S. drivers. The survey included questions designed to determine their attitudes about and knowledge of electric vehicles, as well as what factors might motivate them to purchase an electric vehicle.

Forces of change

The topic of oil spurs controversy and debate across a hotbed of issues, such as climate change, environmental concerns, price volatility, politics and peak oil. While there might be disagreements regarding these issues and the best ways to address them, there is little debate that changes are inevitable for the transportation industry. Almost three-fourths of U.S. oil demand is for transportation, half of which is for passenger cars and light trucks.[7]

A dramatic change in the vehicle mix will be required to meet potential mandates aimed at reducing the environmental impact of automotive transportation. For example, 98 percent of new vehicle sales were for internal combustion engine (ICE) vehicles in 2007. However, to meet carbon dioxide emission stabilization levels of 450 to 550 parts per million, suggested by the Intergovernmental Panel on Climate Change, this number would have to drop to 50 percent by 2020 and 40 percent by 2030.[8] Close to half of the auto industry executives we interviewed believe that annual sales of conventional gas and diesel vehicles will have begun to decline by as soon as 2020.

So, what is the most logical solution to achieve more efficient energy usage in vehicles? When considering energy efficiency across the full lifecycle of producing, transporting and using fuel – typically referred to as "well to wheel" – electric vehicles offer high efficiency and the lowest carbon emissions per mile, raising the potential for elimination of petroleum usage.[9] A report published by the California Environmental Protection Agency's Air Resources Board concludes that an electric vehicle can travel three times farther than a gasoline-powered vehicle given the same amount of fuel energy.[10] This superior, comparative energy efficiency propels EVs ahead of most other alternatives.

Believing electricity to be the most efficient alternative, many organizations have introduced proposals to move consumers toward EVs. For example, a report by the U.S. Electrification Coalition, an energy policy group, proposes to reduce oil consumption from today's 8.6 million barrels per day (mbd) to 2.0 mbd to effectively eliminate oil imports. To do so, the coalition recommends that 75 percent of light-duty vehicle miles traveled be electrically generated by 2040.[11]

The majority of executives we interviewed (63 percent) believe governments in major markets will initiate formal programs aimed at moving consumers from conventional to alternatively powered vehicles by 2020. A number of governments have already implemented programs or committed funds. For example, in 2009, the French government committed US$2.2 billion to a plan to put two million electric cars on the road by 2020.[12] China, which set an annual sales goal of one million units of new energy vehicles by 2015, plans to invest 100 billion yuan (US$16 billion) into the alternative-energy vehicle industry by 2020.[13]

Anticipating a growing market for electric vehicles, most automotive original equipment manufacturers (OEMs) already have electric vehicle programs in place or in progress.[14] Our interviews with auto executives also point to a move toward electric vehicles, with 83 percent citing migration of the product portfolio toward electrified vehicles among the "best options" for developing mobility solution offerings.

"Everyone must change their product mix: OEMs that ignore this will not be able to stay in the market over the long run."

European auto OEM executive

Given that a majority of the industry is developing and investing in EVs, it has a collective stake in their success. However, this success hinges on surmounting some important obstacles.

Spreading the news

While many signs point toward a bright future for electric vehicles, several issues threaten their broader adoption, including a lack of knowledge among consumers and driver concerns regarding range and price. Automakers must convince consumers that EVs offer the same convenience and value as conventional vehicles. To do this, they need to better educate consumers about EVs and, in doing, focus on the right messages to alleviate concerns.

