

Equities

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U.S. Autos and Auto Parts

Electric Vehicles: Perspectives on a Growing Investment Theme

■ Industry Overview

- **What's New?** — In collaboration with Ceres, the Investor Network on Climate Risk, Baum and Associates, the Rutgers University School of Planning and Public Policy and the University of Michigan Transportation Research Institute, we conducted an overview of the current state of the dynamic electric vehicle (EV) industry, with a focus on individual company product plans, key technological issues, and latest government policies that may influence the development of this industry. The report is designed to provide investors with an educational overview of this important automotive theme.
- **Automaker EV Product Highlights** — Traditional automakers, as well as a number of start-ups, continue to establish inroads into the EV market, which currently comprises ~3% of U.S. sales volume. General Motors headlines a new class of electric vehicles with the recent launch of the Chevy Volt. Toyota remains a key player as it develops a suite of EV vehicles around the popular Prius name, and Nissan is staking its claim on full electrics with the mid-size Leaf. Of the non-traditional manufacturers, Fisker and Tesla's plans appear the most advanced, with significant technological and financial resources in place.
- **Hybrid & Electric Vehicle Sales Outlook** — By 2015, Baum & Associates forecasts over 100 models available in the U.S. market covering the four technology groups (including fuel cells), but many of these products will sell only in modest volumes. The forecast outlined in this report anticipates that sales will grow from approximately 2.5% of the total market this year to 6.3% in 2015 with total sales of over 900,000 units. Regular hybrids will remain most prevalent in both number of vehicle offerings and volume (approximately 55% of projected volume); with plug-ins and full electrics each representing about 20% of projected volume.
- **Key Developmental Issues to Address** — Critical technological issues include the status and cost of battery technology and infrastructure support. Increasing volume, technological advancements, and creative business models (battery leasing) all promise to improve the value proposition of electric vehicles over time. Government regulation and policy are also influencing the industry through measures such as the Federal Corporate Average Fuel Economy (CAFE) standard and emissions requirements, the California Low Emission Vehicle Program, and its zero emissions vehicle standard, and other state and regional fuel standards.

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See Appendix A-1 for Analyst Certification, Important Disclosures and non-US research analyst disclosures.

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Overview:

Background:

Established auto manufacturers, as well as a number of start-ups, remain committed to gaining a foothold in the fast-growing electric vehicle market. Additionally, governments at all levels are supporting this growth with a variety of incentives to spur production, measures to support charging and parking infrastructure, and programs to encourage consumers to adopt electric vehicles. This report provides an overview of this fast-changing field. Specifically, this analysis will address the following: (1) the current state of the industry's products and likely sales volumes in 2015; (2) the technological barriers that must be overcome for the industry to reach its potential; and (3) the relevant governmental incentives and regulations that are currently in place.

Figure 1. Fuel Economy Summary "Cheat Sheet"

	Traditional ICE Downsizing & Boosting	Diesels	Full Hybrids	Plug-in Hybrids (PHEV)	Electric Vehicle (EV)	CNG
Fuel efficient gains	15-20% better mileage. Turbocharging preserves performance.	35-40% better mileage. Comparable with many full hybrids in highway driving.	25-50% improvement in today's NiMH hybrid systems. Advantage over diesels in city driving. Less so in highway driving.	40-100+% improvement with all electric drive (10-40 mile range)	100+% improvement with zero tailpipe emissions (Renewable sources can drive WTW gains over time)	Somewhat lower energy density vs. conventional ICE
Appeal to performance & adaptation	High – 20% superior torque typically. Little consumer adaptation concerns.	High – 50% higher torque and "fun to drive". Consumer acceptance an issue.	Medium – Performance compromised somewhat but low adaptability hurdles. Consumers perceive it as "Next Gen" technology.	Medium - Dual motor/battery lessens battery anxiety risk for consumers.	Medium– "Fun to drive" factor of EVs partially offset by potential battery range anxiety, with the latter likely to be addressed by infrastructure and improving range	High – Adaptation likely smooth
Appeal to environmental & national goals	Low - Not an environmental "game changer". Stricter proposes regulations beyond MY16 might make these technologies less impactful.	Developing – New marketing in U.S. and old stigma of diesels	High – Emission reduction and lower dependency on foreign oil. Great environmental appeal particularly in larger cities.	High – Pure electric range offers breakthrough from conventional hybrids	Very High – Reduces emissions and dependency on foreign oil. Lithium availability and battery recycling are key debatable issues.	High – Lower foreign oil dependency. WTW GHG improves over gasoline
Cost	Reasonable. Technologies exist and logistics manageable. Ideal choice for capital constrained auto industry and strained consumer.	High – Similar to slightly below typical hybrids, better durability adds to value proposition	Higher than diesel but payback improves with higher gas prices and greater city driving. In the U.S. where highway driving exceeds city, diesel makes more sense at present gasoline prices.	High – But more affordable with government credits/incentives. Battery cost reductions key over time.	High – But more affordable with government credits/incentives. Key is reduction in battery cost over time and creative ways to unlock the consumer value proposition (i.e. Better Place model)	High – Infrastructure and vehicle adaptability, but mainly infrastructure.
Challenges	Meeting long-term regulatory standards without additional technology.	Emissions costs and consumer perception	Costs, safety, and potential changes in consumer demand.	Costs, safety and infrastructure	Costs, safety and infrastructure	Infrastructure and less zero tailpipe emission appeal as EVs
U.S. Exposed Companies	BWA	BWA, TEN	JCI	JCI, EnerDel, A123 among others	JCI, EnerDel, A123 among others	Possibly BWA with turbo technology

Source: Citi Investment Research and Analysis

Electric Vehicle Product Plans:

As the electric vehicle industry continues to evolve amid ever changing technology and policy updates, auto companies continue to develop diverse approaches to compete in the market. Toyota remains the industry leader, building upon its high volume Prius model. Toyota also offers a variety of other hybrid vehicles including the Toyota Camry and Highlander and the Lexus RX, GS, and the hybrid-only HS. At the same time, Toyota remains more conservative on plug-in hybrids and full electrics, concerned that a failure to meet consumer expectations regarding these vehicles could damage the entire electric vehicle market. Nevertheless, Toyota does not want to be left behind and so is developing plug-in and full electric vehicles, both independently and with partners including Tesla.

Ford is already active in the hybrid market through the Escape, the Fusion, and now the Lincoln MKZ. Ford will also be expanding into both the plug-in and full electric markets with the launch of the Focus and other products. To date, Nissan has been a modest player with a hybrid version of the Altima based on Toyota technology. Carlos Ghosn, CEO and President of Nissan and Renault, has made clear his skepticism of hybrids, and has strongly committed both companies to the full electric market, exemplified by the global launch of the Leaf. GM has been a modest player in the hybrid market with two rather unique technologies, the mild hybrid (used in midsize vehicles) and the Two Mode Full Hybrid (used in large trucks). The company has widely promoted the Chevrolet Volt (which will also be marketed as the Opel Ampera in Europe) as a means to position the company as an industry leader in the growing plug-in market.

Other established automakers have been more conservative. Consistent with its overall strategic approach, Honda has been cautious in its approach to electric vehicles. Chrysler (now with Fiat's influence) and Mazda have elected to participate in a modest way in the market, and are planning to be more active in diesel-powered products rather than electric-powered vehicles. Likewise, some of the European-based manufacturers are conservative in their approach to electrics, preferring to focus on their already strong position in diesel, with Volkswagen the possible exception in its plans for a variety of electric vehicle products. BMW has or will have a number of products, although the expected volume is limited.

Among the non-traditional players, Tesla and Fisker are the leaders, both producing vehicles in limited volume at higher price points. Both companies have committed to reducing vehicle costs and thereby increasing their volumes with more mainstream offerings. A number of other firms are also seeking to enter the market, with investors and government funding supporting their launches, though not all of these companies are likely to succeed.

By 2015, Baum and Associates forecasts over 100 electric vehicle models could be available in the U.S. market covering the four technology groups (including fuel cells), but many of these products will sell only in modest volumes. The forecast anticipates that sales will grow from approximately 2.5% of the total market this year to 6.3% in 2015 with total sales of over 900,000 units. Regular hybrids should be the most common in terms of number of entries and volume (approximately 55% of projected volume); with plug-ins and full electrics each representing about 20% of projected volume.

Toyota is anticipated to be the market leader, with a variety of other companies splitting the balance of the market. Volume in the market is somewhat skewed in favor of products that will be sold in high volume, with almost 40% of the total volume based on only four models, each with sales of 50,000 units or more annually by 2015. These four models are the Toyota Prius hybrid, the Nissan Leaf, the Chevrolet Volt, and the Toyota Prius plug-in.

Key Technological Issues

The traditional hybrid vehicle is the current industry standard. Growth in plug-ins and full electrics will require dramatic improvements in cost, packaging, and chemistry in the underlying battery technology. The industry is shifting from nickel metal hydride to lithium ion (the technology used in cell phones and portable computers). Private and public investments are also supporting a number of potential successor technologies. Energy density is the leading measure of efficacy, allowing the best combination of power and (lack of) weight. Of course, battery cost reduction remains a critical issue, and while manufacturers continue to make progress on that front, it remains a key industry focus.

The growing vehicle market has led to increased interest from companies seeking to supply batteries, with a number of both large and small players joining Panasonic and Sanyo (acquired by Panasonic). These new players include A123 Systems, Compact Power, Dow Kokam, EnerDel, Johnson Controls, LG Chem, and Sony. Equally important is the development of a charging infrastructure to support the batteries and provide convenience to users who will need to continuously charge their vehicles at home, work, and other locations. The provision of high voltage charging sources is important so that charging time can be minimized (particularly when drivers are not at home). Designing charging stations that will accommodate a wide range of vehicles is critical and a number of trade groups and companies are addressing the issue.

Beyond the direct technology issues, the industry must address other vehicle systems and components challenges, including advances in motors (that will provide power to vehicle systems that previously relied on the engine), major improvements in electronics, and enhanced cooling systems.

Even with these improvements, the electrification of the vehicle will require adjustments across the supply base, with reduced vehicle weight (including the weight of most vehicle subsystems) and increased aerodynamics necessary for improved performance from battery powered vehicles. The use of electronic brakes and steering systems are necessary and will require improvements in the vehicle's electrical system. Finally, the availability of lithium and certain rare earth materials is a debatable concern, as these supplies are concentrated in a small number of countries including China.

Government Policy

The United States has seen a steady increase in government support for the electric vehicle industry that is designed to not only catalyze manufacturing of the vehicles but also to support infrastructure development and consumer preferences. This support comes at all levels of government: municipal, state and federal. Additionally, it includes a complementary suite of measures that comprises a mix of "carrots and sticks," including fuel standards, subsidies, financial credits and tax incentives, and non-financial incentives such as access to HOV lanes and preferred parking.

Financial Incentives

Government has provided financial incentives both to influence consumer demand and commercial availability of advanced EV technology. These financial incentives are offered at the state and federal level with the federal government providing the largest source of resources. In particular, the American Recovery and Reinvestment Act (ARRA) has not only applied a significant level of resources to EV deployment but also has deployed those resources to a diverse range of policy areas including incentives for EV and component part manufacturing, consumer purchase, and charging infrastructure installation. A majority of ARRA's funds have been directed towards grants, tax credits, and loans for both vehicle and component part manufacturers, including for new "start up" operations as well as expansion of existing EV portfolios. Other public sector strategies designed to grow the market include consumer tax credits for the purchasing of electric vehicles, and requirements or incentives for vehicle purchases by government entities. Tax credits and sales tax deductions aimed at consumers and businesses are designed to defray high purchase costs.

Monetary grants to date have been to a wide variety of recipients, including major automotive manufacturers as well as emerging companies. Traditional auto suppliers have been active in seeking and receiving funds, while a variety of less well-known specialty firms in the areas of battery development and components and/or supporting technology for batteries have also been awarded funds. The federal strategy, to date, has been to distribute funds to a variety of companies and technologies, with the expectation that the market will ultimately determine the most cost-effective approaches.

Regulatory Thresholds

Considerable efforts are underway at the state and federal level to develop market-based regulations that, while not directly prescribing EV deployment per se, support and foster a market for EVs. Key regulatory actions include the new Corporate Average Fuel Economy (CAFE) requirements, and the California electric vehicle requirements that will provide incentives (and penalties) to automakers for meeting (or missing) regulatory requirements. Electric vehicles will also receive "bonus points" within the CAFE system to encourage development over the long-term.

Over the past 20 years, the California Zero Emission Vehicle (ZEV) program has had a significant effect on developing advanced technology vehicles, especially zero-emission vehicles (ZEVs). The ZEV regulations, which have been modified several times since 1990, have spurred new low and zero emission technologies in a series of interactive steps. These zero emission vehicle standards in California (and also adopted by the northeastern states), have encouraged electric and other advanced technology vehicles and have given pure ZEVs significant credits towards meeting the standards. However, under the new ZEV requirements, plug-in hybrids and pure electric vehicles look to be heavily favored. And since over a dozen other states either have the California Low Emission and ZEV programs or are in the process of adopting them, the number of such vehicles may increase for the nation as a whole.

Additionally, the emergence of state and regional fuel standards intended to favor lower carbon fuels may potentially emerge as a driver of growth in the EV industry. For example, California's Low Carbon Fuel Standard (LCFS) requires fuel providers to reduce the carbon content of their products sold in California gradually over time by mixing lower carbon fuels into their product portfolio, or by buying credits for the sale of lower carbon fuels. Various permutations of the LCFS are under design or consideration in 26 states and four Canadian provinces.

Non-Financial Incentives

A wide variety of non-financial incentives are emerging, particularly at the state and local level. These incentives, including the use of HOV lanes, parking privileges, and reduced inspection fees and requirements, cannot singularly drive major EV market deployment, though the convenience they provide can help win inroads into consumer preferences. Also important for some is the status symbol that owning a "green" vehicle represents, a phenomenon especially directed at higher income consumers who are more likely to purchase EVs.

Definitions

As shorthand throughout this report, the term "electric vehicles" or EV will be used to refer to the three electric vehicle variants listed below, plus fuel cell vehicles.

