AFV Insider

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A Word from the Publisher

Welcome back to the AFV Insider! Electric and hybrid vehicles are notable for their quiet, quick and smooth acceleration. By contrast, the AFV industry as a whole has come through a rough patch this year: multiple bankruptcies, missed targets for production and sales, battery failures, car and bus fires, and – in the United States, at least – political controversy over the ends and means of government policy.

Our mission at the Insider is neither to promote nor to denigrate the emerging global industry attempting to carry off a revolution in transportation. Instead, we aim to understand it by establishing the facts and elucidating them as best we can. We aim to equip each of our readers and subscribers with the information and analysis needed to be successful participants in the AFV world, whatever their role.

To that end, one focus for this issue is safety concerns. A few scary incidents in China and the US have caused understandable concern. When the facts are on the table, those concerns seem to be unjustified for the most part. The bottom line is that on average one person dies in the US every day due to vehicle fires, but not a single American fatality has ever been attributed to an AFV battery.

At the same time, those incidents underscore the need for each government to do its part and do it well. Sound regulations, careful testing, and meticulous investigation of accidents are essential to fostering the fullest possible development of a safe, competitive AFV industry. Both Chinese and American authorities must do better than they have in the past year to ensure that no unfounded safety concerns cloud the public's perception of AFVs.

We also have profiled BYD, a company championed by the Chinese planners and favored by Warren Buffett who owns ten percent of its shares. The company got off to a fast start and has high ambitions, but now it's fighting to sustain a solid competitive position in the face of technological challenges and intensifying competition.

We also feature a critique of the recent "Electric Vehicles in China: Emissions and Health Impacts" study, which makes the case that electric vehicles might be more harmful to human health and the environment than internal combustion vehicles. Our analysis points out several methodological biases.

While preparing this issue, we're continually updating and expanding our website. For example, we've added:

- New energy vehicle sales in China
- China's new energy vehicle policy updates
- Profiles of leading AFV companies in the industry
- Detailed specs of AFV models around the world

In coming issues, we plan to profile Coda's corporate strategy, Japan's national policy, and to comparatively analyze state and local incentives for AFV production and sales, and developments in the expanding network of charging stations. As always, we will report on the emerging sector's successes, failures and challenges. We welcome your letters and will gladly consider opinion pieces for publication.

We offer our subscribers two options: four issues of the Insider Quarterly, or for premium subscribers four issues of the Quarterly plus unlimited access to the website. You can find full subscription information at www.afvinsider.com. We hope you'll join us.

Quarterly Developments

NORTH AMERICA

1. Market

Tesla Announces New Model S Beta	Tesla's new Model S beta has already gathered a following: with over 6,500 reservations, the 2012 model is sold out. The Model S boasts acceleration from 0 to 60 mph in less than 6 seconds. Three range options are offered: 160 miles, 230 miles and 300 miles. The base price is $57,400 for a 160-mile Model S, or $49,900 including the federal tax credits for electric vehicles. The two longer-range versions command a $10,000 and $20,000 price premium. Tesla has planed an initial release of 5,000 units, and 20,000 units per year after 2012. U.S. deliveries began in June, 2012.
Tesla Anticipates Battery Cost To Drop Below $200/kWh	During a conference call announcing Tesla's fourth quarter financial results, CEO Elon Musk announced he believed battery costs would fall below $200/kWh in the "not-too-distant future". Tesla has scheduled the beginning of production of its third-generation Blue Star vehicle in 2015. If the anticipated battery price drop materializes, Tesla plans to sell a mass-produced Blue Star for around $30,000. The Chevy Volt's battery costs around $500-600/kWh, while the Nissan Leaf's costs around $375/kWh. Makoto Yoda, the president of Mitsubishi's battery supplier GS Yuasa, predicts a similar price change. Tesla, GM and Nissan's battery suppliers are respectively Panasonic, LG Chem and NEC/Nissan.
Fisker Lowers 2012 Sales Target for Karma	Fisker has adjusted its 2012 target sales for the Karma to 10,000 vehicles, down from an original target of 15,000 announced in November 2011. The Fisker Karma plug-in luxury four-door sports sedan is manufactured in Valmet, Finland. The EPA has rated the vehicle's fuel economy at 52 mpg, with a 32-mile all-electric range. The basic model costs $102,000 and the top model, $166,000. In 2010, the DOE provided Fisker with an ATVM loan totaling $529 million, of which $169 million were allocated to producing the Karma.
Bad Karma: Fisker Battery Shutdown Causes Bigger Problems for A123	Fisker's Karma flunked a road test conducted by Consumers Reports magazine in February, stopping dead during a warm-up lap on the track. Efforts to restart the PHEV failed, and it had to be towed. Nonetheless, Fisker insisted that the car behaved as intended when it detected a fault. Owners of some of the other 500 Karmas on the road also have reported battery problems, and in 2011 250 were recalled for a battery replacement. Fisker's problems only compounded those of A123 Systems, which supplies batteries to both Fisker and BMW. A123 announced on May 15 that it had retained an outside expert to supply strategic financial advice. A123's sales for 2012 are projected to reach only $145 – 175 million, well below the original forecast of $230 – 300 million.
GM Makes eAssist Standard on the 2013 Buick Regal	After the 2012 Buick Lacrosse, the 2013 Buick Regal will become the second Buick vehicle to include GM's eAssist engine as a standard feature. The eAssist system is the second generation of GM's belt alternator starter (BAS), a mild hybrid system. BAS is based on a "start-stop" system that shuts down the engine when the vehicle comes to stop and restarts it instantly when the brake pedal is released. The eAssist system is paired with a 2.4L gasoline engine. The EPA has rated Buick Regal's city fuel economy at 26mpg, and its highway fuel economy at 36mpg. The eAssist was awarded the 2012 Environmental Excellence in Transportation (E2T) award by the SAE.
GM to Launch OnStar Renewable Energy Monitor	GM has announced the development, in partnership with utility PJM Interconnection, of an OnStar application that will allow Volt owners to monitor the availability of renewable energy in order to help them decide when to charge their vehicles. For example, PJM estimates that wind power production peaks between 10 PM and 6AM. With the OnStar application, Volt charging could be timed during this window. Google is currently testing the application on its headquarters fleet of 17 Volts. PJM Interconnection's territory covers Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