The simple facts

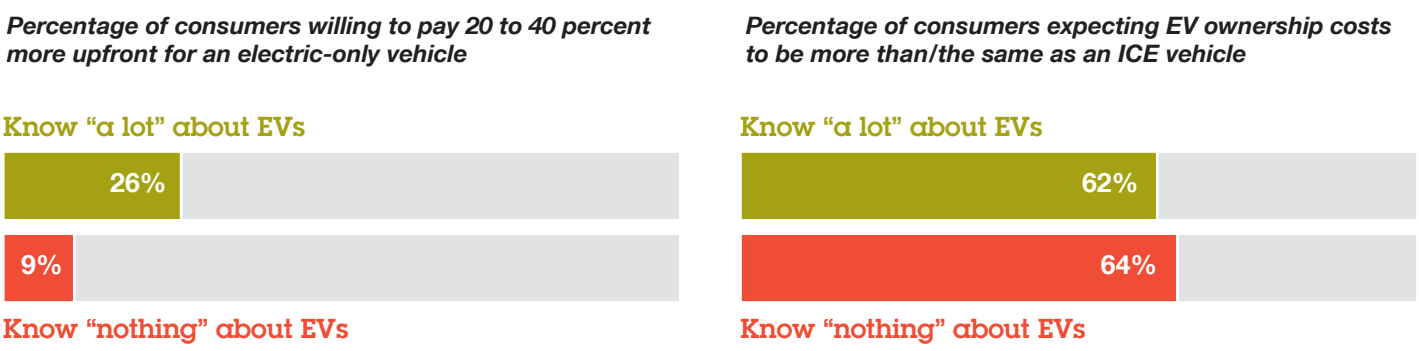
Many consumers have limited – if any – knowledge about electric vehicles, and many who profess knowledge are still misinformed in some areas. Our survey revealed that 45 percent of drivers believe they have little to no understanding of electric vehicles. However, despite this lack of knowledge, almost 20 percent of consumers surveyed are likely or very likely to consider an EV when buying their next car.

If you break this interest percentage down further and compare those who know "a lot" about EVs with those who acknowledged they know "nothing," it becomes obvious that more informed drivers are more likely to think about purchasing an electric vehicle (see Figure 1). In fact, consumers who consider themselves knowledgeable are more than two and a half times more likely to consider an EV than those who believe they know "nothing" about EVs.

Source: IBM Institute for Business Value Electric Vehicle Consumer Survey. 2011.

Figure 1: **Drivers who know more about EVs are more likely to consider purchasing one.**

Our survey also revealed that knowledgeable consumers are more willing to pay a higher upfront purchase price for EVs. Regarding expected cost of ownership, they generally share the same sentiment as their uninformed peers, with roughly 60 percent expecting these costs to be the same or higher for an EV (see Figure 2). However, in reality, some EV cost of operation estimates for a five- to six-year period are up to three times *less* than those for similar ICE vehicles.[15] So, even informed consumers are not aware of the potential long-term savings offered through EV ownership. Obviously, education is important for consumers across the knowledge spectrum.

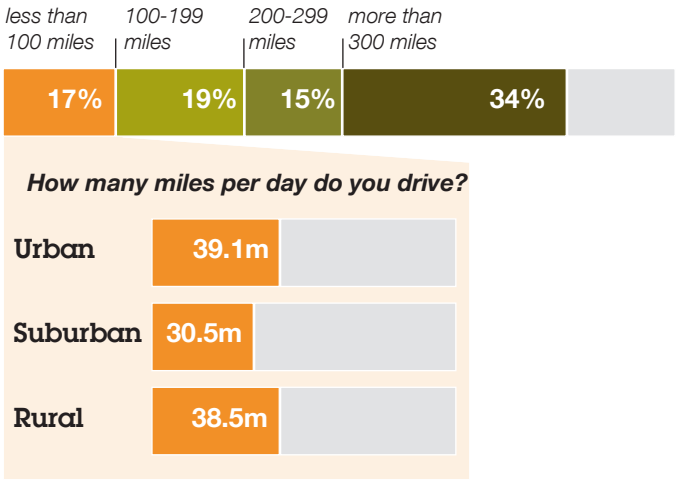


Source: IBM Institute for Business Value Electric Vehicle Consumer Survey. 2011.

Figure 2: **Consumers who consider themselves knowledgeable about EVs are more willing to pay higher up-front costs but are unaware that operating costs could actually be less.**

As automakers focus on increasing drivers' understanding of EVs, they also need to ensure they are communicating the *right* messages. A key message, which doesn't seem to resonate with many consumers, is that electric vehicles are viable for the vast majority for use in their daily lives.