Battery Electric Vehicles (BEVs) or Full Electric Vehicles (FEV)

Pure electric cars are propelled by electric motors that run on batteries with no internal combustion engine present. FEVs therefore produce no tailpipe emissions. A number of car manufacturers and other companies are developing these vehicles with some already on the road. The cost of vehicle operation is modest, although there is a lack of infrastructure for charging the vehicle both in homes and in other places. In addition, vehicle cost is quite high as this is a nascent industry.

Hybrid Electric Vehicles or HEVs

Hybrids are vehicles that typically include a traditional internal combustion engine and one or more electric motors. Although there are a number of technologies, most hybrid vehicles charge their batteries by regenerative braking. Engines in a hybrid can run on gas or diesel or potentially other fuels. In general, the size of the internal combustion engine is smaller than if the batteries were not "on board," resulting in higher gas mileage and lower emissions. The cost of these vehicles is relatively high, since two propulsion systems are included in the vehicle.

Plug-In Hybrid Electric Vehicles or PHEVs

Plug-in hybrids are gasoline-electric hybrid vehicles that can be recharged from the power grid, allowing increased range and thereby reducing the cost of operation. A traditional engine provides additional driving range as needed after the batteries have been depleted. PHEVs are best suited for relatively short commutes, thereby limiting the amount of gasoline used. The inclusion of two power plants (just as in the HEVs) adds cost to the purchase price of the vehicle (although leasing and a separation of the cost between the batteries and the vehicle are two ways to reduce the upfront cost).

Fuel Cell Vehicles or FCVs

Fuel cell vehicles run on hydrogen gas and emit no greenhouse gases. A number of automakers have test fleets, but the technology remains under development. The need for supporting infrastructure is particularly important. FCVs contain a fuel cell stack that converts hydrogen gas from the vehicle with oxygen from the air into electricity that powers the electric motor that propels the vehicle. A hydrogen storage tank is the heart of the system where the element is stored at extremely high pressure.

Analysis of the Electric Vehicle Industry

Overview of Manufacturer Product Plans

At present, a variety of “regular” hybrids (not plug-ins) are on the market with a number of products forthcoming. A description of current and future plans by automakers is shown below, with products currently on the market or those that will be soon listed.

BMW

The X6 uses the Two Mode hybrid technology shared with GM and the former DaimlerChrysler and has launched, with other offerings including an X3 hybrid, a full electric Mini and a 7-Series hybrid. The company has also shown a concept version of a 2+2 sports car with a diesel electric powertrain and is testing an electric version of the 1-Series, known as the Active E. A 5-Series Active Hybrid is also being developed along with a plug-in hybrid known as the Vision, utilizing lithium polymer battery technology.

In addition BMW began to offer early images of an electric city vehicle that they are calling the Megacity Vehicle (MCV). According to early announcements, it is being developed as a zero-emission electric vehicle for sale sometime in 2013 under a sub-brand. The MCV will be made out of a futuristic carbon-fiber/plastic composite material and that lightweight material will be designed to offset the usual weight increase of the vehicles battery pack, (which can add as much as 750 pounds of additional weight). The MCV will use an all-new lithium-ion battery, which is currently being tested on the BMW ActiveE concept car, and will have an expected range of 100 miles.

Chrysler

For a brief period, the Dodge Durango and Chrysler Aspen hybrids were on the market. However, the non-hybrid versions of these vehicles were discontinued, which also resulted in the termination of the hybrid models. A small number of Fiat Doblos (a commercial van) are expected to be fitted with electric technology for fleet customers by 2012, along with an electric version of the 500 in that same time frame.

A regular hybrid version of the Dodge Ram (using Two Mode technology shared with GM and BMW) has been scrapped, but a plug-in version and perhaps full electric versions may be readied in limited numbers for fleet customers for 2011 or later.

Ford Motor Company

The Ford Escape and Mercury Mariner (as well as the platform mate Mazda Tribute) represented the first sport utility hybrids in the market and have been successful since their introduction in 2005, although the Mercury brand has since been terminated. A plug-in version of the Escape may appear when the vehicle is updated in 2012. The Ford Fusion Hybrid launched last year and has been joined by the Lincoln MKZ. The Transit Connect (imported from Europe for now, but final assembly and powertrain placement will occur in the U.S. this year) will launch as a full electric vehicle with technology from Magna, Johnson Controls/Saft, and BorgWarner. It will have a range of up to 100 miles and requiring six to eight hours to charge. Once the Ford Focus is updated to its global platform in late 2011, a full electric version should be available, followed by a plug-in version in 2012. Ford has been testing a small fleet of Focus fuel cell vehicles for some time, but the project remains in the research stage. The C-Max off the C1 Platform will have a hybrid variant, launching in 2013.

General Motors

General Motors currently has two hybrid technologies in its “stable,” namely a Two Mode Hybrid (developed in concert with BMW and the former DaimlerChrysler) and a mild hybrid that, due to issues arising from GM’s changing product plans and production issues, is just returning to production. “Mild” hybrids provide a more modest mileage improvement from gasoline versions at lower additional cost than other hybrids. Mild hybrid technology should reappear on other GM models in the near term. The technology recently appeared on the Chevrolet Malibu, Saturn VUE, and Saturn Aura.

The Two Mode technology is aimed at larger vehicles that require more torque for special purpose uses (e.g., towing) and is designed to be especially useful for highway use. The more common hybrid technology currently in the marketplace (e.g., that used on the Toyota Prius) is more appropriate for city driving. The technology may be applied to rear wheel drive cars in the Cadillac ATS in the near-term and in the Cadillac CTS when it is redesigned in 2013.

The technology receiving the most attention is plug-in technology, which first launched in Q4 2010 on the Chevrolet Volt. The Volt retails for \$41,000 with a \$7,500 federal incentive reducing that price. The Volt powertrain may also appear on the Cadillac ATS, Cadillac XTS, and perhaps on the Opel Ampera, although that vehicle will not be marketed in North America. Based on GM’s plans for electric vehicle componentry, the company is looking at 70,000 plug-in units annually.

GM is also looking to develop a battery-powered version of the small car Spark, but the sale of the Indian company Reva to Mahindra and Mahindra has slowed these plans.

Also in the development process is a fuel cell vehicle based on the Chevrolet Equinox. A small number of vehicles have been provided to fleets for testing purposes.

Honda Motor Company

Honda was one of the first automakers to introduce a hybrid vehicle, launching the Insight in 1999. Although it was off the market for a time, it was reintroduced in the U.S. in 2009. The Civic Hybrid (launched in 2002) continues to be available and sells in significant numbers, albeit well below the Prius, and will incorporate lithium ion technology in 2011. The Accord Hybrid launched in December 2004, but tepid sales led to its termination in 2007. Honda’s hybrids have been “mild” hybrids; meaning that the mileage improvement obtained is a modest increment from gasoline versions, with the additional cost also less than that of other automakers.

Honda has launched the hybrid CR-Z sports car with a U.S. sales goal of 15,000. Other products include a hybrid version of the Fit, possible in 2011, a full electric and plug-in hybrid in 2012, which has been confirmed by Honda, as well as regular hybrid versions of some Acuras.

The FCX Clarity is now available as part of a test fleet, using fuel cell technology. A significant amount of development must occur before the vehicle proceeds beyond this stage.

Hyundai Motor Company

Hyundai launched its first hybrid on the redesigned Sonata using lithium polymer batteries. A plug-in version may follow by 2012. Kia has shown a plug-in hybrid version of the Forte as a concept and plans to launch a hybrid version of the Optima soon. The company is also planning to launch fuel cell vehicles in low volume by 2012 and is testing a product based on the Hyundai Tucson.

Mazda Motor Corp.

Mazda's current offering was based on its relationship with Ford Motor Company and was produced in very limited volumes. It has also agreed to license technology from Toyota in order to quicken the development of its own products.

Mercedes

The S-Class is Mercedes' first hybrid vehicle available in the U.S. (using lithium ion batteries instead of the current industry standard of nickel metal hydride), although its availability is limited. The M-Class is also available in hybrid form utilizing the Two Mode system. The E-Class hybrid will follow in 2011 and an S-Class plug-in hybrid has been shown in concept form. The next version of the S-Class may be offered only in hybrid form. A diesel hybrid version of the E-Class may launch in 2011.

The parent company of Mercedes (Daimler) currently supplies diesel hybrid buses to the city of Seattle. The Smart ForTwo Car will be released in full electric mode, with Tesla providing the lithium ion batteries for the vehicle with modest volumes in 2010 and larger volumes to come in 2012. A B-Class fuel cell vehicle is also being considered for regular production, with limited volumes available this year to select customers.

Mitsubishi

Mitsubishi and Peugeot (PSA) have collaborated on a full electric vehicle with Peugeot planning to launch its vehicle in the European market in 2010. Mitsubishi plans to introduce this vehicle (currently called the i-MiEV) in the U.S. in December 2011 at a cost of under \$30,000 (before incentives) with batteries provided by GS Yuasa. In addition, a plug-in version (currently named PX-MiEV) has been shown as a concept and could launch in 2013.

Nissan

Nissan currently markets the Altima hybrid in modest volumes, based on Toyota technology provided on license to Nissan. Nissan's CEO Carlos Ghosn had been skeptical of hybrid vehicles and as a result no significant development had occurred. Ghosn has shown a strong commitment to full electric vehicles, with the Leaf representing Nissan's first entry into the market. The company looks for U.S. volumes of 100,000 or more, with around a 100-mile range and pricing at \$33,000 before incentives, competitive with similarly sized gasoline-powered vehicles. With a special 3-phase 200 volt charging station, full charging could occur in 30 minutes. More conventional charging facilities would require 8 to 16 hours. NEC serves as the battery supplier for this and other vehicles. The company's strategy is to focus on larger cars, based on the expectation that buyers of small cars are more sensitive to price and therefore do not represent the most promising market. Ghosn has estimated that more than 1 million plug-in hybrids will be sold globally by 2015.

Other products include an Infiniti M35 hybrid in Spring 2011, an electric sedan with an Infiniti badge off the Leaf, a delivery van, and a sports car. Nissan believes there is potential for 10% of the company's total volume to be full electrics by 2015. Renault (Nissan's alliance partner) is similarly enthusiastic about full electric vehicles for the European market, with the Kangoo being the first product.

Subaru

Subaru, which is now controlled by Toyota, has recently shown the R1E full electric vehicle, a sports car with lithium ion batteries and a 50-mile range. Subaru is also looking at a hybrid vehicle for potential launch in 2012.

Suzuki

Suzuki plans to introduce the hybrid version of the Kizashi, a stylish and high-performance mid-size car in 2011. However, this small automaker will have difficulty being competitive in this portion of the automotive marketplace.

Tata

Tata has announced plans to provide the Range Rover Evoque as a regular hybrid for release in Fall 2011.

Tesla Motors

The Tesla Roadster is now available for \$109,000 as a full electric vehicle with an EPA-rated range of over 240 miles and a sales volume of 700 annually. The Model S sedan is expected to appear in 2012 and will be built in Fremont, California at an estimated cost of \$50,000 and projected annual sales of 20,000 units, with a range of 160, 230, or 300 miles based on the nature of the charging system. The company is also looking into a subcompact with estimated pricing of \$30,000 and a launch date in 2016.

Toyota

Toyota has led the industry in the sale of electric vehicles and has used this leadership to build its reputation among consumers and other industry participants. The Prius has been the best selling electric vehicle by far. Toyota will use the Prius name for a variety of electric vehicles including a PHEV (powered by a lithium ion battery) expected in 2011 and a full electric minicar expected in 2012.

The Camry hybrid has also been popular, with sales of almost 50,000 units in 2008 (with vehicle assembly in Georgetown, KY), although volume has declined since then due to the economic recession. The Toyota Highlander and Lexus RX have been available in hybrid versions for some time, although volumes have been somewhat limited due to cost and a modest fuel economy increment relative to the gasoline versions. Most recently, hybrid versions of the Lexus LS and GS have been made available, and the HS has just been launched as a hybrid-only vehicle. The Lexus LF-A high-end sports car will be available as an electric vehicle in limited numbers (under 200 units) at high cost, perhaps as much as \$400,000.

Future plans include a hybrid version of the Yaris (probably launching in 2012), with hybrids also likely for the Avalon (2013), Corolla (2013), RAV4 (2012) and Sienna (2011). The Toyota iQ (just launched in Europe) will appear as a Scion in the U.S. and a full electric version is likely. Also possible is a Lexus IC coupe as a regular hybrid. The Toyota FT-CH has been launched in concept form as the “little brother” of the Prius, and could be ready by 2012. The Lexus CT200h hybrid has also been shown and will launch in early 2011.

Toyota and Tesla are teaming up to develop test versions of the RAV4 (slated for sale in 2012) and Lexus RX as full electric vehicles. The vehicles would use Tesla’s approach to batteries, based upon thousands of lithium ion battery cells packaged together to power the vehicle, as opposed to larger cells that Toyota has used in cooperation with Panasonic.

Volkswagen Group (Audi, Porsche and VW)

Volkswagen has launched a hybrid Touareg and also plans to release a hybrid Jetta in 2012. The full electric subcompact Up! or Golf (regular diesel hybrid) may appear in the U.S. around 2013 after appearing earlier in Europe. The company has shown a concept of the electric version of the Audi R8 sports car, which it named the e-tron and is set for launch in 2012. Audi also plans to launch the Q5 as a hybrid in 2011 and an A6 in 2012, with an A8 also possible. Porsche (soon to be fully integrated into Volkswagen) is planning a hybrid version of its Panamera sedan and the Cayenne SUV in 2011.

Volvo

Volvo’s plans are unclear, given Ford’s sale of the brand to Geely. However, Volvo has worked on a diesel powered plug-in hybrid with a 60-mile range, with a possible launch date in 2012. The company is also evaluating a full electric variant of the C30 with a 90-mile range due for launch in 2012, using batteries provided by Indiana-based EnerDel, a subsidiary of Ener1. An S60 hybrid is possible at the end of 2012.

Others

The electric vehicle market is full of new firms seeking opportunity in what is seen as a growing industry. While some success stories are likely, some of these firms could fail to produce viable product offerings, while others may be purchased by mainstream automakers.

BYD

The Chinese battery company BYD (benefiting from huge investments by Warren Buffet and the Chinese government) plans to launch the e6 sedan as its first all-electric model in 2011. The vehicle will have a range of 200 miles at a cost of \$40,000 (before incentives) and will require eight hours to fully charge. A plug-in hybrid, currently known as the F3DM, is also planned.