Nissan Unveils Infiniti LE Luxury EV	At the 2012 New York Auto Show, Nissan unveiled its Infiniti LE all-electric concept luxury car, which will use the same 24 kWh lithium ion battery pack as the Leaf. The Infiniti LE will be powered by a 100kW electric motor, versus the Leaf's 80kW. It will have 134 hp and 240 lb/ft torque, compared to the Leaf's 107 hp and 207 lb/ft torque.
Coda Launches EV Sedan	Coda shipped its first vehicle, an all-electric sedan, in March. The vehicle has two range options: 125 and 150 miles. The manufacturer's suggested retail price for the former is $37,250, and $39,900 for the latter. The company has received final certification from the EPA and NHTSA. Coda also announced it had canceled plans to build a battery plant in the U.S. due to difficulties obtaining an ATVM loan. Coda has withdrawn its application for the loan, which it claimed would have allowed for the creation of 2,000 jobs in the U.S.
2012 Ford Focus Will Hit Majority of U.S. Markets by September	Ford expects its 2012 Focus EV to reach 78% of the U.S. market by September 2012. The company is currently is rolling out the Focus in the following markets: Atlanta, Georgia; Austin and Houston, Texas; Boston, Massachusetts; Chicago, Illinois; Denver, Colorado; Detroit, Michigan; Los Angeles, San Francisco and San Diego, California; Orlando, Florida; Phoenix and Tucson, Arizona; Portland, Oregon; Raleigh and Durham, North Carolina; Richmond, Virginia; Seattle, Washington; and Washington, D.C. Deliveries to fleet customers in the U.S. began in December 2011, when 7 vehicles were sold in three initial markets: New York, New Jersey and California. Another three were sold in January; none in February, March and April; 6 in May; 89 in June; and 38 in July . The Ford Focus is manufactured in Wayne, Michigan. It has a range of up to 100 miles per charge and its price starts at $39,995. Last April, Ford launched an electrification plan including hybrid, plug-in hybrid and all-electric vehicles using five technologies: auto Start-Stop, Human Machine Interface (HMI), regenerative braking systems, new batteries, and new motors. Auto Start-Stop is a feature designed for city driving. When the vehicle is stopped, the engine restarts the instant the driver's foot leaves the brake pedal. HMI shapes the vehicle's interaction with the driver. At the end of each trip a display screen indicates the distance driven, miles gained through regenerative braking, energy consumed and a comparative gasoline savings achieved by driving electric. Other range enablers include a budget view, range view and Brake Coach, which gives drivers feedback on their braking performance to maximize battery regeneration. In 2011, only 1% of Ford's fleet was electrified. Ford aims for 70% of its fleet to be hybrid, 20 to 25% plug-in hybrid, and 5% all-electric by 2020. The Focus Electric's battery is supplied by Compact Power of Troy (Michigan), a division of Korea's LG Chem. The Ford Focus Electric compares favorably with the Nissan Leaf on range (76 miles versus 73 miles), power (141 hp versus 110 hp), MPGe (105 versus 99), and charging time (4 hours versus 7 hours). However, the price is higher ($39,200 versus $32,780).
DMC Plans 2013 EV Launch	Detroit-based DeLorean Motor Company (DMC) has announced plans to release an EV in early 2013 for $95,000. The DMCev will be powered by a 32kWh lithium iron phosphate (LFP) battery, which will take less than three hours to charge using a Level-2 home charging station. Its top speed will be around 125 mph, like the Tesla Model X. The vehicle will have a range of 100 miles and be able to go from 0 to 60 mph in under 6 seconds (the Tesla X's range is over 200 miles and it can hit 60 mph in 4.4 seconds). The DMCev will be assembled in Houston, Texas, with the help of Louisiana's Epic EV, the company working on the Torq and Amp vehicles.

Magna and Hyundai Heavy Industries form battery partnership

Magna E-car Systems has partnered with Hyundai Heavy Industries (HHI) to jointly conduct engineering, design, development and testing of battery cell and battery pack technologies for electric and hybrid electric vehicle applications. Their joint venture Mahy E-Cell is 60% owned by Magna E-Car. The partnership will allow HHI to enter Europe and North America's EV battery markets. Magna E-Car is a subsidiary of Magna, a Canadian auto parts giant and global supplier of components and systems for hybrid and electric vehicles.

ChargePoint offers free home charging stations to EV buyers

Coulomb Technologies, the company behind the ChargePoint network of public charging stations, announced that it is offering free home charging stations to EV drivers under the ChargePoint America Program. The Program is funded by a $15 million grant from the American Recovery and Reinvestment Act as well as by certain automakers. Eligible vehicles include the Chevrolet Volt, Ford Transit Connect, Ford Focus Electric, Nissan Leaf, Smart Electric Drive, and BMW ActiveE. The Program aims to provide 4,600 public and home charging stations. ChargePoint is deploying its CT500 model as the home charging station. The 7.2 kwt unit provides a 240-volt charge and 30 amp feed and has a market value of $1,850. While the unit is free, the installation by authorized technicians is an expense. A standard installation costs approximately $900, excluding permits. This includes approximately 35 feet of conduit, mounted on the exterior of the home, no trenching, coring or boring, and one penetration from the exterior to the garage. In exchange for receiving the charger, EV drivers are requested to submit data on electricity usage and timing to the DOE through the end of 2013. The program is only currently available in some regions: Austin, Boston, Los Angeles, New York, Orlando/Tampa, Sacramento, the San Jose/San Francisco Bay Area, Redmond/Bellevue, Washington, Washington DC/Baltimore, and Southern Michigan (including Grand Rapids, Lansing, Ann Arbor, and Detroit). Home charging stations can wirelessly relay data to the ChargePoint network. The DOE is interested in collecting data on the station's utilization, such as the amount and time of energy use.

II. Policy

DOE increases battery budget

In its new budget the DOE increased funding for EV battery makers by 20% with the stated goal of bringing down EV battery prices faster. The increase will bring the Batteries and Electric Drive Technologies budget up to $203 million, out of a total budget of $420 million for the ATVM program. The U.S. battery industry's competitiveness is threatened by lower cost batteries from Japan, South Korea, and China.

B.C., Canada starts to build out EV charging stations

Environment minister of British Columbia (B.C.) Terry Lake has committed $2.74 million (Canadian dollars) to fund 570 public EV charging stations in B.C., Canada. In Victoria, The Fraser Basin Council will manage the funds and develop an implementation strategy. This program will provide 440-volt level-3 chargers and 240-volt level-2 chargers. Victoria already has some charging stations installed by the Fairmont Empress hotel and Thrifty Foods store.