The average number of miles driven per day for consumers surveyed is under 40 – whether they live in urban, suburban or even rural areas. However, when asked how many total miles per battery charge a car would need for them to consider switching to an EV, only 17 percent selected "under 100 miles" (see Figure 3). Approximately 50 percent selected more than 200 miles – this despite an average of less than 40 miles driven per day. Most EVs in the market today have more than sufficient range for the vast majority of customers on a typical day.[16]



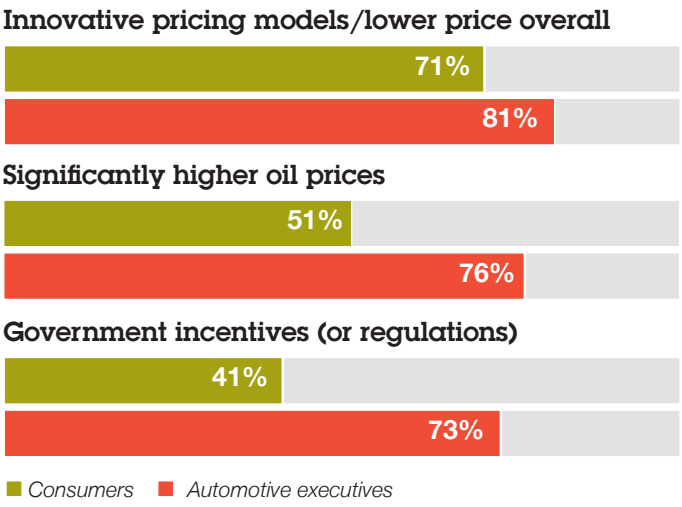
Source: IBM Institute for Business Value Electric Vehicle Consumer Survey. 2011.

Figure 3: **Most consumers desire more range than they need in a typical day.**

Green versus $green$

Automakers also need to consider messaging related to price. Consumers gave mixed responses on how different aspects of price might affect their buying decisions, and auto execs were not always on the same page (see Figure 4). When asked about what factors might motivate consumers to transition to electric vehicles, auto execs placed greater emphasis than consumers on government incentives and oil prices.

What are the primary drivers for consumers to transition to electric vehicles?



Sources: IBM Institute for Business Value Electric Vehicle Consumer Survey. 2011; IBM Institute for Business Value Advancing Mobility Study. 2011.

Figure 4: **For consumers, vehicle price is the greatest driver for transitioning to EVs.**

Auto executives predicted consumers would be more or less equally compelled to transition to EVs by all three price-related drivers – their expectation being that consumers believe "money is money." They are correct in their assumption that price is important to consumers. However, consumers seem to differentiate how the lower price is achieved. They are far more inclined to respond to innovation in pricing and packaging of EVs than in simply attaining a lower price through a government subsidy.

The fact that the top driver for consumers is "innovative pricing models/lower price overall" is significant – particularly since some electric vehicles are listed at a 45 to 100 percent higher price than comparable ICE vehicles.[17] This puts them beyond the desired cost range for many consumers. Half of the consumers surveyed are ***not*** willing to pay more for an electric vehicle over a similarly featured gasoline, diesel or hybrid.

As such, it is particularly important that automakers emphasize the lower overall cost of ownership when educating consumers about electric vehicles. Equally important, they must listen to consumers' request for more innovative pricing models. Automakers could potentially offset the initial cost to purchase an EV by employing novel business and pricing models – some of which we explore further in this paper.

"Green image is something that sells well and provides for good marketing, but it is not a real aspect of the consumer's decision."

European captive finance executive

Another messaging element to consider is the "green" or environmental pitch typically associated with EVs. Although 48 percent of consumers listed green/sustainability concerns as a primary driver to transition to EVs, a number of executives we spoke to are cautious about relying on such statistics. Although they concede that consumers are drawn to "green" messages and the idea of ecofriendly purchasing, most executives believe these messages aren't the sole factor when making purchasing decisions. The "green" messages and associated positive feelings are outweighed by price, range and other considerations. Price is, after all, consumers' number one driver for transitioning.