Bright Automotive

Bright Automotive plans to launch the IDEA as a plug-in hybrid designed as a small van/cargo vehicle for business fleets in 2013 or 2014, although production may be contingent on the receipt of a U.S.-backed loan. The company has been assisted by a \$5 million investment from GM (via its GM Ventures unit), which may lead to closer ties going forward.

Coda

Coda Automotive of Santa Monica, CA seeks to sell China-built electric sedans in the U.S. at a price of \$32,000 after incentives, forecasting volumes of 20,000 annually.

CT&T

CT&T plans to launch a neighborhood electric vehicle in 2011 that can reach a top speed of 35 miles per hour. At this time, lead acid batteries will be used, but lithium polymer batteries are planned with LG Chem as the supplier. Domestic production in Southern California or South Carolina is under investigation. The company is also making plans to produce vehicles in Hawaii, which is a strong market for this two-seater low-speed vehicle.

Fisker

Fisker has generated a lot of interest with displays at recent auto shows. The Karma, a plug-in HEV sports car with lithium ion batteries, will launch in early 2011. The vehicle will retail for \$80,000 (after incentives) with a range of 50 miles before the engine kicks in and an estimated volume of 15,000 units. The company is also planning a small car known as the Nina (also a PHEV) at a cost of under \$40,000 (after incentives), with projected volumes of up to 100,000 by late 2012. Fisker plans to build the Nina at a former GM plant in Wilmington, Delaware and eventually plans to bring production of the Karma there with 2016 as a likely timeframe. Much of the volume of both vehicles would be exported.

GreenTech

GreenTech Automotive has announced plans to ramp up to production levels of 150,000 vehicles "in the next few years" at a plant to be built in Tunica, MS. Its vehicle is based upon German engineering and design. The company says it will eventually produce a full line of cars (of different sizes) and SUVs. Employment is slated to grow to 1,500 with an investment of \$1 billion. The company appears to have made little progress towards its ambitious goals.

Myers Motors

Myers Motors currently produces the NmG ("no more gas") one-person vehicle and plans to launch a two-person vehicle called the DuO ("doesn't use oil") in 2011. Pricing for the DuO is slated at \$25,000 before a \$2,500 tax credit. Both of these vehicles are three-wheelers, exempting them from certain regulatory requirements. These vehicles are full electric cars and reach normal highway speeds.

Navistar

The company plans to build all electric delivery trucks in Indiana, helped by a \$39 million federal grant.

Smith Electric Vehicles

This Kansas City-based company has received a federal grant to produce delivery trucks in full electric form. It has plans to expand production to other locations around the country.

Think

Think has produced a small number of full electric cars in Finland for some time. In cooperation with EnerDel, Think will provide the City small car to selected pilot and fleet customers in 2011. Think has selected a site in Elkhart, Indiana for domestic manufacturing and is seeking federal loan dollars. The company plans volumes of 2,500 in 2011 and 20,000 by 2013, with available capacity of 60,000.

ZAP

ZAP plans to make the two-seater Alias, with production starting in China with Zonway, a company it has recently purchased. Domestic production is possible at a later date.

EV Sales & Production Forecast for 2015

The market for electric vehicles is complex and evolving. As described above, a variety of automakers are marketing and developing a range of products to meet regulatory requirements and consumer demand. Beyond the mainstream automakers, a variety of start-ups are active in the marketplace. Sales of hybrid vehicles are just under 300,000 units, or ~ 3% of the market, with 2011 figures expected to remain fairly consistent. Continued economic slowness and low gas prices have reduced demand for these vehicles in the short term, but we do expect an increase in volume going forward.

This section includes volume forecast for the calendar year 2015. The forecast is derived from, and is consistent with, a broader forecast from Baum and Associates that includes sales and production volumes for all vehicles in the North American market at the vehicle nameplate and powertrain level. The inclusion of a powertrain forecast provides the detail necessary to differentiate models that are offered in both internal combustion and electric form (e.g., Ford Escape). This forecast and the data in this document incorporate a variety of factors, including:

- Assumptions on the growth of the overall economy, focusing upon gross domestic product;
- Interest rates;
- Fuel prices;
- Vehicle pricing;
- Manufacturer plans including timing of vehicle updates and available capacity;
- Government policy including incentives to manufacturers and consumers;
- Fuel economy/emissions requirements that manufacturers must meet at the state and federal level;
- Strategies of the various manufacturers; and
- Changes in vehicle segmentation.

Fuel prices and government incentives directly affect the affordability/cost justification of electric vehicles to consumers. Manufacturing incentives and fuel economy and emissions requirements affect the amount and timing of corporate investment, pricing, volume, and production ramp of these vehicles.

Electric Vehicle Sales Volume Forecast for 2015

Figure 2 details 118 separate models that are currently available or could potentially be available in the U.S. market by 2015. While many of these models may sell in relatively modest volumes or not reach the market at all (due to challenges in research and obtaining development funding), the market is clearly growing strongly.

Figure 2. Alternative Fuel Vehicles Currently Available, Confirmed for Future Availability, and Potentially Available by 2015

Current Alternative Fuel Vehicles for Retail Sale

<u>Hybrid Electric Vehicles</u>	<u>Battery Electric Vehicles</u>	<u>Plug-In Hybrid Vehicles</u>	<u>Fuel Cell Electric Vehicles</u>
BMW X6 BMW 7-Series Cadillac Escalade Chevrolet Malibu (Mild) Chevrolet Silverado Chevrolet Tahoe Ford Escape Ford Fusion GMC Sierra GMC Yukon Honda Civic Honda CR-Z Honda Insight Lexus GS450h Lexus HS250h Lexus LS600h Lexus RX450h Lincoln MKZ Mercedes M-Class Mercedes S-Class Nissan Altima Toyota Camry Toyota Highlander Toyota Prius 2010 BMW X3 2010 Hyundai Sonata 2010 Porsche Cayenne S 2010 VW Touareg	Myers Motors NmG Tesla Roadster 2010 BYD e6 2010 Coda Sedan 2010 Ford Transit Connect 2010 Mini E 2010 Mitsubishi iMiEV 2010 Nissan Leaf 2010 Smart Fortwo	2010 Chevy Volt	None

Confirmed/Likely Future Alternative Fuel Vehicle Launches

<u>Hybrid Electric Vehicles</u>	<u>Battery Electric Vehicles</u>	<u>Plug-In Hybrid Vehicles</u>	<u>Fuel Cell Electric Vehicles</u>
2011 Audi Q5 Crossover 2011 BMW 5-Series 2011 Honda Fit 2011 Infiniti M35 2011 Lexus CT200h 2011 Mercedes E-Class 2011 Peugeot Diesel * 2011 Porsche Cayenne 2011 Porsche Panamera 2011 Suzuki Kizashi 2011 Toyota Sienna 2012 Audi A6 2012 Kia Optima 2012 Toyota RAV4 2012 VW Jetta 2013 Acura MDX 2013 Acura TL 2013 Cadillac CTS 2013 Ford C-Max 2013 Toyota Carolla 2013 Toyota Yaris 2013 VW Golf	2011 CT&T Neighborhood Vehicle 2011 Ford Focus 2011 Infiniti Sedan 2011 Myers Motors DUO 2011 Peugeot Urban EV * 2011 Renault Fluence Z.E. 2011 Renault Kangoo Z.E. 2011 Think "City Car" 2011 ZAP Alias 2012 Audi e-tron 2012 Fiat 500 2012 Fiat Doblo 2012 Honda - unnamed 2012 Lexus LF-A 2012 Ram Pickup 2012 Renault City Car * 2012 Renault Urban EV * 2012 Scion (iQ-based) 2012 Tesla Model S 2012 Toyota Prius Full Electric 2012 Toyota RAV4 2014 Volkswagen E-Up (possibe U.S.) *	2011 Fisker Karma 2011 Opel Ampera 2011 Toyota Prius PHEV 2012 Cadillac ATS 2012 Fisker Nina 2012 Ford Escape 2012 Ford Focus 2012 Hyundai Sporty Car 2012 Ram Pickup 2012 Volvo C30 Diesel 2014 Bright Automotive IDEA Van 2014 Cadillac XTS	Chevy Equinox GM Hydro-GEN3 Honda FCX Clarity Toyota - unnamed

Potential Alternative Fuel Vehicles

<u>Hybrid Electric Vehicles</u>	<u>Battery Electric Vehicles</u>	<u>Plug-In Hybrid Vehicles</u>	<u>Fuel Cell Electric Vehicles</u>
Audi A8 BMW Sporty Car Chevrolet Camaro Lexus IC Range Rover Evoque Subaru Sedan Toyota Avalon Toyota FT-CH Volvo S60	BMW Active E (1-Series) Green Tech - unnamed Lexus RX Navistar Delivery Vehicles Nissan Sporty Car Nissan Van Reva NXR Smith Electric Vehicles Subaru R1E Volvo C30 V-Vehicle	BMW Vision BYD Sedan Hyundai Sonata Kia Forte Mercedes S-Class Mitsubishi PX-MiEV	Mercedes B-Class Ford Focus Hyundai Tucson

Note: Years shown are calendar year; (*) denotes Europe

Source: Baum and Associates

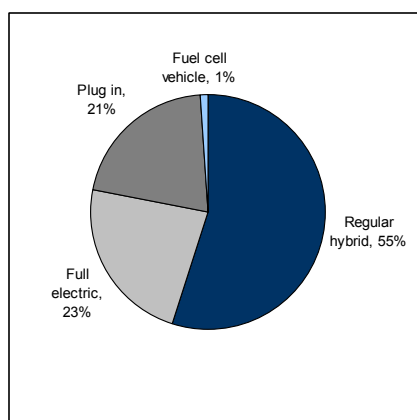
Figure 3. Electric Vehicle Sales Forecast by Type Based on U.S. Sales for 2015

<u>EV Type</u>	<u># of Models</u>	<u>Volumes</u>	<u>% of EV Market</u>
Regular hybrid	57	518,200	55.2%
Full electric	37	215,200	22.9%
Plug-in	18	200,500	21.3%
Fuel cell vehicle	6	5,700	0.6%
All Electric Vehicles	118	939,600	100.0%

Note: Total vehicle sales volume (electric and non-electric) in 2015 is forecast to be 14.8mm
6.3% electric vehicle market share assumption for 2015

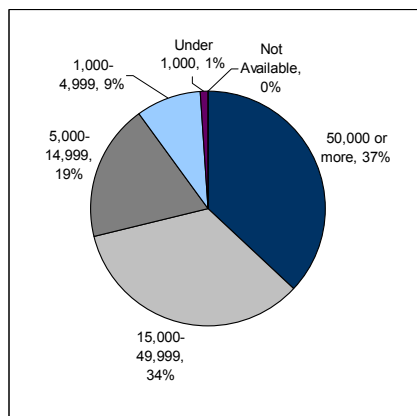
Source: Baum and Associates

Figure 4. EV Sales Forecast by Type - 2015



Source: Baum and Associates

Figure 6. EV Sales by Volume Range - 2015



Source: Baum and Associates and CIRA

Figure 5 demonstrates that almost half of the electric vehicle models expected to be on the market in 2015 will sell in the volume range of 1,000 to 4,999 units. Naturally, the EV models sold in the highest volume ranges will make up the largest share of the total EV volume.

Figure 5. Electric Vehicle Sales Forecast by Volume Range - 2015

<u>Volume Range</u>	<u># of EV Models</u>	<u>% of Total EV Models</u>	<u>EV Volume</u>	<u>% of Total EV Volume</u>
Probably not available	10	8.5%	-	0.0%
Under 1,000	18	15.3%	8,600	0.9%
1,000-4,999	46	39.0%	83,000	8.8%
5,000-14,999	24	20.3%	177,500	18.9%
15,000-49,000	16	13.6%	320,500	34.1%
50,000 or More	4	3.4%	350,000	37.2%
Total	118	100.0%	939,600	100.0%

Source: Company reports, Baum and Associates, and Citi Investment Research and Analysis

Figure 7 demonstrates that a small number of companies are expected to lead the EV market in 2015; namely Toyota, Ford, Nissan, Honda, and GM.

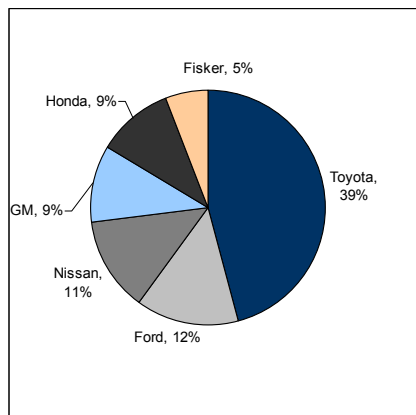
Figure 7. Electric Vehicle Sales Forecast by Company for Calendar Year 2015

<u>Manufacturer</u>	<u># of EV Models</u>	<u>% of Total EV Models</u>	<u>EV Volume</u>	<u>% of Total EV Volume</u>
Toyota	20	18.5%	361,900	0.0%
Ford	9	8.3%	115,400	12.3%
Nissan	6	5.6%	99,300	10.6%
Honda	8	7.4%	84,500	9.0%
GM	12	11.1%	83,500	8.9%
Fisker	2	1.9%	52,000	5.5%
Tesla	2	1.9%	23,500	2.5%
Hyundai	6	5.6%	23,000	2.4%
Volkswagen	9	8.3%	22,200	2.4%
BMW	7	6.5%	14,500	1.5%
Daimler	6	5.6%	12,800	1.4%
Meyers Motors	2	1.9%	11,500	1.2%
Others	19	17.6%	35,500	3.8%
Total	108	100.0%	939,600	100.0%

Note: This table excludes the vehicle models that are considered "potential" where no volume assumed in 2015

Source: Baum and Associates

Figure 8. EV Sales by Company - 2015



Source: Baum and Associates and CIRA

Figure 9 demonstrates that a relatively small number (8) of EV models are expected to account for almost 50% of total EV volume in 2015.