III. Technology

Ford uses kenaf to increase vehicle efficiency

Ford has replaced oil-based materials used in the doors of its Ford Escape with kenaf plant material. The switch will allow Ford to reduce its use of oil-based resin in North America by 300,000 pounds per year. It will also reduce the weight of Ford Escape doors by 25%, yielding fuel savings. Kenaf is a cotton-related plant that is native to Africa and can be grown in the Southern U.S. and parts of California. Kenaf is currently used in rope, paper, and insulation. The new Ford Escape, which is 85% recyclable, was released this past spring. Other green changes to the Escape include an EcoBoost engine that give vehicles more power and better gas mileage at the same time; the use of one-third post-consumer and two-thirds post-industrial materials for the polyester carpeting; the use of recycled tires in the vehicle's climate control gaskets; and the industry-first use of microcellular (MuCell) technology in the injection molding process for the instrument panel, allowing for a one pound weight reduction.

Nissan, ABB, 4REnergy & Sumitomo form partnership to re-use Leaf batteries

ABB, 4R Energy, Nissan North America, and Sumitomo Corporation of America have partnered to find ways of re-using the lithium-ion battery packs that power the Nissan Leaf. The partnership will evaluate and test residential and commercial applications for energy storage systems or back-up power sources using reclaimed EV lithium-ion battery packs.

Electric vehicle batteries are able to maintain 70% of their capacity following 10 years of use in a vehicle. Second-life applications might include smart-grid community energy management systems or battery energy storage for utilities to store power from the grid during periods of low usage and feed that electricity back into the grid during periods of peak demand, thereby increasing grid performance and providing back-up power during outages. The team plans to develop a Leaf battery storage prototype with a capacity of at least 50 kWh, enough to supply 15 average homes with electricity for two hours.

Innovative energy storage solutions are a key component of smart grids and the efficient and reliable integration of renewable energy sources into the grid. Yokohama, Japan-based 4R Energy is a joint venture that was created by Nissan and Sumitomo in 2010 to develop a system that combines solar power generation with high-capacity, second-life lithium-ion batteries in order to develop charging stations for electric and hybrid vehicles. The "4R" stands for "Reuse, Refabricate, Resell, Recycle".

BMW partners with Tendril for smart energy home demo

BMW has announced a partnership with Boulder-based clean energy startup Tendril Networks Inc. to build a demonstration smart energy home in Mountain View (CA). The demo will use Tendril's connect cloud platform to facilitate connecting and charging BMW's new ActiveE vehicle while communicating with energy providers. The platform achieves this by establishing a two-way dialogue between energy providers, product and service providers, developers and consumers, connecting utilities, homes, applications and devices.

The home will feature Tendril's smart thermostats and devices, and solar panels. BMW and Tendril will also include an EV charging station that can help manage the intermittent energy produced by the solar panel, and reduce the home's impact during periods of peak electricity demand. Thus, the software will enable both the utility and EV owner to monitor and manage electricity supply and demand. The utility will be able to prevent grid overload, while the EV owner will be able to charge at off-peak lower rates. Other smart services include preventative maintenance and diagnostics, such as sending consumers alerts when their refrigerator needs a new water filter or their dishwasher needs servicing.

Tendril Connect will coordinate the project, which will be accessible via Tendril Energize. Tendril Connect provides applications and products that allow customers to track energy costs and consumption using appliances, electronics and household devices in the home. Tendril Energize is an energy application suite for home energy management.

The BMW ActivE is a rear-wheel drive four-seat EV that was unveiled at the 2010 North American International Auto Show. ActivE can reach 60 mph in 8.5 seconds. Its EcoPro mode retards throttle response and tweaks climate control to boost efficiency by up to 10%.

IBM unveils 500-mile range battery

IBM has developed a lithium-air battery that would enable EVs to achieve a range of 500 miles (804 km) per charge. Lithium-air batteries have better gravimetric energy density than traditional lithium-ion batteries. That is, they have higher energy densities (theoretically 1,000 times higher) and a lower weight (about a fifth). Furthermore, their lifespan is quintuple that of regular lithium-ion batteries. Lithium-air batteries generate electricity by using carbon in their positive electrode to react with oxygen in the air, unlike lithium-ion batteries that use metal oxides, such as lithium cobalt oxide. IBM discovered that the oxygen in the air not only reacted with these carbon electrodes, but also with the battery's electrolyte. After simulating models of reactions using alternative electrolytes, Physicist Winfried Wilcke and his colleague Alessandro Curioni at IBM's Zurich research labs in Switzerland finally found suitable alternative electrolyte compounds. They expect to have a full-scale prototype available by 2013 and commercial batteries on the market around 2020. IBM has been working on the commercialization of batteries since 2009. The principal challenge in developing lithium-air batteries is their chemical instability and shorter lifespan after repeated charging.

Eos Energy announces zinc-air battery breakthrough

Pennsylvania-based startup Eos Energy is developing a new electrolyte to enable zinc-air batteries. Zinc-air batteries are lighter and cheaper to produce than lithium-ion batteries. They are also non-toxic, safe, and environmentally friendly. Finally, zinc is an abundant resource. Zinc-air batteries have long been on the market, but an impediment in the development of rechargeable ones has been that when electrolytes mix with CO2 from the air they cause damage to the zinc anode during charging and recharging. This makes their charge deplete far quicker than competing technologies and makes recharging difficult and inefficient. The new electrolyte developed by Eos eliminates the traditional membrane on the air electrode to solve this problem. The technology will be applicable to EV batteries, although Eos plans to focus on the grid storage market first. The target price is $1,000 per kilowatt and $160 per kWh – far cheaper than other technologies, such as lithium-ion or sodium-sulfur batteries, which are primarily used for grid storage.

Eos has already produced a 0.33 kW model that has charged 2,700 times without degradation. It aims to produce a battery able to charge 10,000 times without degradation, meaning the battery could last up to 30 years. Eos plans to test megawatt-size batteries in partnership with a small number of utilities and corporate customers in 2013.

Eos specializes in developing novel, low-cost energy storage for utilities and the transportation sector. It aims to produce the most cost effective energy storage solutions in the industry.