As such, we suggest automakers educate consumers about potential long-term ownership cost savings while exploring new pricing models to lure those who might otherwise be turned off by the higher up-front purchase price. Equally important, the industry must launch an information campaign to educate consumers on the benefits of EV ownership and, in doing, dispel some of their worries relating to range.

Connected driving: A win-win proposition

Continued technological advances and the rapid adoption of digital and mobile devices have changed almost every aspect of daily life – including how individuals work, communicate, spend their free time – and travel. Armed with smartphones, mobile music players, PCs, tablets and more, today's consumers expect to be connected – anytime, anyplace. Consumers' desire for connectivity in everything they use aligns directly with the notion of electric vehicles as sophisticated machines.

By 2020, there will be an estimated fifty billion devices connected to the Internet.[18] The ability to use – and synch – these devices with vehicles will be a compelling value proposition for many consumers, in particular early adopters. A 2010 study suggests that early EV adopters tend to be particularly more "connected" consumers. Drivers who said they were likely to purchase an EV in the next two years were also more inclined to be involved in online activities, use technology to enhance their driving experience and have adopted smartphones.[19]

In capitalizing on the extensive connectivity inherent in electric vehicles, automakers can bring a unique "connected driving" experience to consumers who are adopting new technology at breakneck speeds. Consumers can look forward to new ways to interact with vehicles directly and remotely, as well as the security that comes from greater information sharing with automakers through this new platform. In turn, automakers can benefit from the exchange by collecting extensive data from consumers about how they use EVs and how the vehicles perform on the road – and then use this data to further cater to driver needs and safety concerns.

A connected experience

EVs are being designed from the ground up for connectivity. And these connected vehicles can offer exciting features – and added efficiency – for consumers. Connected solutions can provide consumers reassurance in areas ranging from safety to navigation by providing extensive driver assistance.

For example, the use of remote diagnostics featuring real-time alerts could enable proactive servicing, avoiding or reducing service and repair times. Telematics within connected EVs can also offer emergency assistance features, road warnings, driver status updates, automated drive features, advanced navigation, traffic prediction and green routing capabilities, and multimodal optimization options. Digital solutions can provide information that allows drivers to choose alternate routes based on accident rates, climate conditions and road construction, as well as provide live updates for drivers while they are en route and even assist in locating stolen vehicles.

In addition to telematics within the vehicle, "connected" EVs could facilitate the use of smartphone applications. One consumer survey revealed that more than half of likely EV drivers consider the ability to use their smartphone applications inside their vehicle a positive influence on their decision to purchase an EV.[20]

Smartphone and other applications can help drivers locate and reserve charging stations, distinguish between free and paid charging stations, monitor charge status remotely and facilitate payment options through mobility commerce. There is even an EV network app. PlugShare, a community-powered electric vehicle charging network, connects EV supporters and lists available public charging stations – some of which are in individuals' garages.[21]

What you need when you need it

Despite the potential "connected driving" experience, many consumers are still hesitant to consider electric vehicles due to their limited battery range. In fact, our survey revealed that 90 percent are "very" or "somewhat" concerned with range. The future might bring new battery technology to help solve consumer "range anxiety" (see sidebar: A possible antidote to "range anxiety"? The battery 500 project). However, to alleviate these worries today, automakers must look beyond conventional automotive business models and toward innovative solutions. If they remain locked to the traditional sales approach, it could severely hamper EV adoption.

Automakers can take the issue of range out of the picture completely by employing a business model based on flexible vehicle access. In this scenario, consumers who purchase an EV also receive access to a variety of other vehicles on an as-needed basis. This flexible access would alleviate concerns regarding range – or the "What if I want to take a long road trip?" quandary.

As an added bonus, this flexibility also provides yet another way to extend the driving experience. Automakers can turn the "negative" issue of range into a positive by offering consumers more choice and variety. More than 80 percent of consumers say they want over 100 miles per charge on an EV, and 50 percent want more than 200. Rather than trying to convince them that – based on their average miles driven a day – they don't need that much range, automakers should sell consumers on the added feature of flexible access.