Figure 9. Highest Volume Electric Vehicles in Sales by Type in 2015

<u>Model</u>	<u>Volume</u>	<u>Type</u>
Toyota Prius	150,000	Regular Hybrid
Toyota Camry	40,000	Regular Hybrid
Nissan Leaf	90,000	Full Electric
Tesla Model S	22,500	Full Electric
Toyota Prius PHEV	55,000	Plug in
Chevy Volt	55,000	Plug in
Fisker Nina	40,000	Plug in
Honda FCX	3,500	Fuel Cell
All Electric Vehicles	456,000	

Source: Baum and Associates

Figure 10 demonstrates that these high-volume vehicles represent a significant share of their respective categories. Volume in the plug-in category is the most concentrated.

Figure 10. Highest Volume EV Models as a Percentage of Electric Vehicle Type - 2015

<u>EV Type</u>	<u># of Models</u>	<u>Volume</u>	<u>% of Type</u>
Regular Hybrid	2	190,000	36.7%
Full Electric	2	112,500	52.3%
Plug in	3	150,000	74.8%
Fuel Cell Vehicle	1	3,500	61.4%
Total	8	456,000	48.5%

Source: Baum and Associates

Electrical Vehicle Sales Volume Forecast for 2015

Comparing Forecasts to the U.S. Department of Energy

The Energy Information Administration (EIA), the statistical agency of the U.S. Department of Energy (DOE), presents an annual long term projection and analysis of U.S. energy supply, demand, and prices. The EIA's Annual Energy Outlook 2010 (AEO2010) has projections to 2035, based on results from the National Energy Modeling System (NEMS). The AEO2010 includes a reference case and additional cases examining alternative energy markets. Federal agencies, Congress, and analysts in industry and academia rely upon EIA's forecasts and analyses. The NEMS is becoming the de facto standard tool for national-level comprehensive modeling of energy.

The forecast of electrified vehicles based on Baum and Associates is national in scope, but limited to the light vehicle sector. Please see Figure 11 below for a list of the alternative vehicles that are covered in this forecast. Comparing the forecast of electrified vehicle sales with AEO2010 at the total sales level for 2015, we find that, despite the differences in methodology and approach, the forecasts are consistent with each other and remain well within the mainstream.

Figure 11. List of Alternative Powertrain / Fuel Vehicles Covered in 2015 Forecast

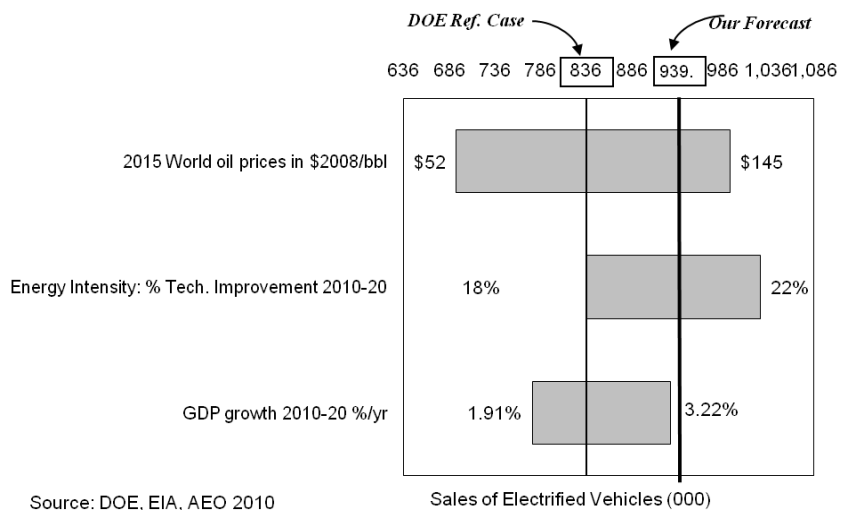
	Ethanol-Flex Fuel ICE
	Ethanol ICE
X	Electric Vehicle
X	Plug-in 10 Gasoline Hybrid
X	Plug-in 40 Gasoline Hybrid
X	Electric-Diesel Hybrid
X	Electric-Gasoline Hybrid
	Compressed Natural Gas ICE
	Compressed Natural Gas Bi-fuel
	Liquefied Petroleum Gases ICE
	Liquefied Petroleum Gases Bi-fuel
X	Fuel Cell Gasoline
X	Fuel Cell Methanol
X	Fuel Cell Hydrogen

X denotes coverage by our forecast and analysis

Source: Baum and Associates

The forecast of unit sales of 939,600 is 103,600 (12%) higher than the AEO2010 Reference Case (836,000). Figure 12 shows total 2015 sales forecasts for electric vehicles along with the AEO2010's alternative scenarios. The AEO2010 Reference Case sets a vertical axis in the figure, and for each scenario, a shaded horizontal bar represents the range of upside and downside impacts of the risk variables. At the ends of the shaded bars we show the values of the scenario factors that have produced the sales impacts.

Figure 12. Scenarios for Electric Vehicle Sales in 2015



Source: DOE, EIA, AEO 2010

The figure reveals that the forecast is higher than the AEO2010 Reference Case, but well within the upside extremes that either higher world oil prices or more rapid improvement in energy intensity would produce, and the forecast is just above what sales would be under the upside economic growth scenario. These assessments are confirmed by the numerical details in the table below.

Figure 13. The Impacts of Significant Risks to the DOE's Forecast of Vehicle Electrification by 2015

Scenarios	Scenario Assumptions			Scenario Outcomes (unit sales in '000s)		
	Downside	Base	Upside	Downside	Base	Upside
2015 World Oil Prices, \$2008/bbl *	\$ 52	\$ 95	\$ 145	694	836	994
Technology & Energy Efficiency % reduction **	18.0%	19.0%	22.0%	884	836	1,028
U.S. Economic Growth %/yr ***	2.3%	3.0%	3.8%	778	836	929

Note: * Imported low-sulfur light crude oil; weighted average price delivered to U.S. refiners. \$2008 per bbl.

** Reduction in thousand BTU per GDP \$2000 from 2010 through 2020 in %

*** Real GDP (billion chain-weighted \$2000) 2010-2020

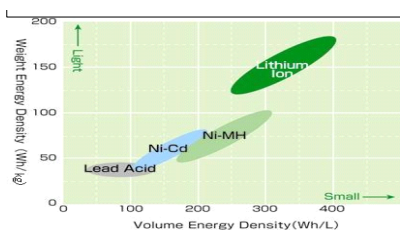
Source: U.S. Energy Information Administration, Annual Energy Outlook 2010 with Projections to 2035 Report #DOE/EIA-0383(2010) Release Date: May 11, 2010

The above outlook was designed to represent the impacts of world oil price, technology, and economic growth on EVs for the sake of individual scenario analysis. We acknowledge that real world market forces can produce divergent results with respect to demand and overall sales volumes.

Overview of EV Technology Issues

The extent of commercialization for PHEVs and EVs will depend on battery technology advancements, infrastructure development, and consumer acceptance (including cost). We briefly discuss these and other issues below.

Figure 14. Battery Characteristic Overview



Source: AESC

Battery technology is a key enabler: The most critical technology enabler of electric vehicles lies in the energy storage, power capability, safety, and life expectancy of the battery. Traditional automotive batteries such as lead-acid (common in nearly all automobiles) and nickel-metal hydride (or NiMH, common in today's hybrid vehicles) have provided affordable and safe energy storage solutions, but they require the existence of the internal combustion engine. We foresee improvements in NiMH technologies, but experts do not expect these technologies to overcome existing shortcomings that include weight and energy density. Rather, the most promising battery technology currently lies in lithium-ion chemistries, which carry significantly higher power and energy density than NiMH. While both lithium-ion and NiMH technologies are expected to have a place in the electrification of the vehicle, only lithium-ion technology is currently promising enough for the truly game-changing plug-in vehicles and full electrics.

Not all lithium-ion batteries are created equal. A typical lithium-ion cell contains an anode (negative electrode) and a cathode (positive electrode) with a thin separator in between. Lithium ions travel to the anode from the cathode through the electrolyte during discharge, and back to the cathode during charge. There are currently a number of different battery chemistries being adopted by companies. Whereas the anode has typically been formulated using graphite, hard carbon, or lithium titanium oxide, the materials used in the cathode often are distinguished by diverse chemical compositions. The aim of the different chemistries is to strike the right balance between power and energy density, safety, life, and cost. Some companies are researching the next material change, namely lithium air or lithium sulphur. These materials are cheaper and lighter than lithium ion, thereby allowing for longer range. The construction of the battery is also a point of differentiation; automakers tend to favor prismatic batteries because they offer high energy density, high capacity, and long cycle life. Once the lithium-ion cells are produced, they are stacked together to form modules and then integrated into a full battery pack system (the final box).

The industry has yet to agree on a "perfect" chemistry; each one has certain tradeoffs. As a quick background, technical attributes are measured based on a few criteria; 1) Power – the rate of energy transfer measured in kilowatts (kW), also expressed as power per kilogram of the battery (W/kg); 2) Energy Capacity – a density measure of capacity storage in the batteries, measured in kilowatt-hours (kWh), expressed as density per kilogram (Wh/kg); 3) Safety; 4) Life; and 5) Cost. Today's hybrids utilize nickel-metal hydride (NiMH) batteries, a reliable long-lasting battery with a proven chemistry to which consumers have become accustomed. However, most scientific studies conclude that the power (kW) and density (kWh) limitations yield low prospects for future extended range capabilities.

Of these criteria, safety would likely rank as the top priority early on for OEMs, since any safety issue could derail the entire momentum of vehicle electrification. The most critical safety issue is what's known as thermal runaway, where chemical reactions lead to potentially fire-causing heat release. The design must take account of the "normal" safety issues associated with charging, as well as the less common issues associated with accidents and repair procedures. Regenerative braking (which charges the battery) followed by a fast charge may introduce too much heat. Thus, the battery must be designed to address that issue (perhaps by "refusing" to charge until the temperature declines). Cooling systems will include air, liquid, or both. Still, even those chemistries deemed less safe today are being modified and improved to address concerns. At this stage, there does not appear to be a clear chemistry winner.

Figure 15. Overview of Lithium-Ion Battery Chemistries

Name	Description	Electrodes: Positive (Negative)	Companies	Automotive Status	Power	Energy	Safety	Life	Cost
LCO	Lithium cobalt oxide	LiCoO ₂ (Graphite)	Various consumer applications (not automotive)	Limited auto applications (due to safety)	Good ⁴	Good ⁴	Low ^{2,4} ; Moderate ³	Low ^{2,4}	Poor ^{2,3}
NCA	Lithium nickel, cobalt and aluminum	Li(Ni _{0.85} Co _{0.1} Al _{0.05})O ₂ (Graphite)	JCI-Saft ³ ; GAA ³ ; Matsuhita ³ ; Toyota ⁶	Pilot	Good ^{1,3}	Good ^{1,3}	Moderate ¹	Good ¹	Moderate ^{1,3}
LFP	Lithium iron phosphate	LiFePO ₄ (Graphite)	A123 ³ ; Valence ⁵ ; GAA	Pilot	Good ¹	Moderate ^{2,6}	Moderate ^{1,2,4}	Good ^{1,4}	Moderate ¹ ; Good ^{2,3}
NCM	Lithium nickel, cobalt and manganese	Li(Ni _{1/3} Co _{1/3} Mn _{1/3})O ₂ (Graphite)	Litcel (Mitsubishi) ³ ; Kokam ³ ; NEC Lamillion ³	Pilot	Moderate ³	Moderate ³ ; Good ⁷	Moderate ³	Poor ³	Moderate ³
LMS	Lithium manganese spinel	LiMnO ₂ or LiMn ₂ O ₄ (Li ₄ Ti ₅ O ₁₂)	GS Yuasa ³ ; Litcel (Mitsubishi) ³ ; NEC Lamillion ³ ; EnerDel	Developing	Moderate ²	Poor ^{1,2,3}	Excellent ¹ ; Good ²	Excellent ¹ ; Moderate ⁶	Moderate ²
LTO	Lithium titanium	LiMnO ₂ (LiTiO ₂)	Altairano ³ ; EnerDel	Developing	Poor ³ ; Moderate ⁷	Poor ³	Good ³	Good ³	Poor ³
MNS	Manganese titanium	LiMn _{0.5} Ni _{0.5} O ₄ (Li ₄ Ti ₅ O ₁₂)		Research	Good ^{1,3}	Moderate ¹	Excellent ¹	Unknown	Moderate ¹
MN	Manganese titanium	Li _{1.2} Mn _{0.8} Ni _{0.2} O ₂ (Graphite)		Research	Excellent ¹	Excellent ¹	Excellent ¹	Unknown	Moderate ¹

Source: 1) Nelson, Amine, and Yomoto (2007, p2); 2) Kromer and Heywood (2007, p37); 3) Kalhammer et al. (2007); 4) Chu (2007); 5) Kohler (2007); 6) Anderman (2007); 7) UC Davis Testing

Battery companies: A variety of companies are involved in the development of these improved batteries. Although Panasonic has been the sole supplier of nickel metal hydride batteries to Toyota to this point, growing demand and technology changes have led Toyota to also contract with Sanyo (whose battery division has been acquired by Panasonic). A variety of other companies are developing batteries including A123 Systems, ActaCell, BYD, Boston Power, Cobasys (recently purchased by SB LiMotive, which is a joint venture of Bosch and Samsung), Compact Power, EnerDel, GS Yuasa, Johnson Controls (with Saft), Sakti3, Sony, and even IBM, which is developing a 500-mile battery. Sakti3 and others want to take non-energy material out of batteries and reduce their cost and weight, thereby increasing energy density. Other approaches are to use new anode materials and improved manufacturing processes.

Figure 16. Major Battery Companies and Their Current and Future Customers

Battery Maker	Automaker Customers
A123	BMW, Daimler, Fisker, GM, Navistar
BYD	BYD, SAIC, VW
Continental	Daimler
Dow Kokam	None announced at this time
Electrovaya	Chrysler
EnerDel	Fisker, Think, Volvo
GS Yuasa	Honda, Mitsubishi
Hitachi	GM
JCI/Saft	BMW, Daimler, Ford
LG Chem (Compact Power)	Ford, GM, Hyundai, Various commercial vehicle makers
Magna	None announced at this time
NEC	Fuji, Nissan, Renault
Panasonic	Tesla, Toyota
Sanyo (acquired by Panasonic)	Ford, Honda, Suzuki, Toyota, Volkswagen
Sony	None announced at this time
SB LiMotive (Bosch/Samsung)	BMW, Renault, Samsung
Tesla	Daimler, Tesla, Toyota
Toshiba	Mitsubishi, VW

Source: Baum and Associates

Over time, it is expected that actual battery chemistries will become more commoditized. Therefore, battery makers would differentiate themselves on the actual design and manufacturing of the battery packs (expertise in assembly, or the “cooking process”), workability, service and manufacturing footprint. Many of today’s existing battery companies have already forged relationships with OEMs, including joint ventures. Companies that are early to build capacity and establish a first-mover supplier advantage of volume contracts may also gain an edge, as they could more quickly benefit from the learning curve, thereby reducing cost. There is some evidence that there may be a surplus of lithium ion battery capacity in the near-term, thereby reducing costs, as battery makers seek to solidify their position in what will be a growing market.