ANL & VTT issue study on savings potential from friction reduction

A 2012 joint study conducted at the Metal Products and Mechanical Engineering strategic competence cluster in the DEMAPP program and funded by VTT Technical Research Centre of Finland and Argonne National Laboratory (ANL) in USA shows that new surface technologies, such as diamond-like carbon materials and nanocomposites can reduce vehicular friction by 10% to 50%. The study estimated that in five to ten years products using these technologies could yield worldwide savings of 117,000 million liters (30,908 gallons) of fuel and 174,000 euros ($227,500) per year, and reduce carbon emissions by 290 million tons per year. The report was published in the Tribology International Scientific Journal. Vehicles allocate about a third of their fuel consumption to overcoming friction. Average annual friction loss per vehicle totals an estimated 11,860 MJ, of which 35% is used to combat rolling resistance in the wheels, 35% in the engine itself, 15% in the gearbox and 15% in braking. Only 21.5% of the fuel is used to actually move the vehicle. Engine design changes are another way to reduce friction. For instance, Ford offset the crank under the cylinders in its new 1L 3-cylinder engine to reduce friction. Other automakers are using thinner oils and hotter-running engines to allow the oil to more easily flow in the engine.

U.S. military's FED program to develop fuel efficient vehicles

The US Military has unveiled a new 6.8 mpg humvee prototype, the FED (Fuel-Efficient Ground Vehicle Demonstrator) 'Alpha,' to respond to the US Army's need for more fuel-efficient battlefield vehicles. The FED program was initiated by the Office of the Secretary of Defense to demonstrate a tactical vehicle with significantly greater fuel efficiency than a Humvee while maintaining capability. The ultimate goal of this program is to update military vehicle technology to lower fuel consumption on the battlefield and reduce oil dependence.

The Alpha consumes 70% less fuel than previous models. Its fuel economy is achieved through both internal and external changes. On the mechanical side, Alpha uses a Cummins 4-cylinder 200-horsepower diesel engine coupled to six-speed transmission (older humvees are three-speed), a lightweight aluminum frame (except for the armored cab and blast shield), a rear-mounted solar array to recharge electrical equipment, and low-resistance tires (which alone create a 7% efficiency gain). Externally, its shell is made from lightweight aluminum and, on the underside, Alpha has an aluminum blast shield protecting the interior from the impact of explosions caused by IEDs (Improvised Explosive Devices) of the type that have claimed multiple lives among allied forces deployed in Afghanistan. The dashboard includes a display that assists fuel-efficient driving. The FED Alpha is currently in trials at Maryland's US Army-operated Aberdeen Proving Grounds.

The FED program is also developing a 'Bravo' model with a hybrid-electric drive train. In February, the U.S. Army also started testing a fleet of 16 hydrogen vehicles in Hawaii.

Quarterly Developments

EUROPE

1. Market

Volkswagen and Škoda Developing Electric Cars Based on Up! and Citigo

Volkswagen and its Czech subsidiary Škoda have announced plans to produce electric versions of their respective UP! and Citigo city cars, which were launched in the last quarter of 2011. The Citigo is a variation on the Up! The e-EUP! will be produced in Germany and launched in 2013, and the e-Citigo will be produced in the Czech Republic and launched in 2014. The vehicles will use an 18-kWh battery pack and an 80-hp electric motor, enabling a driving range of about 81 miles and a maximum speed of 81 mph. VW plans to slightly change the design of the Up! for its electric version. The concept version shows slightly softer, more aerodynamic fascias than the regular Up!, along with unique bracket-shaped LED running lights at the front. VW is characterizing the Up! as the "Beetle of the 21st Century". Škoda and Volkswagen are also conducting battery propulsion trials on the Octavia model.

Bentley Unveils Pioneer Hybrid Plug-In SUV Concept Car

Bentley unveiled the first hybrid concept car in its 94-year history at the 2012 Geneva Auto Show, which was held from March 8 to 18: the Bentley EXP 9F. The plug-in SUV uses a 6.0-liter W-12 engine fitted to the higher-end model of the Continental GT. It provides an electric range of 15 to 20 miles at urban speeds, using a lithium-ion battery pack. The range is designed to comply with zero-emission zones that have been implemented in a number of European city centers. Bentley's stable of large, ultra-luxury vehicles with 12-cylinder engines consistently rank among the EPA's worst in terms of fuel economy. In July 2011, Bentley Chairman and CEO Wolfgang Durheimer announced that Bentley's hybrid SUV could be launched within three years if parent company Volkswagen Group approves the project. The model would be Bentley's third and production would be 3,500 to 5,000 annually. Durheimer projected an expansion of the range to 100 km (62 miles) in 20 years: "For the time being, we won't because nobody can afford the batteries and nobody wants to carry them around."

Mercedes to expand Vito E-CELL variants and markets

Mercedes-Benz has announced plans to expand the number of variants of, and markets for, its all-electric Vito E-CELL vans after successful field-testing projects with partners in Berlin and Stuttgart. Mercedes delivered 50 Vito E-CELLs each to Berlin in September 2010, and to Stuttgart in January 2011, as part of a four-year trial. As of January 2012 the vehicles had covered a cumulative 650,000 km (404,000 miles). The seven-seat E-CELL has a range of at least 80 km (50 miles), even in the winter. It can achieve a maximum speed of 89 km/h (55mph). The vehicle's safety features include ESP and battery protection. The van has a load capacity of up to 900 kg (1,984 lb.). The Vito E-CELL uses Smart Charge Communication Unit (SCCU) smart charging technology, allowing for charging during off-peak times at lower rates, or for charging from renewably-generated electricity. Mercedes has produced 400 E-CELLs and aims to produce 2,000 more at its Victoria plant in Spain for deployment in other major European cities.

Mercedes worked with power company Vattenfall in Berlin under the Electrification of Mercedes-Benz Small Vans in Development and Production project (EMKEP) with funding from the German Federal Ministry for the Environment and Nature Conservation. In Stuttgart, Mercedes' partner was utility EnBW and funding was provided by the German Federal Ministry of Transport, Building and Urban Development under the Integrated Concept for Sustainable Electric Mobility Project (IKONE). Both projects were part of the German federal government's second economic stimulus package. In addition to being Mercedes-Benz' headquarters, Stuttgart was selected for the trial because of its topography. In contrast to the largely flat terrain of the greater Berlin area, the differences in elevation within the Stuttgart metropolitan area are as great as 350 meters (1,148 feet), presenting a stamina test for the Vito E-CELL's range, recuperation performance and driving properties.

Hiriko trial production begins in Spain

Trial production has begun for the Hiriko, the product of a partnership between MIT Media Lab, the Spanish government and Basque businesses. Twenty test vehicles are being produced in Spain's Basque region, where they will take part in a pilot program. European Union Commission President José Barroso inspected a prototype earlier this year. The project has benefited from funding from the European Social Funds. MIT stopped working on the project after the initial corporate sponsor, GM, cut funding in 2008. However, MIT consented to allowing the other partners to transform the Hiriko experiment into a commercial project. The goal is now to deploy the Hiriko in city fleets around the world. Trials are planned for Bilbao (Spain), Malmo (Sweden), and Boston. Berlin, Barcelona, San Francisco and Hong Kong have also expressed interest.