By enabling their product portfolio for portability of vehicle parameters and content, automakers could allow drivers to take their settings and preferences with them. For example, a driver could have a common log in across an automaker's portfolio, which would allow her to "take" common settings, ranging from simple seat placement to navigation features, music preferences, calendar entries and business applications, from vehicle to vehicle. An electric vehicle might be the ideal solution for a driver 90 percent of the time, as he drives to work, goes shopping and chauffeurs family members. However, for a weekend road trip or family vacation, he might like a car with more extended range. Along the same lines, he might choose a two-seater convertible for a weekend drive to the beach. Being able to drive different cars is exciting, but taking their comfortable electronics environment with them could be a game-changer for some drivers.

A possible antidote to "range anxiety"? The battery 500 project

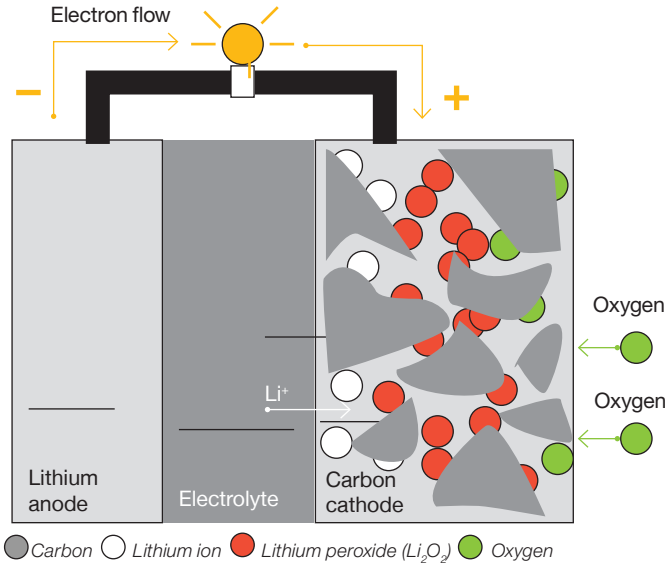
IBM and partners are taking a new approach to solving one of the biggest barriers to widespread electric vehicle adoption: limited battery range. Electric cars today typically can travel only about 100 miles on lithium ion batteries (LIB), the kind of batteries that power laptops or smartphones.

LIB technology stands little chance of being cheap, light and small enough to power a typical family car. Recognizing this, IBM started the Battery 500 project in 2009 to develop a new type of lithium-air battery technology that is expected to significantly improve energy density, dramatically increasing the amount of energy these batteries can generate and store. Partnering with teams from around the world, including Argonne National Laboratory, Lawrence Livermore National Laboratory, Pacific Northwest Laboratory and Oak Ridge National Laboratory, IBM aims to create a lightweight, rechargeable battery that will power the typical family car about 500 miles between recharges.

IBM reduces the battery weight by getting rid of the heavy transition metal oxides like cobalt oxide or manganese oxide and replacing them with a lightweight, high-surface carbon structure. Such batteries theoretically could pack ten times the energy density of the lithium ion batteries now used in electric cars because they use air drawn in from outside the battery as a reactant. That means lithium-air storage devices weigh less than lithium-ion batteries, a factor that also improves the performance of electric vehicles.

Today, IBM researchers have successfully demonstrated the fundamental chemistry of the charge-and-recharge process for lithium-air batteries and continue their efforts in redefining the power source for electric vehicles.

How it works
Lithium-air batters are air breathing: During discharge (driving), oxygen from the air reacts with lithium icons, forming lithium peroxide on a carbon matrix. Upon re-charge, the oxygen is given back to the atmosphere and the lithium goes back onto the anode.



Fleets: A key growth area for electric vehicles?

Fleet sales will likely play an important role in the early development of the electric vehicle market, helping build scale and create economic efficiencies in production.