With increased emphasis on hybrids and electric vehicles, the battery industry is racing to find new solutions. A consortium of some 50 U.S. companies has formed The National Alliance for Advanced Transportation Batteries (NAATBatt). The aim of NAATBatt is to enable its members to manufacture lithium-ion battery cells in the U.S. The Society of Automotive Engineers has created a Vehicle Battery Standards Committee to ensure that the developing field of automotive batteries meets industry-established standards of performance and safety.

Cost is perhaps the biggest challenge: The U.S. Advanced Battery Consortium (USABC), an industry consortium leading R&D efforts, has set a number of goals for both PHEV-10 (10-mile electric range) and PHEV-40. Assuming 100,000 units of production, the USABC has set a goal of \$1,700 total OEM cost for PHEV-10 and \$3,400 for PHEV-40, or \$300-500 per kWh of targeted available energy (3.4kWh for PHEV-10 and 11.6 kWh for PHEV-40). This would compare to an estimated \$1,000/kWh today, which on a 16KWh battery pack would amount to \$16,000. Material costs account for about 60% of battery costs. The cost of these battery packs is widely expected to decline over time through typical production volume efficiencies that the growing market will engender along with cheaper materials and technology advancements, all of which will improve the energy density. Industry experts estimate that lithium-ion battery packs may decline by 35-50% by 2020 and perhaps as much as 65% by 2030, even without a technological breakthrough.

While such cost reduction might not meet existing USABC goals, they suggest that the technology should achieve a respectable level of vehicle penetration over the next ten years. Of course, gas prices, government policies, technological advancements and consumer tastes likely render any penetration forecast a moving target. Reducing the cost of these batteries (currently estimated at \$1,000 per kilowatt hour en route to perhaps \$300 per kilowatt hour) is critical.

Another way of looking at the battery cost is on a per vehicle basis. The U.S. Department of Energy estimates that the cost of a battery for an all-electric car is \$33,000 today, declining to \$16,000 by 2012. For a plug-in hybrid, current costs are estimated at \$13,000 today, declining to \$6,700 by 2013. As stated above, increased demand and technical innovation will continue to reduce costs going forward.

Providing an “afterlife” for vehicle batteries would allow for reduced costs since the battery could be resold for use after its period powering a vehicle was complete. EnerDel is researching a program that would allow batteries to be “sold” to the grid to store power, thereby reducing the “original” cost of the battery, whether the vehicle is purchased or leased.

Infrastructure is also an issue, but solutions are on the way: Another major issue in the development of the industry is the infrastructure for plug-in or full electric vehicles. OEMs and other companies are trying to address this issue in a variety of ways. For example, Ford is working with cities and utilities to design in-vehicle technology to assist drivers in locating charging stations based on their personal driving situation and to manage utility load and reduce cost.

Access to charging needed, both at home and in public. A variety of companies including AeroVironment, Ecotality (and its subsidiary eTec), Columb Technologies, Sealed Power (part of Federal Mogul), and General Electric are leading the process to install and improve charging stations in homes and elsewhere. Consumers must get used to charging whenever the equipment is available, instead of only when the battery life is depleted (although batteries will need to be designed to allow for this behavior). The power industry is working on a number of programs to incentivize customers to charge at night to make the best use of the grid in off-peak times. Other companies are rolling out plans to install higher voltage outlets at home and in public locations which allow for shorter charging times, although this requires substantial investment. Infrastructure for “fast” charging at 480 volts (providing an 80% charge in as little as twenty minutes) remains exceedingly expensive (at over \$100,000) and cannot be used in homes. Charging at 240 volts can occur at home or in public places, but also comes with significant installation costs and equipment upgrades. Current products may deteriorate prematurely if “fast” charging is used too often, though new technologies may alleviate these shortcomings.

Better Place is pushing a combination of battery swap and charging stations in several places around the globe beginning in Israel and Denmark and later adding Hawaii and San Francisco. Indeed, battery leasing structures and other secondary market battery business models seem very promising, as they exploit the lower operating costs inherent in electric vehicles in a creative manner than aims to unlock the value proposition for the consumer. Tesla is partnering with a number of entities to develop a charging footprint from Los Angeles to San Francisco. The federal government is also involved in this issue, which is more fully described below.

Industry is working with trade groups to ensure that the public charging stations (including their “quick” charge infrastructure) are not specific to any particular vehicle, initially with the use of adaptors and eventually with common design of the vehicles themselves. The low volume of many of the vehicles envisioned requires this approach. This is a huge issue and Japanese companies (with the support of its government) appear to be taking the lead in this critical area, with another group of European manufacturers and suppliers also attempting to weigh in on this issue.

Developing technology will also allow drivers to find charging stations, ranging from in-vehicle technology (e.g., GM’s OnStar or Ford’s Sync system) to smart phone applications. Private businesses are looking to use the availability of charging stations as an incentive for customers to spend time and money at their establishments.

A novel approach is linking the generation of solar power with vehicle recharging, as evidenced in a project in Tennessee. Elsewhere, parking garages are being outfitted with technology that allows for recharging of vehicles with solar power generated from a photovoltaic system. Recharging at locations where drivers will leave their cars for some time period (e.g., shopping, parking garages, entertainment complexes, etc.) is part of the development of a system that will meet the needs of drivers in a convenient manner.

Recycling of batteries is also a concern. Currently, 90% of lead acid batteries are recycled, so the proliferation of lithium ion batteries will require a recycling infrastructure. The U.S. Department of Energy has provided a \$9.5 million grant to Toxco Inc. of California to build plants for the recycling of lithium ion batteries.

Fuel cells are considered by many to hold great promise, but issues with the technology persist. For the purpose of reducing emissions and petroleum usage (to zero in fact!) and providing durability, performance, potential cost, fast refueling (about three minutes), vehicle flexibility, and capability in multiple driving conditions, fuel cell vehicles work well. For these reasons, a push for fuel cell vehicles began in the 1990s with strong government support and has flowed and more recently ebbed since then. Similar to electric vehicles, the main problem for fuel cells remains the current lack of necessary infrastructure. Building an infrastructure to provide the refilling of hydrogen on these vehicles is a “chicken and egg” situation, which is tied to the lack of vehicle volume.

A variety of other technical issues are important for electric vehicles, some of which are listed below:

- Besides the battery, at least three other product areas are critical for EVs, namely: electric motors, power electronics, and thermal systems. Companies such as Magna, Denso, Bosch, BorgWarner, Valeo, Toshiba, among others, are heavily involved in this growing market:
- OEMs are having problems finding suppliers capable of making components (either low volume or part complexity or both can be problematic) and smaller companies are often trumping the larger and more well-known suppliers:
- Asian companies are dominant in the areas of motors and power electronics:

- Aerodynamics are critical in EV design:
- Battery range is highly variable based on common driving conditions such as weather, terrain, use of vehicle accessories, and driving habits;
- DuPont is introducing a battery separator technology it has dubbed “Energain,” which is designed to prevent electrical interference within the battery packs, thereby increasing durability and safety. Polypore is also involved in this area;
- Reduced weight of vehicle components is needed throughout the vehicle (thus creating opportunity for suppliers well beyond the powertrain) in order to enable longer battery range;
- Electronic brakes and steering systems are necessary, resulting in upgraded electric wiring in electric vehicle to meet the electrical demand;
- Drive units must be improved including upgraded and unique transmission designs;
- Cooling electric vehicles is a huge issue, with Behr a major player in trying to come up with solutions including electric water pumps (replacing mechanical versions in traditional vehicles);
- The addition of noise to full electrics for safety reasons;
- GM and Ford plan to build their own EV, with production (and design) occurring domestically;
- Availability of raw materials, including lithium, is a debatable concern. Most lithium sources are offshore in countries such as Bolivia, Chile, and China, although Western Lithium Corp. is currently developing an area in Nevada to meet the growing demand;
- Availability of rare earth minerals such as dysprosium (used in electric motors) and terbium are also a concern, as the majority of the supply of these minerals and other “rare earths” are found in China, which is starting to restrict exports. The demand for motors (which will provide power to replace that provided by the internal combustion engine) requires permanent magnets that utilize rare earth minerals such as lanthanides and neodymium.

Investment Themes Overview

Investors have generally approached the electrification theme by evaluating battery companies, other related suppliers and to some extent the OEMs themselves.

U.S. Battery Makers: The lithium-ion battery market has traditionally been dominated by Asian players, but global momentum for electrification investments and the need for new manufacturing footprint have expanded the market. In the U.S., the main battery suppliers include Johnson Controls (through the JCI/Saft joint venture), Ener1 Inc. and A123 Systems Inc, among others. All three are well on their way to forming capacity expansion plans and relationships with key automakers. The investment appeal for battery makers lies in their development of value-added cell chemistry and increasing pack manufacturing expertise. Battery companies that gain early mover and/or technological advantages may be able to capture share in the early stages of the electrification phase. In addition, battery companies might also benefit from non-automotive opportunities. The investment challenge lies in framing future earnings expectations, potential cash calls through the development stages, risks in technological changes, and valuation.

U.S. Automakers: Much like Toyota's early launch of the full-hybrid Prius years ago won the company praise (and market share) for leading the hybridization movement, so can the same occur for OEMs applying next-generation PHEVs and EVs. Investing in electrification through OEMs not only allows investors to capture volume growth potential, but also the potential benefits of market share gains across the OEMs other vehicle segments by virtue of improved brand perception (technology leadership, environmental friendliness). In this regard, General Motors may emerge as the first-mover leader in the PHEV space with its launch of the Chevy Volt extended-range-electric vehicle, which delivers about 25-50-miles of all-electric drive. Nissan has leapfrogged directly to EVs with the launch of the Leaf. Toyota isn't far behind with the new Prius models including a PHEV version. Ford entered the EV market first with the Transit Connect and will add the Ford Focus in late 2011. The key for any automaker is to strike the right balance between price, quality, range anxiety, practicality and availability. When looking at different company plans, key strategic differences are evident such as technology selection (PHEV, EV), vehicle size (city car vs. family vehicle) and all-electric mile capability (price). General Motors appears to have taken a "no compromise" solution with the Volt, opting for a robust ~40-mile electric drive (expected to cover 70% of U.S. daily driving needs), including a range-extender to address battery anxiety and opting for a slightly larger vehicle.

Where Suppliers in Our Coverage Universe Stand: Traditional tier-one suppliers are not sitting idle. Virtually every supplier in our coverage universe has and continues to invest in HEV, PHEV and/or EV related products. While traditional tier-one suppliers (with the exception of Johnson Controls) are not directly involved in lithium-ion cell manufacturing, they are leveraging core competencies in other areas and their scaled automotive expertise. A few examples are cited below:

BorgWarner: Investing in electric transmission systems and thermal accessories. BorgWarner is already supplying transmission systems to Tesla and is total working with 13 PHEV & EV vehicle manufacturers (3 traditional OEMs and 10 non-traditional).

Lear Corporation: Through its Electrical segment, Lear is positioned in various energy management systems (converter, traction inverter, integrated power module), charging systems and power distribution systems. Related revenue is expected to climb towards \$250 million by 2012E, or about 2% of total. Lear currently has about \$2,000 worth of content on the Chevy Volt.

Magna: Magna is allocating significant resources towards electric car components including E-Car Systems, its dedicated electrification unit. The product portfolio is fairly robust consisting of control units, batter pack (not cells), cooling systems, DC-DC converters, torque transfer devices and others. Magna can be thought of as a systems integrator that utilizes its broad vehicle expertise to “rethink” the entire system for an electric vehicle. Currently the biggest program for Magna is the Ford Focus EV, expected to launch in late 2011 with a range of 100 miles. Over time, we believe Magna could look to leverage its complete vehicle assembly capability to provide an outsource opportunity for OEMs looking to either enter the market or increase volume at a more reasonable cost.

Johnson Controls: Through its 51% owned joint venture with Saft, JCI is leading player in the lithium-ion battery space, using NCA chemistry. Key customer relationships include the Ford, the Mercedes-Benz S-Class hybrid (mild hybrid), the BMW 7-Series ActiveHybrid (mild hybrid) and the Azure Dynamics Balance TM Hybrid Electric.

One of the issues that often come up for these “traditional” suppliers is whether future increasing EV & PHEV penetration will come at the expense of existing product, creating a substitution effect. Perhaps the only company in our universe where EV/PHEV technologies can truly be deemed incremental is Lear, since it’s primarily a seating supplier.

Policy Issues

Federal Programs

The federal government has generated several programs and policies to stimulate the growth of the electric vehicle market. These are organized into the following categories: federal regulatory standards, American Recovery and Reinvestment Act (ARRA), other federal funding, federal fleets, and federal legislation.

Federal Regulatory Standards

Corporate Average Fuel Economy (CAFE) Standards

Congress first enacted the Corporate Average Fuel Economy (CAFE) Standard in 1975 to improve the average fuel economy of cars and light truck (including vans, pickups and sport utility vehicles) sold in the U.S. The standard is a sales-weighted average of fuel economy (miles per gallon – MPG) of each manufacturer's fleet of current model year passenger cars or light trucks weighing 8,500 pounds or less and manufactured for sale in the U.S. The National Highway Traffic Safety Administration (NHTSA) regulates CAFE standards and the U.S. Environmental Protection Agency (EPA) measures vehicle fuel efficiency. At present, fuel economy standards are 25 miles per gallon in the US, 45 MPG in Europe, and higher in Japan.

Final Rule, (2012-2016)

On April 1, 2010, the EPA and DOT set new rules to significantly increase the fuel economy standards for all new passenger cars and light trucks sold in the U.S. Originally proposed in September 2009, the new rules establish a single standard that meets the goals of the two agencies and the state of California (and its Air Resources Board). The final rules establish increasingly stringent fuel economy standards under the National Highway Traffic Safety Administration's (NHTSAs) CAFE program and greenhouse gas emission standards under the Clean Air Act for 2012 through 2016 model year vehicles.