The Hiriko, which means urban in Basque, is a two-seater car with four-wheel drive and a range of over 100 km (60 miles). Its battery pack will be leased. The vehicle's most novel feature is the wheelbase's ability to collapse into a smaller footprint (the passenger "pod" section detaches from the rear wheels, which fold underneath the car), meaning that a single parking space could accommodate three vehicles. Portuguese engineer Armando Gaspar is heading the manufacturing process. Gaspar previously worked for Daimler Chrysler in Germany, Brazil, and Spain. Parts will be sourced from local Basque manufacturers and a newly created company called Basque Robot Wheels, which is working on an in-place turning radius to improve urban maneuverability. The Hiriko's lithium-ion battery provides a 75-mile range. The battery will be leased through Axeon, Europe's largest independent supplier of lithium-ion battery systems. The Hiriko's production costs are around 12,500 euros ($16,400). The Hiriko is produced in Vitoria Gastiez, close to Bilbao.

Electric Home Delivery Initiative Started in Barcelona

The Spanish supermarket chain Condis Group celebrated its 50th anniversary by inaugurating a new service: electric home delivery. Through its "Turn Key Operation" project, Condis has become the first private company in Barcelona to deliver internet orders to homes with electric delivery vans. Condis' partner, Quimera, electrified the fleet. With over 500 branches and more than 5,100 employees, the Condis Group is a leading Catalan distribution company. Quimera is an urban sustainable mobility expert.

Condis' electric delivery van has a range of 160 km, a maximum speed of 80 km per hour and a 2-ton weight capacity. The vehicle is also equipped with a reinforced isothermal body. The Condis headquarters in Barcelona has 200 solar panels, biodiesel tanks for 20 vans, and charging stations for the new electric vans. In the experimental phase of deployment Condis has found that the electric vans save the company 70% in operation costs. While conventional delivery vans cost 351 euros for 100 km, the electric ones cost 122 euros to operate.

BYD partners with Veolia to bring first EV bus to Finland

BYD recently announced its partnership with Veolia Transport Finland Oy, to operate a fleet of BYD eBUS12 electric buses in Espoo city, part of the Helsinki Metropolitan Area. The project is also supported by VTT, the Helsinki Regional Transport Authority, the Finnish Funding Agency for Technology and Innovation (TEKES), and the Ministry of Transport and Communications. Sami Ojamo, the development director of Veolia Transport Finland, has expressed high hopes for the pilot project: "If [the issue of temperature variation] can be handled accordingly, we are confident that electric buses can replace diesel or gas buses and realize real zero-emissions in the future in Finland."

The project aims to test whether the buses can withstand extreme variations in temperature, which typically vary from -22 to 86 degrees Fahrenheit in Finland. The project will begin later this year and is expected to run for three years. Finland's Technical Research Center will monitor the buses every day for potential wear and malfunctions.

BYD's 31-seater eBUS-12 has a 155 mile range in urban conditions with a top speed of 62 miles per hour. It is powered by an iron-phosphate battery, which has the advantage of being completely recyclable, environmentally friendly and safe since it contains no heavy metals or toxic/flammable electrolytes. According to BYD one of the major advantages of its battery is that the materials it contains can all be cleanly recycled. The bus can be charged in three to six hours. Solar panels mounted on the bus roof can also partially charge the battery.

Charging companies announce new developments at Geneva Auto Show

A number of charging companies announced new partnerships and products at the Geneva Motor Show. Swiss firm Alpiq E-Mobility AG announced a deal with Toyota to improve charging infrastructure at its 250 dealerships across Switzerland. Moreover, Alpiq E-Mobility was selected to provide the charging stations for Toyota's plug-in hybrid Prius. Another Swiss company, Green Motion, exhibited several types of new chargers, ranging from a portable gadget that weighs just 6 kilograms (13 pounds) and a 210-kilogram charger that looks like a petroleum pump. British company Controlled Power Technologies demonstrated an energy booster that increases the energy produced by small engines. The booster is able to generate more pulling power while meeting tough EU emissions standards.

Liotech, World's Largest Lithium Battery Plant, Opens in Russia

Liotech, a joint venture between Chinese lithium battery manufacturer Winston/Thunder Sky Group and Russian state-run company Rusnano, recently started operations in Novosibirsk, Russia. The venture aims to produce up to 500,000 lithium batteries per year for use in a variety of energy storage applications, for emergency power supply, and in electric vehicles, including buses. The project is expected to become the world's largest manufacturing base for lithium-yttrium and lithium-sulfur batteries. The venture plans to employ more than 500 people.

In December, Chief Executive Officer of Liotech Alexander Erokhin announced that the venture had secured a customer base, including public utilities, electric power networks, telecommunications, and public transportation companies.

Rusnano intends to commercialize its nanotechnology. The company also has branches focusing on solar energy, mechanical engineering, metalwork, nanoelectronics, medicine, and venture financing. The company's customers include Russian Railways, Moscow Metro, electric power networks and power generating companies, businesses in the military industrial complex, the public utilities sector, and telecommunications companies. Prime customer Mobel has already concluded a three-billion-ruble contract for batteries.

Winston Battery Limited is a private joint-stock company registered in Shenzhen with a capital of RMB 130 million. Winston focuses on researching, developing and selling lithium-ion batteries for electric vehicles and boats and energy storage systems. The company was founded by inventor, scientist and entrepreneur Winston Chung, who holds many international patents. Winston's main products are rare earth lithium-yttrium and lithium-sulfur rechargeable batteries.

II. Policy

Britain extends EV tax credit

As another initiative to encourage EV purchases, the UK government has recently announced an extension of the tax credits for electric vehicles through 2015. In addition, the program's scope was widened to make electric vans eligible for the tax credit.

EV purchasers will now receive a credit for as much as 25 percent of the value of their new vehicle, which is up to 5,000 British pounds, or just under $7,800. Commercial EV purchasers are eligible for an up to 20% credit, up to 8,000 pounds ($12,500).

The full credit reduces the cost of a Nissan Leaf by 14%, to 25,990 pounds ($40,500). The price of a Renault Kangoo Z.E. is reduced by 20 percent, bringing the cost down to 16,990 pounds ($26,500). The Chevrolet Volt and Nissan eNV200 van are set to debut in the UK this year.