Many fleet managers are considering electric vehicles to help manage increasing fuel costs, as well as reduce emissions. They are looking beyond the higher initial purchase price and focusing on the total cost of ownership for their vehicles, including fuel and service costs, as well as corporate sustainability aspects. Electric vehicles are especially useful for delivery services, as their predictable routes make charging easier to manage.

However, the configuration of price is also important, as fleet managers have to manage to cost accounting norms. Buying a more expensive vehicle but saving money on fuel essentially capitalizes the cost of fuel (an expense). Few businesses are interested in such a proposition in large volumes. For more companies to consider buying EVs in large numbers, automakers must develop innovative pricing models that substantially lower the capital cost of the vehicle, while constructing an ongoing service-based payment model that can be expensed. Perhaps it could be based on fuel costs that are averted by purchasing an EV.

Fleet sales could indeed serve to drive EV growth. Not only could large orders from fleet companies potentially push prices down and adoption levels up, they also help "publicize" electric vehicles. With more and more electric vehicles on the road, consumers are likely to become more accustomed to them and, perhaps, consider them for personal usage.

At your service

As alluded to earlier, the connected vehicle provides an opportunity to offer a new – and unique – serviceability experience. Remote electronic diagnostics provide the ability for OEMs and fleet companies to monitor vehicle condition and performance. In these situations, drivers could receive instant diagnostic vehicle alerts. A connected EV could also feature remote control of car functions, such as starting and stopping the air conditioning and monitoring state of charge reports.

The fact that EVs have fewer components is another service-related benefit. Rather than the thousands of parts typical of an ICE vehicle, EVs sport a handful of parts and no emissions equipment, simplifying services. As a result, they tend to have lower maintenance costs.[22] Minimal – and lower-cost – service-ability is a huge selling point for many consumers.

Winning across an ecosystem

The electric vehicle ecosystem – and necessary infrastructure – expands far beyond what currently exists for conventional vehicles. This represents both opportunities and challenges for automakers.

To succeed, automotive companies need to expand their existing ecosystem to include new partners who also have a vested interest in the success of EVs. Automakers are already heading in this direction. According to an IBM survey conducted at the 2010 Automotive News World Congress, automakers have increased their collaboration over just the last two years with numerous entities, including alternative energy providers, battery suppliers, local and state governments, electric utilities, and fleet and car-sharing companies.

The auto industry needs to continue and expand these efforts. Partners will be critical to successfully build the battery charging infrastructure, as well as solve some of the EV pricing challenges. Essentially, there will be two sets of partnerships, one led by automakers and the other by their captive finance organizations.

Automakers will likely lead partnerships related to infrastructure, such as those with IT providers, government entities and utilities. These partnerships require strong alliance management. Captive finance organizations can lead partnerships that enable mobility commerce and help ensure access to a distributed network of transportation options for customers. They will certainly work with dealers, but they might also benefit from creating an even more distributed network of access to vehicles through partnerships with retailers, hotels or public transportation systems. These partnerships – and their success – will be based on business model innovation.

Charging infrastructure

Establishing the charging infrastructure necessary for large-scale EV adoption is an enormous but essential undertaking for wide-spread adoption. While EVs today typically come with a connection that can be used to charge the vehicle, this line accommodates only one type of charging, Level 1.[23] There are three levels of battery charging associated with electric cars manufactured in the United States:

- **Level 1** charging is done by plugging into a 120-volt household electrical outlet circuit. However, it is very slow, with some cars taking more than 20 hours to fully recharge.
- **Level 2** charging uses a 240-volt circuit, similar to a household dryer outlet. Level 2 charging is faster than Level 1 and typically requires wall- or pedestal-mounted equipment.
- **Level 3** charging requires large stations and is faster than levels 1 and 2, using very high voltage and current. Not all cars support this type of charging.[24]

Level 1 and 2 being the most common methods today, fully recharging an electric-only vehicle takes hours – so it's important for owners to be able to charge their vehicles in places they park for extended periods of time. According to our survey, almost three fourths of drivers park their primary vehicle in either the garage or driveway of their private residence when they are at home.