Starting with 2012 model year vehicles, the rules require automakers to improve fleet-wide fuel economy and reduce fleet-wide greenhouse gas emissions by approximately 5% every year and to reach an estimated 34.1 MPG and 250 grams of CO₂ per mile for the combined industry-wide fleet for model year 2016. While the standards can be met through adoption of conventional technologies such as more efficient engines, the federal government expects that some of the rules also provide inherent incentives for manufacturers to pursue more advanced technologies including electric vehicles. The new federal fuel efficiency standards follow EPA's decision to grant California's 2005 waiver request enabling the state to enforce its greenhouse gas emissions standards for new motor vehicles. The Clean Air Act gives EPA the authority to allow California to adopt its own emission standards for new motor vehicles due to the seriousness of the state's air pollution challenges. The Bush Administration had previously denied the request in 2008. The new federal fuel efficiency standards align with those set by both the federal EPA and DOT and establish the standard for the State of California until 2016, at which point California is authorized to resume promulgation of its own standard.

The 2010 Notice of Intent to Issue a Proposed Rule for Additional CAFE Improvements (2017-2025)

When President Obama issued the memorandum directing the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) and the Environmental Protection Agency (EPA) to conduct a joint rulemaking for light duty trucks and cars (NHTSA regulating fuel economy and EPA regulating greenhouse gas emissions), he also directed them to issue a Notice of Intent to Issue a Proposed Rule (NOI) on additional reductions over a longer time frame.

On October 1, 2010, the US DOT, NHTSA and the US EPA released a Notice of Intent that further advances the future horizon for auto efficiency standards, with an announcement that NHTSA and EPA will be looking at stricter standards for vehicles produced in model years 2017 through 2025. The NOI discusses and asks for public comment on four different proposed miles-per-gallon requirements. The proposals would require average MPG levels in 2025 of 47, 51, 56, and 62, leading to carbon dioxide emissions of 190, 173, 158, and 143 grams per mile, respectively. The Interim Technical Assessment Report (TAR), conducted with the California Air Resources Board and issued with the NOI, presents the agencies' initial assessment of the potential cost and effectiveness of and lead-time requirements for over 30 technologies that could be available to be applied toward new standards through model year 2025. This initial assessment in the TAR produced projected vehicle cost estimates of approximately \$800 to \$3,500 and lifetime savings due to reduced fuel costs of about \$5,000 to over \$7,000, depending on the phase-in stringency scenario and the technology pathway. Whether or not the final standard is set as high as 62 miles per gallon, all the proposals show that NHTSA and EPA understand that the 35 miles per gallon target for 2020, which Congress enacted and President Bush signed into law in 2007 (the Energy Independence and Security Act of 2007), is a "floor" and not a "ceiling".

Fuel Economy Labels

On August 30, 2010, under authority of the Energy Independence and Security Act of 2007, USEPA and the USDOT jointly proposed changes to fuel economy labels consumers see on the window of new vehicles (www.epa.gov/fueleconomy). The goal of the new fuel economy labels is to provide consumers with simple, straightforward energy and environmental comparisons across all types of vehicles, including electric vehicles (EV), plug-in hybrid electric vehicles (PHEV), and conventional gasoline-powered vehicles. Two forms of the new labels are proposed under the new rule showing the vehicle's fuel economy and greenhouse gas emissions performance and estimates of expected fuel cost savings over five years compared to an average gasoline-powered vehicle of the same model year. For EVs and PHEVs, the proposed labels translate electricity consumption into a miles-per-gallon equivalent. The proposed label designs for EVs also include energy use expressed in terms of kilowatt-hours per 100 miles.

American Reinvestment and Recovery Act of 2009 (ARRA)

ARRA represents the single most significant set of federal investments in alternative fuel technologies and deployments, with a particular emphasis on electric vehicles. In August 2010, the federal government released a report summarizing results, to date, under ARRA. In "The Recovery Act: Transforming the American Economy through Innovation," the federal government concludes that Recovery Act dollars have substantially contributed to a transformation of the electric vehicle industry, noting the following achievements:

- More than \$2 billion is being invested in private sector companies to produce advanced electric vehicle batteries and advanced drive components, thus increasing battery manufacture in the U.S. from 2 factories in 2009 to 30 by 2012, which could represent around 20% of global battery production capacity.
- Approximately \$400 million supports various electric vehicle deployment programs, thereby increasing the number of electric vehicle charging locations in the U.S. from 500 today to 20,000 by 2012.
- Additional federal investment is targeted at enhancing the commercialization of electric vehicles through improved battery performance and lower battery costs. ARRA monies are contributing to the start up of 21 battery factories by 2013, which the federal government estimates will help to drop battery costs by half.
- The private sector has, at minimum, matched every dollar of ARRA monies invested in advanced batteries and electric vehicles.

ARRA investments in electric vehicles include:

- **Advanced battery and component part manufacturing** – In August 2009, the federal government announced 48 advanced battery and electric drive projects that received a total of \$2.4 billion under ARRA funds, the single largest investment in advanced battery technology in the U.S. The funding includes \$1.5 billion in grants to battery and component part manufacturing and \$500 million in grants to manufacturers of electric drive components.
- **Purchase of plug-in/all-electric vehicle for test demonstrations** – \$400 million for the purchase of plug-in hybrid and all-electric vehicles for test demonstrations.
- **Alternative fuel capacity building** – \$300 million from ARRA is earmarked for groups certified under the federal Department of Energy Clean Cities program for the purpose of advancing deployment of alternative fuel vehicle infrastructure, including electric vehicles.
- **Research and Development** – \$400 million was earmarked in ARRA for the Department of Energy Advanced Research Projects Agency (ARPA) which was established under the authority of the 2007 America COMPETES Act. ARPA's mission is to foster technological innovations in a variety of energy-related areas, including electric vehicles. In particular, ARPA has focused its electric vehicle research dollars on development of a new generation of ultra-high energy density, low-cost battery technologies for long-range plug-in hybrid and electric vehicles. Goals set by the Advanced Battery Consortium, a public-private collaboration between the U.S. Department of Energy and leading U.S. automotive companies, guide ARRA's research goals.

- **Innovative Technology Loan Program** – The Department of Energy's Innovative Technology Loan Guarantee program was initially established in 2005 under the Energy Policy Act. Under the program, the Department of Energy is authorized to make loans to projects that accelerate commercial application of clean energy technologies. The program is not intended for research and development. Under ARRA, an additional \$6 billion was provided to expand the loan program. The program has identified alternative fuel vehicles as one of ten priority areas for its ARRA monies.
- **Establishment or enhancement of federal tax credit programs** – Programs established or enhanced by ARRA are administered by the Internal Revenue Service, including:
 - Plug-In Electric Drive Vehicle Credit – The credits are for vehicles purchased after December 2009, which use a battery that can be recharged from an external source of electricity. Credits range from \$2,500 to \$7,500. Credits are reduced after a particular manufacturer has sold 200,000 vehicles.
 - Advanced Energy Property Manufacturing tax credit – Designed to encourage investment in the development of properties for the purpose of production of renewable energies and other technologies, including production of new plug-in electric drive motor vehicles and their component parts as well as storage systems for electric drive motor vehicles. \$2.3 billion is allocated under ARRA to fund the 30% tax credit program.
 - Alternative Refueling Property tax credit - For property placed in service in tax years beginning in 2009 and 2010, the alternative fuel vehicle refueling property credit (which includes EV/PHEV recharging) was raised from 30% to 50% with a maximum of \$50,000 or \$2,000 for residential properties.
 - Plug-In Electric Vehicle Credit – For low speed vehicles purchased after February 2009 and prior to January 2012, the credit is 10% of the cost of the vehicle up to \$2,500.
 - Vehicle Conversion Credit – For vehicles placed in service after February 2009, this credit is 10% of the cost of converting a vehicle to a plug-in electric drive.
 - Alternative Minimum Tax – Beginning in 2009, purchase of hybrid vehicles can be applied against the AMT.

Other Federal Funding

- **Advanced Technology Vehicles Manufacturing Program** – The Energy Independence and Security Act of 2007 established the Advanced Technology Vehicles Manufacturing Program. It provides both grants and direct loans to manufacturers to support the development of advanced technology vehicles and associated components, including reconstructing and re-equipping manufacturing facilities to produce advanced technology vehicles, component parts and three-wheeled vehicles. While not limited to electric vehicles, the program is a resource to facilities that need upfront capital to develop manufacturing capacity. The overall program received \$7.5 billion in the federal budget. The federal Department of Energy recently announced loans of more than \$2.4 billion to Fisker, Nissan, and Tesla for development of electric vehicle manufacturing facilities in Delaware, Tennessee, and California.

Federal Fleets

- Under the Energy Policy Act, 75% of new light-duty vehicles acquired by certain federal fleets must be alternative fuel vehicles (AFVs). As a result of amendments made to the Act in 2008, the definition of alternative fuel vehicles includes hybrid electric vehicles, fuel cell vehicles, and advanced lean burn vehicles. Additionally, Executive Order 13423, issued in January 2007, requires federal agencies to decrease petroleum consumption by 2% per year and to continue to increase their alternative fuel use by 10% per year.
- On October 5, 2009, President Obama signed Executive Order 13514 intended to reduce greenhouse gas emissions from federal operations 28% by 2020. In addition to other clean energy and water targets, federal agencies are directed to strive to use low GHG emitting vehicles, including AFVs, and to optimize the number of vehicles in agency fleets. The Executive Order sets an overall target of reducing vehicle fleet petroleum use by 30% by 2020. More specifically, it directs federal agencies with fleets of more than 20 motor vehicles, using a baseline of 2005, to:
 - “Reduce the fleet’s total consumption of petroleum products by 2% annually through the end of fiscal year 2015,
 - Increase the total fuel consumption that is non-petroleum-based by 10% annually, and
 - Use plug-in hybrid (PIH) vehicles when PIH vehicles are commercially available at a cost reasonably comparable, on the basis of life-cycle cost, to non-PIH vehicles.”
- Under ARRA, the General Services Administration (GSA) was appropriated \$300 million to replace older federal vehicles with new, more fuel efficient ones and to purchase advanced-technology buses and electric vehicles. To date, the federal government has completed the purchase of 17,205 fuel-efficient vehicles – including 3,100 hybrids electric vehicles – using \$287 million in ARRA funds. By the end of the 2010, the federal government intends to order an additional \$13 million worth of advanced technology buses and electric vehicles for use in the federal fleet.

Federal Legislation Introduced in 2010

Comprehensive Climate Legislation – Three significant versions of comprehensive federal climate legislation made their way through Congress in 2010:

- **American Clean Energy and Security Act (HR 2454)** included provisions to establish a combined efficiency and renewable electricity standard, to develop a strategy for promoting carbon capture and sequestration, to place performance standards on new coal-fired power plants, to support state and local adoption of advanced building codes, to support state building retrofit programs, to instruct states to submit goals for transportation-related greenhouse gas emissions reductions, to establish a cap-and-trade program covering multiple greenhouse gases and sectors, and to establish a National Climate Change Adaptation Strategy.
- **Clean Energy Jobs and American Power Act (S 1733)** included provisions to set goals of reducing U.S. GHG emissions 20% below 2005 levels by 2020 and 83% below 2005 levels by 2050, to create a nationwide cap-and-trade program on greenhouse gas emissions economy-wide, to establish new programs to reduce greenhouse gas emissions from the transportation sector, and to support development of nuclear power and carbon capture and storage technologies.
- **The American Power Act** (discussion draft only) included provisions to support development of nuclear power; to establish state revenue sharing of offshore oil and gas; to promote carbon capture and sequestration technologies, renewable energy and energy efficiency, clean transportation, and clean energy research and development; to establish national transportation-related greenhouse gas emission reduction goals, and to cap GHG emissions from electricity generators and other stationary sources beginning in 2013, phasing in industrial sources and natural gas distributors in 2016.
- **Electric Drive Vehicle Deployment Act of 2010 (HR 5442, S3442)** – The most significant piece of federal legislation that would provide incentives for the transformation of the electric vehicle industry in the U.S. is the Electric Drive Vehicle Deployment Act of 2010 (H.R. 5442, sponsored by Representative Edward Markey), which was introduced in May 2010. The bill is currently referred to the House Subcommittee on Highways and Transit. If enacted, the bill would:
 - Establish a two-phased competitive program to provide financial assistance to states, Indian tribes, or local governments to deploy electric vehicles in five locations. More specifically, the bill would authorize the Department of Energy to award \$800 million to the five locations with the goal of deploying 700,000 electric vehicles in those locations within six years. Consumers who purchase electric vehicles in the five targeted locations would receive a minimum of \$2,000 in financial assistance benefits;
 - Extend through 2016 the tax credit for alternative fuel vehicle refuel properties and also establish a tax credit for electric vehicle refueling property bonds;

- Amend the Public Utility Regulatory Policies Act of 1978 to establish standards for electric utilities regarding electric drive vehicle infrastructure and direct state regulatory authorities and/or electric utilities to require that electric vehicle infrastructure deployed be consistent with federal standards;
 - Authorize the Department of Energy to conduct research and development on commercialization of electric vehicle batteries and establish competitive research and demonstration programs;
 - Require acquisition of 1,000 electric vehicles for the federal fleet;
 - Complement the current Advanced Energy Property Manufacturing tax credit by authorizing a loan program for manufacturing facilities associated with electric vehicles and amend the Energy Independence and Security Act of 2007 to establish loan programs for the purchase of advanced automotive batteries;
 - Continue the Plug-In Electric Drive Vehicle Credit of up to \$7,500 with additional credits for the purchase and installation of electric vehicle charging equipment for individuals (up to \$2,000) or businesses (up to \$50,000).
- **Postal Service Electric Motor Vehicle Act (HR 4711)** – Introduced in February 2010 and currently referred to committee, the bill directs the Postmaster General to transition 10% of the postal fleet to electric vehicles and increase that share to 75% by the end of five years.
 - **Extension to the Alternative Motor Vehicle Credit (HR 4990)** – Introduced in March 2010 and referred to committee, the bill would amend the internal revenue code to extend through 2010 the Alternative Motor Vehicle Tax Credit for advanced technologies, including electric vehicles, and increase the level of the credit and the number of qualified vehicles.
 - **Electric Vehicle Enhancement Act (HR 5705)** – Introduced in July 2010 and referred to committee, the bill would amend the tax credit for plug-in electric vehicles to allow an increased tax credit for purchase of 2- or 3-wheeled electric vehicles.
 - **Promoting Electric Vehicles Act (S 3495)** – Introduced in June 2010 and referred to committee, the bill was also separately introduced as a subset of the Clean Energy Jobs and Oil Company Accountability Act (S 3663; a discussion draft of the latter was released from committee in late July 2010). Provisions of both introduced versions would:

- Direct the Secretary of Energy to provide assistance to state, local and tribal governments in deploying electric vehicles, require development of a national plan for plug-in electric vehicle deployment including provisions for local community deployment plans, and allow for grants to be awarded to state, local and tribal governments to assist them in preparing community deployment plans;
- Direct the development of model building codes to promote electric vehicle recharging, including smart grids, and award grants for training and education for workforce development pertaining to electric vehicle recharging;
- Direct the federal government to assess the transition of the government fleet to electric vehicles and direct use of electric vehicles in certain parts of the federal fleet over five years;
- Establish a research and development fund for advanced batteries and electric vehicle component parts, including research on materials needed for production of advanced batteries; and establish an advanced battery initiative with prizes;
- Amend the Public Utility Regulatory Policy Act to require utilities to develop plans to support plug-in electric vehicles;
- Extend the Department of Energy loan program for purchase of electric vehicle batteries;
- Establish a Presidential Plug-in Electric Vehicle Interagency Task Force.