The UK has started the rollout of the 9,000 charging stations that it plans to have completed by 2013

London Welcomes The New Red (And Green) Routemasters

Since its original launch back in the 1950s, the red double-decker bus is a globally recognizable symbol of London. The buses were taken off the road six years ago as they were aging and becoming less cost-efficient. However, a hybrid version of the bus called the Routemaster has recently reappeared on London's streets. Designed by Heatherwick Studio and bus manufacturer Wrightbus, the new bus is supposed to be the most environmentally friendly of its class, and is claimed to be 15% more fuel-efficient than existing hybrid buses operating in London. The bus is 11.23 meters in length (33 feet), 2.52 meters in width (8 feet), and 4.39 meters in height (14 feet). The Routemaster costs $2.25 million U.S. dollars, translating into a cost of $36,000 per seat. According to a government report published in 2006, transportation accounts for 20% of London's carbon emissions, of which buses account for 5%. It is estimated that the new Routemasters could reduce the city's overall emissions by half a percent. The Routemaster's hybrid engine is powered using a battery and diesel fuel, resulting in the release of half the CO2 of its rivals. In tests the vehicle emitted only 640 grams of CO2 per kilometer and 3.96 g/km of nitrogen oxides (NOx) – less than half the levels of CO2 and NOx emitted by a regular diesel bus (respectively 1,295g/km and 9.3g/km).

In addition to the increased fuel efficiency the interiors were updated with LED lighting and signage indicating the next stop. New features also include an open rear door that can be closed during quiet times and that provides for hop-on and hop-off services. In terms of external design, a long asymmetric window gives the driver clear curbside views, while a wrapped glazing panel reflects passenger circulation. Increased glass makes the bus much brighter inside and provides passengers with better views over London. Finally, the new bus has greater passenger capacity, with 87 seats: 40 on the top deck, 22 at ground level, and room for 25 people to stand. A demo line has been running the 38th route between Victoria and Hackney since February 27th, with seven more buses having come on line at the rate of one every two weeks as they rolled off Wrightbus' production line. A team of 25 engineers built the prototypes. The Wrightbus production team includes 40 people. All eight buses have been operational since the end of May. The City of London purchased all of these buses.

Wrightbus is part of public transportation supplier Wright Group, which is based in Ballymena, Northern Ireland. The company mainly serves the European market, and especially the UK and Germany; it also has an overseas presence in Hong Kong.

France Signs MOU on Electric Cars

The Union Technique de l'Automobile du Motocycle et du Cycle (UTAC), a member of the French ANFOR group of standardization bodies, recently signed a memorandum of understanding with Taiwan's Automotive Research & Testing Center (ARTC) to cooperate in promoting production standards and testing technologies for electric vehicles. The partnership paves the way for mutual certification of electric vehicles from both countries.

France and Taiwan have identified the development of electric vehicles as a priority area for bilateral industrial cooperation. The two bodies will especially focus on certification in electro-magnetic compatibility (EMC)-related fields. A Taiwanese delegation visited a number of French automotive firms seeking potential partners, including Renault, Valeo, Faurecia, Bollorre and Venturi. The Taiwanese delegation also expressed interest in gaining a deeper understanding of France's Autolib and Autobleue projects.

III. Technology

Toyota enters first hybrid in FIA World Endurance Championship

The new Toyota Sport TS030 hybrid had an impressive start at its race debut on June 16-17 in the Le Mans 24 Hours race. Within the first four hours the two TS030 vehicles in the race had progressed to the second and third places behind the winning Audi R-18. However, both hybrids were subsequently knocked out due to accidents. The TS030 is the second hybrid car to race in Le Mans. The Oreca Swill Hytech Hybrid was the first, in June 2011. The TS030 was supposed to make its debut on May 5 in the Six Hours of Spa-Francorchamps, the second round of the FIA World Endurance Championship. Toyota would have been the first automaker to enter a hybrid in the FIA Championship, in which Toyota has participated since 1983. However, the vehicle crashed during testing in April and Toyota did not have a duplicate. The Toyota TS030's hybrid system was developed by official team partner Nisshinbo, its motor system was produced by Aisin AW, and its rear motor system by DENSO. The TS030 is nearly 4.65 meters long and is placed on a brand new carbon fiber LMP1 chassis. The TS030s use a THS-R (Toyota Hybrid System – Racing) powertrain, featuring an all-new 3.4-litre aspirated V8 petrol engine and hybrid system with capacitor storage. The carbon fiber LMP1 chassis was developed and produced at Toyota Motorsport GmbH in Cologne, Germany. The TS030 is a successor to the TS010 and TS020 that successfully competed in Le Mans during the 1990's. Unlike its predecessors, the TS030 has a 90° VA aspirated engine combined with regenerative breaking used to assist with acceleration. Pascal Vasselon explained: "The regulations for hybrid powertrains allow us to recover energy under braking and release this to improve acceleration out of a corner, delivering lap-time benefit. For any given performance level, a hybrid powertrain will achieve this with less fuel so it is an extremely relevant technology." The vehicle is also more aerodynamically efficient.

Toyota team president Yoshiaki Kinoshita described the importance to Toyota of showcasing hybrid technology: "Hybrid is a core technology of Toyota so it is important to demonstrate this in a motorsport arena and we want to prove it can bring a performance advantage, both in terms of lap time and fuel efficiency."

Quarterly Developments

ASIA

1. Market

Japan

Toyota expands Prius C production

Due to a backlog in orders, Toyota expanded production of the popular Prius C (known as Aqua hybrid in the Japanese market) for the Japanese market beginning in May 2012. Toyota started selling the Prius C in Japan in December 2011. With a base price of 1.69 million yen ($20,240) and a top-ranking fuel economy, the Prius C was immediately popular and beat Toyota's initial sales target tenfold. Around 120,000 vehicles were ordered in just the first month of sales. Toyota produced about 30,000 Prius C vehicles at its Iwate plant in February. Even with employees at the plant working overtime, Toyota had trouble meeting the increased demand. As a result, Toyota has shifted some of the production of its Ractis compact from the Iwate plant to its Higashi Fuji plant to allow for increased production of the Prius C.

The Prius C is the fourth and latest model in the Prius series (Prius, Prius plug-in hybrid and Prius V). The 'C' stands for 'city', since the Prius C is shorter and lighter than the original Prius. The car's 1.5-liter gasoline engine is the main propulsion system and generates the electricity to charge the vehicle's nickel-mental hydride batteries. The Prius C has fuel economy of 53 mpg in city driving, 46 mpg on the highway and 50 mpg in combined driving.

