ELECTRIC VEHICLES

Electric vehicles are gaining in popularity as clean, reliable alternatives to gasoline-powered automobiles. Battery Electric Vehicles (BEVs) and Plug-In Hybrid Electric Vehicles (PHEVs) present an opportunity to reduce local emissions, expand the U.S. clean fuel sector, and reduce dependence on foreign oil.

Checking our Tracks: The History of EVs

At the turn of the century, steam and electricity were both considerably more popular as transporation fuels than gasoline as both were more readily available to consumers and manufacturers. Biofuels also powered many early vehicles.

Rapid improvement to roads and fueling station availability in the 1910s and 1920s, combined with a precipitous decrease in gasoline prices, paved the way for gasoline as America's transportation fuel of choice.[1] The ability to transport Americans quickly and cheaply at great distances heralded the triumph of gasoline over electricity. Electric vehicle production remained essentially dormant from the 1920s through the 1990s, with scattered attempts to manufacture electric vehicles in the 1960s and thereafter failing.[2] The California Air Resource Board (CARB) attempted to create a market with 1990's Zero Emission Vehicle (ZEV) mandate.[3] The ZEV mandate was ultimately weakened by CARB, and it did not produce a meaningful impact on gasoline's dominance over transportation fuels. It did, however, set the stage for electricity's re-introduction into the market.

ABCs of EVs

HEV: Hybrid Electric Vehicles charge their batteries from a gasoline or alternative fuel engine and regenerative braking and therefore do not need to plug into a grid. The battery and the engine are used interchangeably. *Examples: Toyota Prius, Honda Insight, Chevy Malibu Eco, Ford C-Max Hybrid*

BEV: Battery Electric Vehicles operate entirely on battery power drawn from a grid. These plug-in vehicles use no conventional transportation fuels, operating solely on electric power. The lack of conventional tailpipe emissions qualifies these vehicles as ZEVs. *Examples: Nissan Leaf, Tesla Roadster, Ford Focus Electric, Mitsubishi "i"*

PHEV: Plug-In Hybrid Electric Vehicles use both an electric motor and a conventional engine. Using electricity drawn from a grid, these vehicles can drive entirely on electric power, and then use the conventional engine to charge the battery as normal hybrids do. *Examples: Chevy Volt, Toyota Prius Plug-In, Ford C-Max Energi*

Sales of hybrid electric vehicles (HEVs) have steadily increased throughout the 2000s and now represent a significant segment of new vehicles sold in the United States.[4] Hybrid electric sales in the United States rose over 400% between the years 2003 and 2005, and have continued to trend steadily upwards.[5] On the heels of hybrid electric successes, BEVs and PHEVs have been introduced into the marketplace. Just as hybrid electric vehicles sold limited quantities during their initial years on the market (less than 30,000 total during the first three years of sale), BEVs and PHEVs have sold limited numbers, but also trend upwards.[6]

EVs in the World Today

Electric vehicle technology has overcome many barriers that led to the supremacy of the gasoline engine. Electric vehicles can now travel reliably at high speeds across the nation's interstate highways. If gasoline prices increase as projected, consumers will save money with electric vehicles over a car's lifetime, and

Year	HEV % of Total Sales
2001	**0.13%**
2002	**0.22%**
2003	**0.30%**
2004	**0.54%**
2005	**1.32%**
2006	**1.67%**
2007	**2.31%**
2008	**2.25%**
2009	**3.17%**
2010	**2.01%**
2011	**2.17%**

initial BEV and PHEV prices are steadily decreasing as technology improves.[7] Infrastructure challenges still present a barrier to electric vehicle success, though electric charging station availability has begun to spread widely in recent years (see information box "Connect with Charging Stations").

Current sales of new BEVs & PHEVs average approximately 3,500 per month, or 0.3% of total new vehicle sales in the United States, double the sales rates from the previous year.[8] The sales rate also falls in line with research estimates that project total 2012 sales of BEVs and PHEVs in the range of 40,000 to 60,000.[9] These sales are supplementing HEV sales, not cutting into them – HEVs now account for well over 3% of total new car sales. This percentage is the highest since July of 2009, when the federal Cash for Clunkers program resulted in a spike in new HEV sales.[10]

Similiar to consumer HEV options expanding as HEV sales increased, auto manufacturers are introducing many new BEVs and PHEVs to the market. In 2003, only three HEV models were available to the public; that number increased tenfold by 2011.[11] Seven total BEV and PHEV models are currently on the market, most notably the Nissan Leaf (BEV), the Chevy Volt (PHEV), and the Plug-In Prius (PHEV).[12] Within a year, more than a dozen new models will be available to consumers.

Rolling Forward: The Future of EVs

Electric Vehicle sales are projected to increase steadily in the next decade. Accounting for gas prices, governmental incentives, consumer attitudes, and available infrastructure, Pike Research suggests that approximately 400,000 BEVs and PHEVs will be on American roads by the end of 2015. With new CAFE standards ensuring a market for clean, high-mpg vehicles, optimism for continued sales of electric vehicles is a safe bet. Projecting future electric vehicle sales requires accounting for four major factors:[13]

- gasoline prices;
- government incentives;
- consumer attitudes; and
- available infrastructure.