State Programs

Most states have begun to develop policies to support transformation of the electric vehicle industry to varying degrees. Similar to efforts at the federal level, policy development at the state level includes a mix of incentives designed to influence consumer behavior and support development of an electric vehicle recharging infrastructure. California is leading the way among the states with government programs to support electric vehicle deployment and recharging infrastructure. The Chevrolet Volt and Nissan Leaf represent the initial stage of wide scale electric vehicle deployment. Nissan designated five test markets that will receive the vehicles first: Tennessee, Oregon, San Diego, Seattle and the Phoenix/Tucson Arizona area. Chevrolet initially focused its release on three test markets: California, Michigan and Washington, D.C. and subsequently added Austin, Texas and the New York metropolitan area as target markets for the Volt. Vehicle manufacturers have focused their test markets in these locations due, in part, to highly supportive public policy climates for electric vehicles.

Of note is The Transportation and Climate Initiative (TCI), which was launched in June 2010 by heads of transportation, energy, and environment agencies of 11 northeast and mid-Atlantic states and the District of Columbia in an effort to significantly reduce greenhouse gas emissions in the region from the transportation sector. The states identify four key priorities for their focus over the next three years, one of which is a focus on electric vehicles. Through the development of best practice policies, demonstration projects, and regional initiatives, the states intend to significantly transform the region to one that inherently supports electric vehicle deployment.

Across the country, state government programs fall into three categories of support for electric vehicles:

Financial Incentives from States

- **Grants** – In general, state grants available for electric vehicles support development of manufacturing facilities, public sector purchase of vehicles, or installation of charging stations. For example, New Jersey reimburses local governments, state universities, and school districts 50% for the cost of purchasing and installing refueling infrastructure for alternative fuels including electric vehicles, up to a maximum of \$50,000.
- **Tax incentives, including tax exemptions and credits** – States are developing a broad array of tax incentives ranging from incentives for consumer purchase of electric vehicles; to equipment purchases and construction of facilities for manufacture and production of electric vehicle batteries and component parts; to installation of electric vehicle recharging stations. For example, Colorado allows an income tax credit for alternative fuel vehicles, including electric vehicles, purchased or converted between January 1, 2007, and January 1, 2010. Other tax credits are for manufacturing of electric vehicles, such as Michigan's program to allow a tax credit of up to 75% for vehicle engineering to support electric vehicle battery integration, prototyping, and launching. Additionally, Michigan provides a property tax exemption for electric vehicle manufacturing facilities. Still other credits are for state sales taxes such as Washington's exemption of state sales and use taxes for electric vehicle batteries, including labor to repair or service electric vehicle batteries or recharging infrastructure.
- **Loans, including direct loans, loan guarantees and leases** – Targeted lower interest rates provide a direct incentive for the purchase of electric vehicle and the installation of infrastructure. For example, North Carolina authorizes state and local government credit unions to offer green vehicle loans to purchase new alternative fuel vehicles, including electric vehicles at a 1% interest rate discount as compared to traditional new vehicle loan rates. In Maine, the state has created a non-lapsing revolving loan fund, which may be used for direct loans and grants to support production, distribution and consumption of "clean fuels," including electric vehicles; the program insures up to 100% of mortgage payments with respect to mortgage loans for clean fuel vehicle projects.

- **Rebates, including for the purchase of vehicles, sale of fuel, etc.** – Several states have put in place financial incentives for electric vehicle purchase to address the upfront cost price differential. For example, Illinois provides a rebate for 80% of the incremental cost of purchasing an alternative fuel vehicle, including electric vehicles for up to \$4,000 and 80% of the cost of federally certified alternative fuel vehicles, including electric vehicle conversions for up to \$4,000.
- **Discounted utility rates for electric vehicle recharging** – Several utilities, mainly in California, have established more favorable utility rate structures for electric vehicle recharging. For example, in California, the Los Angeles Department of Water and Power offers a discounted rate of \$0.025/kWh for electricity used to charge electric vehicles during off-peak times.
- **Reduced state registration fees** – Lower vehicle registration fees are in place in a few states. For example, Oregon establishes different classes of state registration fees for alternative fuel vehicles, including electric vehicles.
- **Energy credits** – Some states are considering how to best structure overall utility rates for purposes of electric vehicle recharging. For example, in Delaware, retail electricity customers with one or more grid-integrated electric vehicles are credited in kilowatt-hours for energy discharged to the grid from the vehicle's battery at the same rate that the customer pays to charge the battery.

Regulatory Programs and Statewide Targets

- **Statewide Greenhouse Gas Emissions Targets** – Thirty-two states have set some form of executive or statutory target for greenhouse gas emissions. While the exact targets vary, they are generally aimed at attaining a level of emissions in the atmosphere that current science indicates is necessary to forestall the most devastating impacts of climate change. States that have emissions targets generally have accompanying climate action plans that are the result of a stakeholder process to identify strategies to reduce emissions throughout the economy. The transportation sector is considered in all of these climate action plans and, in some cases, more in-depth analysis of transportation emissions is included along with specific commitments in that sector. For example, Colorado's law specifically requires development of a plan for reducing net greenhouse gas emissions from the state's transportation sector.
- **Statewide Alternative Fuel Targets and Plans** – Some states are setting specific targets for statewide adoption of alternative fuel vehicles, including electric vehicles. For example, Hawaii set a statewide alternative fuel target of 10% of highway fuel use by 2010; 15% by 2015; 20% by 2020; and 30% by 2030. In Massachusetts, a 10-year plan is required to advance electric vehicles and other alternative fuel vehicles.

- **Low Emissions Vehicle (LEV) CO2 Standards** – In September 2009, USEPA and USDOT, along with the state of California, jointly issued federal greenhouse gas emissions standards for vehicles in model years 2012 through 2016. The federal standards currently serve as the national standard with regards to greenhouse gas emissions. However, under the federal program, California may proceed with setting more stringent limits beginning in 2016. At that time, other states may follow suit with more stringent standards should California choose to promulgate them (unless California and EPA/DOT continue their agreement beyond 2016).
- **The Zero Emissions Vehicle (ZEV) Standards** in the California Low Emissions Car Program (also adopted by the Northeast states) – has been setting increasingly stringent mobile-source emissions requirements. In particular, the ZEV component of the California Car Program has required the automobile manufacturers to develop advanced technology vehicles to meet a zero emission standard.

Carmakers can satisfy their ZEV requirement in a number of ways. The most direct route is through pure, battery-electric vehicles. For each 100-mile range EV an OEM sells in California, it can expect to receive three ZEV credits. For example, if Nissan were to sell 3,800 Leafs per year, the car would nearly meet the company's credit mandate completely on its own. As described throughout this report, carmakers are choosing different paths to meet the requirements, but the ZEV requirements are clearly bringing these innovative vehicles into the marketplace. In addition, carmakers that made early progress in auto technology innovation are now benefitting from their efforts in the form of banked ZEV credits.

Not surprisingly, Toyota is in a strong competitive position with regard to its compliance with ZEV regulations for at least a decade because of its strong hybrid sales and early alternative fuel vehicles like the electric RAV4-EV. The carmaker has accumulated a balance of more than 228,000 credits, and remains a leader in the field. Furthermore, advanced technology hybrids like the 2010 Prius will be receiving 0.6 credits each, while the Plug-in Prius will receive about 1.6 credits per vehicle when it's released for 2012.

Other carmakers also have more flexibility in their product lines due to accumulated credits; this program continues to spur innovation and serves as perhaps the most important driver for electric vehicles among many carmakers.

Low Carbon Fuel Standards – A low carbon fuel standard is designed to reduce the carbon-intensity of transportation fuels through a performance-based standard that optimizes cost-effectiveness but that does not mandate any particular fuel or technology. Under a low carbon fuel standard, fuel providers are required to track the carbon intensity of their fuels and be required to meet a declining limit on greenhouse gas emissions as measured via carbon intensity. By implementing the standard, carbon emissions are attributed to various transportation fuels throughout its lifecycle, including the fuel's production, storage, transport and use, and changes in land use associated with the fuel are calculated. Suppliers must reduce emissions of the fuel on an average, per gallon basis.

Rather than promote a particular technology (i.e. E85), fuel suppliers have flexibility to determine the most cost effective means for achieving the continuing declining standard. Other aspects of a low carbon fuel standard involve the use of market-based low carbon fuel credits that a fuel supplier could use to help meet their obligations under the program. A low carbon fuel standard is inherently designed to put a declining cap on the relative intensity of fuels.

To comply with a low carbon fuel standard, a supplier needs to reduce the average intensity of their fuel products by blending in low-carbon fuels, such as cellulosic biofuels or by purchasing low-carbon credits earned by other companies that exceed the standard. One method of purchasing credits is through the sale of low carbon electricity. A fuel provider could replace all of their current fuel supply with an alternative that has 10% lower greenhouse gas emissions or replace half the supply with a 20% alternative. Because of electric vehicles' very low emissions per mile compared liquid fuels vehicles, a low carbon fuel standard could potentially become a strong incentive to advance electric vehicles.

California adopted its low carbon fuel standard in April 2009 and its implementation began in January 2011. It is designed to require California-based fuel suppliers to reduce the carbon intensity in the statewide mix of transportation fuels (both diesel and gasoline) by 10% between 2010 and 2020. The standard is designed to require more stringent reductions in the second five years of the program than in the first five. California's expectation is that compliance with the standard will be achieved through a combination of lower carbon fuels and market penetration of advanced technology vehicles, including electric vehicles.

Eleven states in the Northeast are currently in the process of developing a framework for a low carbon fuel standard. The Northeast States for Coordinated Air Use Management (NESCAUM) estimates that, if a low carbon fuel standard based on the California model was in place in the Northeast, it would result in reductions of 30 million tons of greenhouse gas emissions annually compared to a business-as-usual scenario. NESCAUM further estimates that, if a standard similar to California's were to be established in the Northeast and were to be met via cars powered partially or completely by electricity, the result would be 3 million full or partial electric vehicles in the region by 2020, which NESCAUM estimates could be sustained by the current electricity grid. The development of the framework for the Northeast program is still underway and policy recommendations are expected early in 2011. It is likely that many or most of the states involved would require new statutory authority to impose a standard, so there is currently no schedule for implementation.

The impact of current low carbon fuel standard programs underway and under development could be significant. The markets represented by California and the 11 Northeastern states alone comprise 25% of the fuel market in the United States. In addition to California and the Northeastern states, the states of Oregon and Washington, as well as ten Mid-western states, have programs in place to consider or to develop low carbon fuel standards. In Oregon, state law requires the development of a low carbon fuel standard that mirrors the California standard of 10% by 2020. In Washington, a Governor's Executive Order directs the State to assess whether California's Low Carbon Fuel standard, or a modification of it, would contribute significantly to meeting Washington's statewide greenhouse gas emissions targets.

Non-regulatory Programs

- **Incentive Use of HOV Lanes** – High Occupancy Vehicle (HOV) lanes on highways are set aside for vehicles with multiple passengers to promote carpooling. Some states are expanding use of the HOV lanes to electric vehicles. For example, Arizona's allows for alternative fuel vehicles, including electric vehicles, to use HOV lanes, regardless of the number of passengers.
- **Parking Incentives** – Ensuring parking as an incentive for use of an electric vehicle is underway in many states. For example, Arizona allows alternative fuel vehicles, including electric vehicles, to park without penalty in parking areas that are designated for carpool operators.
- **Exemptions from roadway weight limitations** – States establish vehicle weight requirements on certain roadways for reasons of safety and road maintenance. Some states are relaxing those standards for electric vehicles. For example, in Colorado, gross vehicle weight rating limits for alternative fuel vehicles, including electric vehicles, are 1,000 pounds greater than those for comparable conventional vehicles.
- **Recharging stations** – States have a variety of controls over land use and seek to encourage availability of land for recharging stations. For example, Washington authorizes state agencies and local governments to lease land for installing, maintaining, and operating electric vehicle charging stations or battery exchange stations for up to 50 years.
- **Exemption from vehicle inspections** – State agencies set vehicle inspection programs for safety and air pollution control standards. Some states are providing exemptions or reduced inspection requirements for electric vehicles. For example, Michigan exempts dedicated alternative fuel vehicles, including electric vehicles, from state emissions inspection requirements.
- **Technical assistance** – More so than federal agencies, states often have direct interactions with institutions, businesses and other public and private sector operators with large fleets. Some states are providing technical assistance to encourage adoption of electric vehicle programs. For example, the New York State Energy Research and Development Authority's Flexible Technical Assistance Program provides assistance to fleet managers who want to evaluate the feasibility and cost of adding alternative fuel vehicles (AFVs) and fueling facilities to their operations.
- **Establishment of parking standards** – Separate from providing parking incentives, some states are setting minimum standards for parking spaces with electric vehicle charging capacity. For example, Hawaii requires that all public, private, and government parking facilities with at least one hundred parking spaces must designate at least 1% of the spaces specifically for parking and charging electric vehicles by December 31, 2011. In Washington, state operations must install electric vehicle charging stations in each of the state's fleet parking and maintenance facilities as well as every state-operated highway rest stop by December 31, 2015.