Toyota unveils new AFV models

Toyota unveiled its new hybrid concept vehicles at the Geneva Auto Show. The new models include the much-anticipated hybrid version of the Yaris, which will be introduced to the European market in the summer of 2012, beginning with Germany in June. Like the Prius, the Yaris hybrid model uses a nickel metal hydride battery. Toyota also unveiled its new FT-Bh hybrid, NS4 plug-in hybrid and FCV-R hydrogen fuel concept cars.

Made of high-tensile steel, aluminum and magnesium, the FT-Bh plug-in is smaller and lighter than the Prius. The FT-Bh hybrid runs on an electric motor and a two-cylinder 1.0-liter gas engine, allowing it to achieve an average of 134.5mpg. Toyota is also experimenting with a compressed natural gas powertrain on the FT-Bh.

The NS4 is a mid-size sedan and a plug-in hybrid that features innovative interaction between the driver and vehicle. The NS4 system keeps a memory of the driver's preferences and habits and tailors the driving experience to the driver's style.

The FCV-R hydrogen fuel concept car is a four-seat compact that was first introduced at the 2011 Tokyo Motor Show. The hydrogen fuel cell is located beneath the passenger seat and the car has a range of 435 miles. Toyota has announced plans to start producing the FCV-R around 2015.

Mitsubishi unveils plug-in hybrid Outlander

Mitsubishi introduced the plug-in hybrid version of its Outlander at the Geneva Auto show. The Outlander is based on the PX-MiEV concept car that Mitsubishi displayed at the Tokyo Auto Show in late 2011. The Outlander is a seven-seat SUV featuring a 70kw 2.0 liter four-cylinder petro engine along with two electric motors, each of which generates 60 hp and 148 lb-ft torque. The hybrid runs on a gasoline engine, dual electric motors, and a lithium-ion battery pack. The driver can choose whether to operate the vehicle as a series hybrid, a parallel hybrid, or all-electric vehicle. The series mode can turn the combustion engine into a generator to support the twin electric motors. In the parallel setting, the engine creates battery power for the front wheels. The vehicle has an all-electric range of 31 miles, and a total range of 500 miles. The vehicle is to be released in Russia in the summer of 2012, followed by a global release at the end of 2012.

Mitsubishi has been producing the conventional Outlander for the European market in the Netherlands, but the company is planning to shift the production to Japan or Thailand before the end of the year.

South Korea

Hyundai unveils I-Oniq

Hyundai unveiled its edgy four-seat sports hatchback plug-in hybrid concept car, I-Oniq, at the 2012 Geneva Auto Show. The model is over 14.4 feet long with a shooting brake style body and a scissor-door design. The powertrain includes a 100-horsepower electric motor that has a range of 75 miles and a 60-horse power, 1-liter three-cylinder gasoline engine, which can also serve as a generator for the lithium-ion battery pack. The I-Oniq has a maximum speed of 145km/h and a combined range of 435 miles. Although the I-Oniq is not slated for production yet, it is meant to convey the future of Hyundai's hybrid vehicle development.

III. Technology

Japan

Japanese automakers develop new energy source for AFVs

Japanese leading automakers Toyota, Honda and Nissan have joined forces to jointly promote the development of hydrogen fuel cell vehicles. Ten Japanese natural gas producers and distributors have announced their participation in the deployment of this technology by helping to build hydrogen fuel stations in Tokyo, Osaka, Nagoya and Fukuoka.

South Korea

Posco announces new steel technology for EVs

South Korean steelmaker POSCO announced that it has developed a new type of steel, PBC EV, which can be used in EVs to reduce weight. PBC EV is ultra-strong, flexible and 40% denser than the steel that is currently used in car manufacturing. POSCO applied two newly developed technologies in the steelmaking process: hot press forming and multi-direction forming. The new material could reduce a vehicle's GHG emissions by as much as 50%.

Quarterly Developments

CHINA

1. Market

BYD-Daimler EV joint venture unveils first model

The Shenzhen BYD-Daimler 50-50 EV joint venture - Denza - unveiled its first EV prototype at the Beijing Auto Show, which was held from April 23 to May 2. The design derives from the Mercedes Benz B model and uses the same electric drivetrain as BYD's e6, but with modifications that will allow it cover a greater range. The vehicle is slated to become available on the market in 2013. Denza was formed in March 2011 to develop EVs exclusively for the Chinese market.

Daimler has three other joint ventures in China:

- Mercedes-Benz Car Sales Co., Ltd. is responsible for Mercedes-Benz cars import, brand management, sales, customer services and distribution.
- Beijing Benz Automotive Co., Ltd. is a 50-50 joint venture formed between Beijing Automobile works corporation and Daimler in 2005. It produces the Mercedes-Benz C class and E class. The joint venture has an annual capacity of 100,000 vehicles.
- Fujian Daimler Automotive Co., Ltd. was founded in June 2007. It is a 50-50 joint venture with Fujian Motor Industry Group Company and Hong Kong Daimler Vans Limited, which is a joint venture between Daimler AG and Taiwan China Motor Corporation. Fujian Daimler is located in Qingkou Investment Zone of Minhou County, Fujian. The joint venture produces the Mercedes-Benz brand Viano, Vito and Sprinter. The annual capacity is 40,000 vehicles.

None of these joint ventures produces AFVs.

BYD unveils Qin

BYD unveiled its new Qin dual mode electric vehicle at the Beijing Auto Show. An upgraded version of the FD3M, the Qin uses second-generation dual mode technology, which has a higher voltage and high-speed motor (rotation >10,000r/min). While the Qin carries a smaller battery pack than the FD3M, it has a 50km range on 10 kWh of electricity compared to 60km on 16kWh for the FD3M.

Yixing EV and Brilliance develop EV

Electric bus producer Yixing EV, located in Shandong province's Yixing industrial park, has developed an electric car in a joint venture with Brilliance. The vehicle's lithium-ion battery has a range of 180 km (111 miles). It is scheduled for release in May. The companies received financial incentives from Shandong province, which implemented an incentive program for AFV manufacturers and component producers in 2010. The first 50 vehicles will be sold to the provincial government.

Shandong Yixing Electric Automobile primarily focuses on electric bus R&D and manufacturing. Its holding company is Hong Kong-based Xin Meijing Group, an investment group specializing in AFV R&D and investment. Yixing has released six electric bus models.