Perceived Disadvantage	Description	Solution
Limited Range	"Range Anxiety" is the concern that drivers will not have enough power to reach their destination. This concern stems from a lack of recharging stations relative to the current availability and visibility of gasoline stations.	Public charging stations are proliferating throughout the US. As they become more widespread and visible, and as battery range improves, range anxiety among consumers will diminish.
Price Premium	Electric vehicles cost up to $10,000 or more than similar gasoline-powered vehicles. Many consumers can't or won't pay such a premium for electric power, and not every vehicle qualifies for the $7,500 federal EV tax credit.	Improvements in battery technology will lead to lower price premiums on electric vehicles. Increased economies of scale will reduce prices as electric vehicles become more popular. Lower operating costs lessen the price premium over the life of a vehicle.
Charge Time	Most residential and public charging stations take between 3 and 20 hours to fully recharge a vehicle. The required time to recharge can be burdensome when compared to the quick refueling process for traditional gasoline engines.	DC fast chargers, which take a maximum of 30 minutes to fully recharge a vehicle, are entering the market. Alternative evening electric prices also create incentives for owners to charge their vehicles at night.
Safety	Rumors of lithium-ion battery fires, particularly those produced for the Chevy Volt, created consumer uncertainty over the batteries' safety and stability in vehicular accidents.	The batteries have been extensively tested and have been shown to be safe. Safety is no longer included as a top concern among prospective buyers.

Connect with Charging Stations

BEVs and PHEVs can both be charged through Electric Vehicle Supply Equipment (EVSE). These outlets can be installed residentially, in public places (parking garages and office lots), and on commercial lots that operate like current gas stations. Many, but not all, major auto manufacturers have adopted a universal charging plug in 2011 for their new electric vehicles.[16] Most PHEVs can be recharged at home through standard 110V plugs. BEVs, which have larger batteries, often require a more substantial and expensive charging equipment, with installation often over $2000.

Charging times vary based on the EVSE, but recharging batteries normally takes longer than gasoline refueling. Charging Levels I & II, typically found residentially and publically, can take between 3 and 20 hours. DC Fast Charging, available at commercial stations, can fully charge a vehicle in as little as 15 to 30 minutes.[17] Over 10,000 public and commercial charging stations are scattered throughout the country, with new stations continually being built. Keep up to date with locations here: http://www.afdc.energy.gov/afdc/fuels/electricity_locations.html

State	Stations
Maine	**3**
New Hampshire	**33**
Vermont	**16**
Massachusetts	**301**
Rhode Island	**15**
Connecticut	**107**
New York	**416**
New Jersey	**153**
Pennsylvania	**63**
Delaware	**6**
Maryland	**274**
District of Columbia	**76**
West Virginia	**11**
Virginia	**180**
NEMA Total	**1654**
California	**2258**

Making it Over the Hill: Challenges in the EV Market

Electric vehicles must overcome several disadvantages before gaining wider traction in the marketplace. The chart on the opposite page highlights the most pressing issues confronting electric vehicles and suggests solutions.

Electric Vehicle Geographic Forecasts: Plug-In Electric Vehicle Sales Forecasts by State, Metropolitan Statistical Area, and Selected Utility Service Territories

Pike Research, published in the 1st Quarter of 2011.

Green Light: Current EV Opportunities

Many states promote electric vehicles through subsidies, market incentives, or preferential policies. Every state in the Northeast and Mid-Atlantic offers some combination of the following incentives:[15]

- **Tax Credits, Rebates, and Exemptions:** Many states offer a host of credits, rebates, and exemptions for electric vehicles in addition to the $7,500 federal tax credit for new electric vehicle purchases, including reduced registration fees and credits for the costs of installing residential charging stations.
- **HOV Lanes:** In congested urban areas, HOV lanes are easy and attractive ways to get ahead of traffic. State governments have created incentives to purchase electric vehicles by allowing qualifying single-occupant electric vehicles to access HOV lanes.
- **Alternative Pricing:** Utilities in many states have developed special pricing schedules for electric vehicle owners. These owners refuel at a lower cost due to preferential night time electric prices.

The State of California may provide an interesting test case for these factors. Respective to the list above, California meets all of the criteria for high electric vehicle demand. Unsurprisingly, it is the United States' largest market for electric vehicles, accounting for nearly half of all electric vehicle sales.[14] By similarly investing in charging infrastructure and progressive environmental policies, other U.S. regions can grow into major electric vehicle markets. As the second largest market, the Northeast and Mid-Atlantic show tremendous opportunity for growth.

	HOV Lanes & Preferred Parking	Alternative Pricing	Charging Stations	Tax Credits, Rebates & Exemptions
Maine				●
New Hampshire				●
Vermont				
Massachusetts			●	
Rhode Island				
Connecticut			●	
New York	●		●	●
New Jersey	●		●	●
Pennsylvania				●
Delaware		●		
Maryland	●	●	●	●
Washington, DC			●	●
West Virginia				●
Virginia	●	●	●	●

- **Charging Stations:** ECOtality and Coulomb Technologies offer heavily subsidized residential charging stations in several of the country's largest metropolitan areas, many of which are located in the Northeast and Mid-Atlantic.

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Endnotes

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