- **State Fleet Requirements** – Typically as a Governor's directive, several states are setting standards for state and local agencies (and school districts) to purchase electric vehicles. For example, Connecticut has a standard that at least 50% of all cars and light-duty trucks purchased or leased by the state must be capable of using alternative fuel, hybrid electric vehicles, or plug-in electric vehicles. Beginning January 1, 2012, the required percentage of alternative fuel or advanced vehicles increases to 100%.
- **Requirements on automobile dealers** to make information available on alternative fuel vehicles, including electric vehicles – Some states require that information about electric vehicles be made available at the point of purchase. Arizona requires that motor vehicle dealers make information about alternative fuel vehicles, including electric vehicles, available to the public. Similarly, Connecticut has a greenhouse gas labeling program for new motor vehicles.
- **Insurance** – Regulated at the state level, vehicle insurance can provide some incentives for purchase of electric vehicles. In Florida, insurance companies may not impose surcharges on electric vehicles based on factors such as new technology, passenger payload, weight-to-horsepower ratio, and the types of material used to manufacture the vehicle. In Maine, an insurer may credit or refund any portion of the premium charged for an insurance policy on a "clean fuel vehicle," including electric vehicle.
- **Procurement Preferences** – States set highly specific standards for purchase of all goods and services used in state operations, and these standards are often adopted at the local level. For, example, in determining the lowest responsible qualified bidder for the award of state contracts, Connecticut may give a price preference of up to 10% for the purchase of alternative fuel vehicles, including electric vehicles.

Targeted Programs

Examining the portfolio of government programs in place in the seven test markets involved in the Chevrolet Volt and Nissan Leaf pilot programs offers a broad understanding of the variety of programs in place in any one state.

Arizona

- **Alternative Fuel Vehicle (AFV) High Occupancy Vehicle (HOV) Lane Exemption** – Allows dedicated alternative fuel vehicles, including electric vehicles, to use High Occupancy Vehicle lanes, regardless of the number of passengers;
- **Electric Vehicle Equipment Tax Credit** – Authorizes a tax credit of up to \$75 to individuals for the installation of an electric vehicle charging outlet in a house the taxpayer constructs;
- **Alternative Fuel Vehicle (AFV) Parking Incentive** – Allows parking of an alternative fuel vehicle, including electric vehicles, to park without penalty in parking areas that are designated for carpool operators;
- **Reduced Alternative Fuel Vehicle (AFV) License Tax** – Lowers the initial annual vehicle license tax on an alternative fuel vehicle, including electric vehicle, to less than a conventional vehicle;

- Electric Vehicle (EV) Parking Space Regulation – Prohibits conventional vehicles from stopping, standing or parking in spaces specially designated for parking and charging electric vehicles;
- Joint Use of Government Fueling Infrastructure – Directs state agencies that operate alternative fueling stations, including electric vehicle charging stations, to make such stations available to other state agencies;
- State Alternative Fuel Vehicle (AFV) Acquisition Requirements – Directs state agencies to have at least 75% of their fleets, with some exceptions (i.e. operational, safety, etc.), operate on alternative fuels, including electric vehicles.
- Municipal Alternative Fuel Vehicle (AFV) Acquisition Requirements – Directs local governments in three large counties of the state to develop vehicle fleet plans to promote use of alternative fuel vehicles, including electric vehicles, with the goal of having at least 75% of the total local government fleet operating on alternative fuels;
- School District Alternative Fuel Vehicle Acquisition Requirements – Within the three largest counties of the state, directs school districts to ensure that 50% of a portion of the district's fleet, with some exceptions (i.e. operational, safety, etc.), operate on alternative fuels, including using electric vehicles;
- Alternative Fuel Vehicle (AFV) Dealers Information Dissemination Requirement – Requires motor vehicle dealers to make information about alternative fuel vehicles, including electric vehicles, available to the public.

California

- Alternative Fuel Vehicle (AFV) Dealers Information Dissemination Requirement – Requires motor vehicle dealers to make information about alternative fuel vehicles, including electric vehicles, available to the public;
- Plug-In Hybrid and Zero Emission Light-Duty Vehicle Rebates – Provides for rebates for the qualified clean vehicles, including electric vehicles. The rebates offer up to \$5,000 for light-duty zero emission and plug-in hybrid vehicles and up to \$20,000 for zero emission commercial vehicles. Eligible vehicles are electric drive cars, trucks, commercial medium- and heavy-duty vehicles, motorcycles, and neighborhood electric vehicles;
- Alternative Fuel and Vehicle Research and Development Incentives – Makes grants and loans available for projects that develop or produce low carbon fuels, expand low carbon fuel infrastructure, and establish workforce training programs related to low carbon fuels;
- High Occupancy Vehicle (HOV) Lane Exemption – Allows for qualified vehicles, including electric vehicles, to access HOV lanes regardless of the number of passengers;

- Alternative Fuel Vehicle and Fueling Infrastructure Grants – Provides grant funding for projects that reduce air pollution from on- and off-road vehicles including purchase of alternative fuel vehicles, including electric vehicles, and development of alternative fuel infrastructure;
- Lower Emission School Bus Grants – Provides grants for replacement of older school buses, including for new alternative fuel buses;
- Alternative Fuel and Advanced Technology Research and Development – Provides funds for demonstration projects of innovative technologies that will improve emission prevention or control while promoting new industries and jobs in California, including development of alternative fuel vehicles and component parts;
- Employer Invested Emission Reduction Funding (South Coast) - Provides funding to allow employers to make annual investments into an administered fund to meet emission reduction targets. The revenues collected are used to fund alternative mobile source emission/trip reduction programs, including alternative fuel vehicle projects, such as procurement of low-emission, alternative fuel or zero emission vehicles;
- Technology Advancement Funding (South Coast) - Provides funding for research, development, demonstration, and deployment projects that are expected to help accelerate the commercialization of advanced low-emission transportation technologies, including electric vehicles;
- Parking Incentives (Hermosa Beach, San Jose, Santa Monica, Los Angeles Airport) – free parking for electric vehicles in designated areas;
- Electric Vehicle Charging Rate Reduction (Sacramento, San Diego, Los Angeles, Southern California, Pacific Gas & Electric) – Offers discounted rates as compared to the regular residential rate for electricity used by residential customers to charge electric vehicles;
- Electric Vehicle Infrastructure Evaluation – Directs the California Public Utilities Commission to overcome any barriers to the widespread deployment and use of EVs and plug-in hybrid electric vehicles and adopt regulations by July 2011; and research the impacts on electrical infrastructure and any infrastructure upgrades necessary for widespread use of EVs and PHEVs, including the role and development of public charging infrastructure;
- Electric Vehicle (EV) Charging Requirements – Sets specifications for charging infrastructure for electric vehicles;
- Fleet Vehicle Procurement Requirements – Requires local governments and school districts to have 75% of vehicles be energy efficient, including electric vehicles;

- Vehicle Acquisition and Petroleum Reduction Requirements – Requires that the state maintain specifications for purchase and leasing of vehicles by state agencies. Requires that vehicles equipped to operate on alternatives fuels must do so and required the state to develop a plan reduce the state fleet’s consumption of petroleum products 10% by January 2010 and 20% by January 2020;
- Alternative Fuel and Vehicle Policy Development – Requires the California Energy Commission to prepare a report biannually providing an overview of issues facing the state in promoting alternative fuel vehicles;
- Electric Vehicle Charging Infrastructure Promotion (Bay Area) – San Francisco, San Jose, and Oakland are expanding the infrastructure for electric vehicles by expediting the permit and installation process, developing uniform standards for charging stations, establishing programs to purchase electric vehicles for government employees, and other incentives.

Michigan

- Advanced Vehicle Battery Manufacturer Tax Credits – Provides tax credits for manufacture of electric vehicle batteries. Also, beginning in 2010, provides for tax credits of up to 75% for engineering and manufacture of advanced batteries, battery integration, and demonstration;
- Hybrid Electric Vehicle Research and Development Tax Credit – Provides a tax credit equal to 3.9% of all wages and salaries for employees at a facility engaged in research and development of electric vehicles for up to \$2 million per year;
- Alternative Fuel and Vehicle Research, Development, and Manufacturing Tax Credits – Allows for a nonrefundable credit for research, development or manufacturing of alternative fuel vehicles, including electric vehicles;
- Alternative Fueling Infrastructure Grants – Offers a matching grant program for owners of service stations;
- Alternative Fuel Development Property Tax Exemption – Provides a tax exemption for industrial properties that are used for activities related to creation or production of alternative fuels and alternative fuel vehicles, including electric vehicles;
- Alternative Fuel Vehicle (AFV) Emissions Inspection Exemption – exempts dedicated alternative fuel vehicles, including electric vehicles, from emissions inspection requirements;
- Vehicle Research and Development Promotion – Allows municipalities to authorize creation of local development financing authorities for purposes of funding projects related to advanced vehicles, including electric vehicles;

- Hybrid Transit Vehicle Promotion – Provides funding for the transition of bus fleets to electric vehicles and hybrid vehicles with more efficient fuel economy;
- Advanced Vehicle Acquisition and Alternative Fuel Use Requirement – Requires inclusion of electric vehicles and other alternative fuels as part of the state fleet if determined to be cost effective;

Oregon

- Alternative Fuel Production and Infrastructure Tax Credit – Provides for a tax credit of up to 50% to businesses that invest in alternative fuel production and fueling infrastructure, including electric vehicles;
- Alternative Fuel Vehicle and Hybrid Electric Vehicle Tax Credit – Provides for income tax credits to residents and businesses for the purchase of alternative fuel vehicles, including electric vehicles. The residential credit is \$1,500 and the business credit is up to 35% of the incremental cost of the vehicle;
- Alternative Fuel Loans – Provides for a loan program for a variety of purposes including alternative fuel vehicle production, charging stations and purchase of vehicles for fleets;
- Alternative Fuel Vehicle Acquisition, Fuel Use, and Emissions Reductions Requirements – Requires that all state agencies purchase alternative fuel vehicles, including electric vehicles to the maximum extent possible;
- Pollution Control Equipment Exemption – Exempts electric vehicles from having certified pollution control systems;
- Electric Vehicle (EV) and Hybrid Electric Vehicle (HEV) Registration Fees – Offers reduced state vehicle registration fees for electric and hybrid electric vehicles.

Tennessee

- High Occupancy Vehicle (HOV) Lane Exemption – Allows for low emission vehicles, including electric vehicles, to be permitted in HOV lanes regardless of the number of passengers;
- Alternative Fuel and Fuel-Efficient Vehicle Acquisition and Use Requirements – Requires that at least 25% of newly purchased vehicles in the state fleet be hybrid electric vehicles;
- Energy Task Force – Directs development of a state plan to promote use of alternative fuel vehicles in the state.

Washington (Seattle)

- Alternative Fuel Vehicle Tax Exemption – Allows for dedicated alternative fuel vehicles to be exempt from the state motor vehicle sales and use taxes;
- Electric Vehicle Battery and Infrastructure Tax Exemptions – Exempts public lands that are used for installing or maintaining electric vehicle infrastructure from leasehold excise taxes; exempts electric vehicle batteries as well as their service and repair from state sales and use taxes;
- Alternative Fuel Loans and Grants – Provides financial and technical assistance for the development of alternative fueling infrastructure, including electric vehicle recharging, including along Interstate corridors;
- Electric Vehicle and Plug-In Hybrid Electric Vehicle Demonstration Grants – Provides grants for projects involved in the purchase or conversion of existing vehicles to electric vehicles;
- Alternative Fuel Vehicle and Hybrid Electric Vehicle Emissions Inspection Exemption – Exempts electric vehicles from emissions control requirements;
- Clean and Efficient Fleet Assistance – Provides technical assistance to public and private fleets transitioning to clean fuels, including electric vehicles;
- Electric Vehicle Infrastructure Development – Requires local transportation planning organizations to develop plans for installation of electric vehicle recharging stations and for development of programs to provide incentives for electric vehicles such as dedicated parking spaces;
- Electric Vehicle Charging Infrastructure Availability – Allows publicly and privately owned electric vehicles to be charged at state office locations; requires the state to install electric vehicle charging stations in all state fleet parking and maintenance locations;
- Local Government Electric Vehicle (EV) Charging Infrastructure Requirements – Requires the state to issue model ordinances and regulations for local governments regarding site assessment and installation of electric vehicle infrastructure; requires local governments to adopt the state standards;
- Electric Vehicle Charging and Battery Exchange Station Regulations – Allows state and local governments to lease land for electric vehicle recharging and battery exchange stations for up to 50 years;
- Provision for Alternative Fuels Corridor Pilot Projects – Allows the state to enter into agreements with private and public entities for alternative fuel corridor pilot projects, including electric vehicle recharging corridors;

- Leadership on Climate Change Executive Order – Directs state agencies to seek funding to implement a program of electric vehicle recharging off the West Coast Interstate highway;
- Alternative Fuel Use Requirement – Requires state and local governments to use 100% biofuels or electricity to operate all publicly owned vehicles by 2015;
- Clean Fuel Vehicle Purchasing Requirement – Requires that 30% of all new vehicles purchased by state contract must be clean fuel vehicles, including electric vehicles;

Washington D.C.

- Reduced Registration Fee for Fuel-Efficient Vehicles – Provides for a reduced vehicle registration fee for fuel efficient vehicles, including electric vehicles;
- Alternative Fuel and Fuel-Efficient Vehicle Title Tax Exemption – Exempts alternative fuel vehicles, including electric vehicles, from excise tax;
- Alternative Fuel Vehicle Exemption from Driving Restrictions – Exempts clean fuel vehicles, including electric vehicle, from time-of-day and day-of-week restrictions and commercial vehicle bans;
- Alternative Fuel Vehicle Acquisition Requirements – Requires fleets with 10 or more vehicles to meet minimum specifications for purchasing clean fuel vehicles, including electric vehicles.

Notes

Appendix A-1

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