Because Level 1 charging is very slow, most consumers will likely want a Level 2 set up at home. However, establishing a Level 2 home charging station can cost up to US$2,000.[25] Obviously, the auto industry must partner with utility companies, particularly to ensure they can handle the large increase in electricity demand wide-spread regional adoption would bring (see sidebar: The role of smart grids on the road to electric vehicles). In addition, we suggest automakers consider partnering with home improvement retailers or other service outlets to potentially standardize or reduce the costs associated with establishing a home charging station.

More creative partnerships will be required to build an adequate charging infrastructure outside of home charging. We suggest first concentrating on places of employment, where drivers park their vehicles for up to and beyond eight hours at a time. Automakers can partner with large employers in target regions to create charging infrastructure at the workplace. As workers are there for extended time, Level 1 charging will likely be sufficient.

The next step is to identify other partners to help create scale and increase accessibility for consumers at other locations. Where are the most likely locations for charging other than work and home? When asked where they park most often when not at home or work, 62 percent of consumers cited malls and other retailers.

The challenge with establishing charging stations in office parks, retail locations, hotel parking lots, etc. is largely related to cost, which can range from US$3,000 to $7,000. This cost will not be recouped through selling electricity alone.[26] However, if charging stations are used as media, advertising and incentive platforms, revenues from advertising, coupon offers and other promotional items could help finance them.

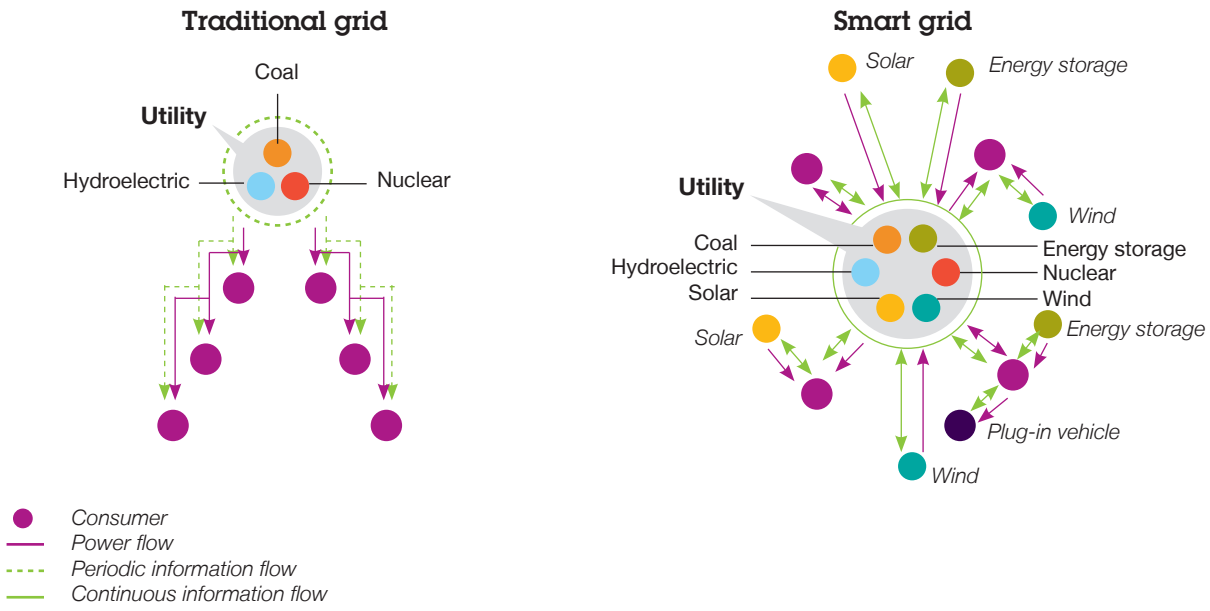
The role of smart grids on the road to electric vehicles

How will utilities meet the need for the additional electricity demands of electric cars? To provide the electricity for the anticipated growing number of electric vehicles, power grids must become smart grids – capable of sending and receiving data along with energy.

