Battery Electric and Plug-in Hybrid Vehicles: The Definitive Assessment of the Business Case

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Abstract

The electric vehicle has come and gone from the mass market, or attempts at the mass market, several times before. They were the technology of choice for consumers attending the New York auto show of 1900, and shared the market of that era equally with internal combustion and steam engines. Within the last decade or so, General Motors, Toyota, Renault, PSA and others have launched demonstration fleets, only to withdraw them from the market after gaining some field experience and consumer feedback. Now, in the midst of global concern over dependence on limited fossil-energy reserves and the impact of man's activities on climate change, the electric vehicle is once again coming to the fore. Established and entrepreneurial manufacturers on every continent are developing electric vehicles as well as advanced batteries, motors and control systems and the infrastructure systems and battery ownership and management schemes to support them. Will the battery-electric vehicle take hold, finally, this time? Or is it once again doomed by an inability to satisfy personal mobility needs when held up in comparison with more established vehicles powered by the internal-combustion engine (ICE)?

A recent IHS Global Insight project aimed beyond the current enthusiasm for electric vehicles and focused on the key developments and areas of uncertainty that could make or break this current thrust towards electrification of the light vehicle fleet. Will the electric vehicle succeed? If so, perhaps more importantly, then, is why?

This study focused on the potential drivers for success as well as the factors that may limit widespread adoption by examining not only the vehicle, but the environment into which the electric vehicle is intended to compete. These environmental factors capture a broad range of subjects that could assure or derail the overall global success of the electric vehicle. Among the subjects examined the following issues became reoccurring themes. On the "Pro" side, advocates have praised the electric vehicle for:

- Enabling a multiplicity of energy sources
  - A diversified energy supply
  - Improved national security
  - Access to reduced greenhouse gas-emitting and/or renewable fuels
- Reduced emissions of all types at the vehicle level
- Displacement of chemical energy conversion processes to stationary sources
  - Enables continuous monitoring of all emissions, and repair as soon as possible, maintaining air quality and efficiency
  - Enables up gradation to the latest technology as soon as it is commercially viable, rather than waiting for fleet turnover
- Quiet
- Potentially reduced operating costs
- Drivability (tailored response with instantaneous torque possible)
- Reduced maintenance requirements
  - More suitable for distributed fleets (car-sharing programs)

- Home refueling
- Enables pre-warming or pre-cooling from the grid
- Flat floor configuration is possible
- Green appeal

There are many challenges to the electric vehicle, but there also many solutions. Key categories of challenge and their solutions are:

Challenge: Consumer preference for long range, versatile vehicles and BEV limitations of range and recharge time

Solutions: Increased urbanization creates greater congestion and concentration of pollutants. Urban centers create opportunities for car-sharing programs. BEVs are the perfect vehicle for car share programs, as the dispersed fleet has little need for routine maintenance and the managed parking spaces offer facilities for double charging i.e., charging the car and billing the customer. Refueling time thus becomes irrelevant and the range (typically 100 miles) is far greater than needed in the urban environment.

Challenge: Purchase cost and uncertainty about battery life, cost and "economics"

Solutions: In the near term, third party financial incentives will ease the purchase burden. In the longer term, battery leasing schemes taking into account the high residual value of used BEV and PHEV batteries for second-life energy storage applications will prevail. Between these time periods it is expected that vehicle-to-grid applications will enable the PEV owner to gain some income by enabling the power utility control over the flow of energy into and out of the vehicle battery. Solutions in terms of battery chemistry are still very much under development, and new options appear almost daily. The study concludes that it is still early days for battery chemistry, despite the battery itself being almost 200 years old.

Challenges: Perceptions of safety with respect to fire and other hazards.

Solutions: The industry must be careful to avoid premature entrance to this market with products that are not up to the highest possible levels of safety. The hazards of high energy storage batteries are well known and for the most part avoidable with good design, proper choice of materials and quality control, just as they are with liquid fuels. Other risks must be assessed and the results clearly communicated in plain terms.

Challenges: Adequacy of the power sector and its infrastructure

Solutions: While electricity generation capacity is not a near term issue, it could become one under certain circumstances in the out years. Utilities will have plenty of time to see this coming, however, and ramp up capacity accordingly. Nearer term, distribution issues could cause local problems. The solution here is for utilities to develop closer understandings of their retail customers. Working with car dealers, dealer trade associations and even car manufacturers, utilities need to understand what their customers are doing--or will be doing--and assess local end-of-line transformer capacity and pro-actively upgrade transformers in anticipation of need. This is not a universal challenge, but maintaining adequate power supplies in the early days of PEVs will set the long-term public view of these vehicles. PEV-related brownouts and blackouts must be avoided.

Challenges: Material limitations

Solutions: The materials in short supply relative to potential demand are those that offer optimal but not exclusive technical solutions to advanced batteries and electric motors. The optimal status of these is very much a function of today's state-of-the-art rather than a fundamental superiority. Material shortages can be addressed though further exploration and production, alternative technologies and recycling. While the shortages when demand is compared with known reserves are real, they are far from being show stoppers. Technology developers need to be aware of these in advance and proactively pursue viable alternative solutions.

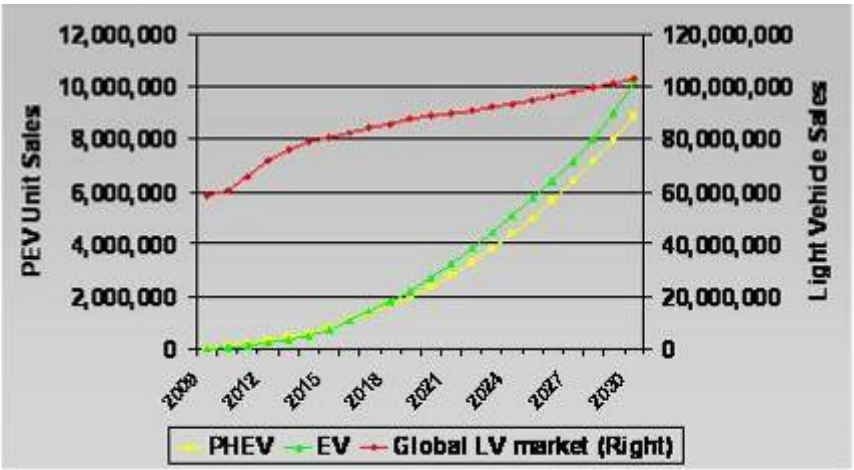
After assessing both the challenges and the solutions, The IHS Global Insight study forecast the future of the grid-based vehicle, known as a Plugged-in Electric Vehicle or PEV, in three different scenarios: Business-as-Expected, and two alternative scenarios, Disruptive and Cornutopia, that spring from a major challenge to sustainability brought about by continued adherence to today's model of personal mobility. PEVs are divided into two subcategories, pure battery electric vehicles (BEVs) that are powered only by an on-board battery charged from the electric power grid, and the plug-in hybrid electric vehicle (PHEV) that combines an internal combustion engine with a battery. PHEVs can be charged from the grid and run anywhere from 20 to 100 miles before needing the internal combustion engine. In some cases, PHEVs may be called extended range electric vehicles (EREVs).

BEVs will find a natural home in urban environments, while PHEVs will play a transitional role in the city-focused markets of Europe and Asia, but a more long term role in the United States. The size of the market will depend upon external motivating factors, as BEVs will continue to offer the end-user less perceived versatility and convenience when compared to their liquid-fueled competition. Pro-active actions by third party stakeholders (third party to the traditional consumer-car maker business model) can and will offset these shortcomings, and new models of ownership through car-sharing and battery leasing schemes will offer urban dwellers greater freedom and potentially lower mobility costs. Achieving a high-volume end-state will require a substantial change in the classic automotive industry business model.

In the Business-as-Expected Scenario, today's market is expected to evolve with only the slightest of manipulation by governments and other third parties. The consumer is expected to continue to use personal motor cars for work and play in a manner more or less the same as today. Each of the two alternative scenarios include strong moves away from the extensive use of the privately owned motor vehicles in urban areas, accompanied by significant third-party influence changing the attitude of consumers towards the car and how it is used.

Indeed, the pathway for commercialization for these new generation vehicles highlights the needed role of government and the utility sector in this debate, as mainstream consumers will be more attracted to the range and convenience of PHEV (including EREV) vehicles. These are expected to dominate early on. As time progresses and the infrastructure evolves, some of the early urban PHEV owners will realize that their usage is predominantly in full-electric mode and a large-scale switch to BEVs could begin. Initially BEVs will be mainly targeted at fleets: cars and LCVs. Fleets use more pure-business criteria for purchase decisions, and the governments will initially target private and public fleets with incentives to grow production volumes and public awareness and comfort with the technology. Car-sharing programs will then also begin to use BEVs. With the evolving charging infrastructure, PHEVs are increasingly sold to those who need to go on long distance trips, due to range and hybrid-like fuel economy. As PEV volumes increase, utilities, perhaps with the urging of the government, develop business models that offer economic incentive to PEV owners to provide spinning reserve and second lives of batteries, reducing life-cycle costs of PEV owners while offsetting capital expenditures by the utilities. By 2025, some direct government incentives to private and fleet owners may begin to decline, as private sector funding takes over. By 2030, with all of this third party assistance (from governments, utilities, employers, etc.) it is expected that the urban transport sector can be largely converted to BEVs. This will be possible only if the consumer gets help in overcoming the initial perceptions of reduced flexibility and convenience they have been led to expect, almost as a birthright. With the assistance of third parties, the BEV is expected to remain an important but niche market product in a business-as-expected world.

Global Market Forecast, Business-as-Expected Scenario



In the two alternative scenarios, PEVs gain a much larger global market share. In these scenarios, urban consumers are expected to evolve away from traditional models of vehicle ownership and use, and a split car market will evolve. One side of the market will consist of small, electric urban vehicles. The other half of the market will consist of large and/or luxury cars along the Gran Turismo theme, suitable for long distance travel. Mid-sized cars will fit neither category, and are expected to decline in importance.

2030 Global Market Shares of PEVs by Scenario

	Business-as-Expected	Cornutopia	Disruptive
PHEV Share	8.6%	31.3%	21.6%
BEV Share	9.9%	29.2%	30.0%

The study concludes that while there are certainly some sound technical contributions electric vehicles powered from the grid can make towards sustainable mobility, their future remains uncertain. Many factors currently point to a positive outlook, but technology, customer expectations and cost limitations exist, and are expected to remain for the foreseeable future. Advances in technology have taken the industry light-years away from the early 1900s and hybrid vehicles have made great inroads, but batteries are still a critical issue for the pure battery-electric (BEV) and even the plug-in hybrid (PHEV) vehicle of the future. Lithium-ion battery technology is likely to take us a long way toward the ultimate solution as is technology that blends the internal combustion engine (ICE) with nano technology for battery chemistry. Ultimately both the consumer and the auto industry must embrace a new and somewhat different relationship with the automobile, its use, enjoyment and ownership.

To purchase the complete study, please contact:

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