Smart grids use sensors, meters, digital controls and analytic tools to automate, monitor and control the flow of energy across operations – from power plant to plug. A power company can optimize grid performance, prevent outages, restore outages faster and allow consumers to manage energy usage right down to the individual networked appliance.

Smart grids can also incorporate new renewable energies such as solar and wind power, and interact locally with distributed power sources – or electric vehicles. Smart grids can balance the charging requirements of electric vehicles with the needs and constraints of the grid, modulating the charge rate of EVs to ensure the grid system is not overwhelmed. This is not only more grid friendly, but allows electric vehicles to be the ideal consuming device for renewable energy, as the charge rate can be increased and decreased in response to renewable energy availability.

Having already started down this path for peak demand reduction, carbon management and cost reasons, utility companies are also making plans and participating in standards bodies to prepare for the energy increase, peak variability and storage mobility that a new global fleet of electric cars represents.



For example, a consumer parked at a charging station located in a mall parking garage might see advertisements from retailers or receive a coupon right before they go shopping. Or consumers could have free or reduced charging if they spend a certain amount while shopping. Companies that are early to market can negotiate agreements with prime commercial locations based on advertising and promotion-based business models.

Effective partnership and collaboration will also be crucial to build integration and interoperability among charging stations from various providers, as well as establish payment methods. Other considerations include whether charging stations are publicly accessible or for members only and whether payment will be at point of sale, prepaid or by subscription service.

Innovative purchasing plans

Automakers should also collaborate with their captive finance companies to determine ways to make purchasing electric vehicles more compelling. Captive finance companies can play a key role in finding creative ways to mitigate the high costs of EVs.

Nearly all the auto industry executives we interviewed agree that the economics of batteries are critical to the success of hybrid and electric vehicles. Batteries could provide a key to reducing cost.

"Pricing is the most important aspect of this transformation."

European captive finance executive

Perhaps batteries could be financed separately from the car over a longer period of time, thus reducing the monthly cost. In a similar scenario, after a battery has reached the end of its life in an electric car, it could still have alternative uses and significant value. Finance companies might allow EV buyers to only finance and pay for the estimated percentage of battery power they will use. For this to succeed, securing secondary markets for batteries with reduced capacity will be critical. For example, batteries might be used as stationary energy storage in grid applications or for energy arbitrage, in which grid service operators buy energy during low-rate periods, store the energy in these batteries and sell the energy back during high-rate periods.[27]

Are you ready for the rebirth of electric vehicles?

To help prepare for a future with wide-spread EV adoption, we suggest auto executives consider some key questions today:

1. What business model and pricing innovations are you considering alongside product development efforts as you bring electric vehicles to market?
2. How are you partnering with others within the auto industry to develop scale and cost reduction opportunities for electric vehicles?
3. In which cross industries are you targeting partners for a large-scale roll out of EVs across many cities and countries?
4. How will you reach consumers in innovative ways to convert their interest in EVs into purchases?
5. How will you build growth in fleets and find the best applications where EVs can be used profitably?

Conclusion

In 1900, the electric vehicle was in its heyday, but its limelight soon faded with the growing popularity of ICE vehicles. However, the cycle seems as if it might come full circle. The tides certainly seem to indicate a move toward electric vehicles, as consumer interest, government incentives and mandates, and increasing environmental concerns all point toward their adoption.

Before wide-spread adoption becomes a reality, however, a number of obstacles must be cleared. For the masses to "plug in," they first need more information. The auto industry should educate consumers, focusing less on environmental messages and more on the feasibility and advantages of EV ownership. In addition, auto manufacturers should utilize the connected aspects of the electric vehicle to deliver a uniquely enhanced driving experience – with features from remote access to automated drive features – for today's connected consumer. Finally, industry leaders must partner extensively – and outside their existing ecosystem – to facilitate wide-spread EV adoption. These partnerships will enable the infrastructure necessary and could also alleviate some of the price concerns associated with EVs.

If auto industry leaders meet the challenges head on through education, innovation and strong partnerships, they can indeed help put consumers in the EV driver's seat, where they can enjoy a more enhanced, connected, safe and environmentally friendly experience.

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