Brilliance Auto Group was formed in 2002 in Liaoning province and has grown into a large manufacturer with RMB 30 billion in assets and 35,000 employees. The company produces complete vehicles and automotive parts. Brilliance wholly owns the following companies: Brilliance Jinbei Automobile Co., Ltd., BMW Brilliance Automobile Co., Ltd., Shenyang Jinbei Vehicle Manufacturing Co., Ltd., Shenyang Aerospace Mitsubishi Motor Engine Manufacturing Co., Ltd. and over 30 other automotive parts manufacturers. Brilliance most notably produces the M1 series, M2 series, M3 series, FRV series, FSV series, Jinbei Haise minibus, Jinbei light truck, Granse MPV and BMW 3&5 series. Brilliance has worked with BMW, Porsche and Toyota, and exports to the Middle East, CIS, Africa, North America, Central & South America, and Europe.

Wuzhoulong Motors to unveil first EV school bus

Wuzhoulong Motors unveiled China's first electric school bus in April. The electric bus is 10 meters long and is designed with a "long nose" to maximize safety. It features a passenger counting system that will automatically stop the engine if the bus is overloaded. Wuzhoulong claims the safety standards for this electric school bus surpass Chinese national school bus safety standards.

Shenzhen Wuzhoulong Motors Group manufactures and exports a range of buses, especially environmentally friendly buses. Headquartered in Shenzhen, Wuzhoulong has 3 branches, in Chongqing, Shenyang and Guangdon, covering 1.1 million square meters, employing 5,000 workers and producing 30,000 units annually. Wuzhoulong has developed more than 150 vehicle models including hybrid buses, all-electric buses, other alternative fuel buses, and diesel buses. Its sales span over 20 provinces and cities in China, including Hong Kong and Macau, as well as overseas markets, such as the United States, Latin America, the Middle East, and Africa, totaling over 40 countries. Its international after-sales service team provides maintenance overseas.

Wuzhoulong started the development of alternative fuel buses at the beginning of 2000. In 2002 the first hybrid sample bus in China named "Chinese No. 1" was successfully launched and exported to the United States. In 2005, Wuzhoulong supplied seven hybrid city buses to Shenzhen in China's first national demonstration operation of an alternative fuel bus line. Shenzhen acquired 50 more in 2008. In August 2011, Shenzhen deployed 2011 new energy vehicles to service the 26th World Universiade. Wuzhoulong new energy buses account for over 75% of these buses, including 1,350 single-decker hybrid buses, 20 double-decker hybrid buses, 53 electric buses, 26 all-electric mid-sized buses, 60 fuel cell site buses and two fuel cell buses. To date, nearly 3,000 Wuzhoulong new energy buses are in operation on more than 20 routes in China. Wuzhoulong is the global leader in terms of the number of new energy buses deployed.

Wuhan to become SGM's AFV base

Shanghai General Motors (SGM) has announced a seven billion yuan ($100 million) investment to build a fourth passenger vehicle subsidiary – Shanghai GM Wuhan – in the Jiangxia district of Wuhan (Hubei province) that will primarily serve as SGM's AFV base.

The project will be completed in two stages and is expected to come on line in 2014 with a production capacity of 300,000 vehicles.

Wuhan's municipal government plans to turn Jianxia district into a manufacturing base for advanced and environmentally friendly technology. In November 2011 Wuhan created an AFV industrial base in Jiangxia. In the coming years the city plans to focus on developing the district's new energy industry supply chain. Jiangxia is also home to Hubei Guotong Qinyang AFV Co., Ltd., which focuses on R&D, manufacturing, and sales of AFVs, power batteries, motors, and power control systems.

SGM is a joint venture between Shanghai Automotive Industry Corporation Group (50%) and General Motors (50%). The company was established in 1997. It has three manufacturing bases in China and produces the Buick, Chevy and Cadillac. In 2008, SGM launched a "Green Future" strategy and began to promote its AFV models. The AFVs that SGM produces are the same as those that GM produces in the US: the Lacrosse Hybrid, Escalade Hybrid, and Chevy Equinox Hydrogen Fuel Cell Vehicle. SGM has three other manufacturing plants in Pudong Xinqiang (Shanghai), Yantai Dongyue (Shandong province) and Shenyang Beisheng (Liaoning province).

Wuhan is part of the "Ten Cities, Thousand Vehicles" program. Wuhan's municipal government also promised to provide RMB 2 million, 10 million and 20 million financial awards to AFV producers that first reach the target of selling 1000, 5000 and 10,000 AFVs.

Quarterly Developments

CHINA

II. Policy

National Level

State Council approves Energy Saving and New Energy Vehicle Development Guidelines

On April 18th, the State Council approved the Energy Saving and New Energy Vehicle Development Guidelines (2012-2020). The guidelines define an overall strategy for AFV development in China, with the goal of transitioning the auto industry to electric vehicles.

The guidelines aim for the production and sales of 500,000 all-electric and plug-in hybrid electric vehicles by 2015, and ten times more by 2020. Additionally, average fuel consumption for passenger vehicles is to be reduced to 6.9 liters per hundred kilometers by 2015, and to 5.0 liters by 2020.

MIIT releases list of AFV models exempt from taxes and new AFV standards

On March 8th, two important policy documents for the AFV industry—"List of energy saving and alternative fuel vehicle models that are eligible for ship and vehicle tax reduction/exemption" (the list) and "Testing standards for AFV and related products" (the Standards), were released.

The list was jointly released by the Ministry of Finance, State Administration of Taxation and Ministry of Industry and Information Technology (MIIT). It complements the new ship and vehicle tax (effective since January 2012) on what energy saving and AFV models are eligible for tax reductions and exemptions.

The original list includes 271 vehicle models, of which 49 are fuel-efficient passenger vehicles and 222 are AFVs. The majority of the vehicle models are produced by indigenous automakers, except for 22 fuel-efficient vehicles produced by joint ventures. The fuel-efficient and plug-in hybrid passenger vehicle models and non-passenger AFV models on the list are eligible for a 50% tax reduction while the all-electric and fuel-cell passenger models are eligible for a tax exemption. On June 6, 65 fuel-efficient passenger vehicle models, 3 all-electric passenger vehicle models, and 7 all-electric non-passenger vehicle models were added to the list. More vehicle models will be added to the list in the coming months. AFV models using lead-acid batteries were not and will not be considered.

The Standards released by the MIIT include 21 national standards covering AFV safety, battery quality, power systems, energy consumption and radiation levels.

MIIT tightens lead-acid battery standards production

On March 3rd, the Ministry of Industry and Information Technology (MIIT) and Ministry of Environmental protection released draft "Industry entry requirements for lead-acid battery production" (draft requirements).

The draft requirements impose higher standards on lead-acid producers. For example, they forbid the production of conventional lead-acid batteries (as opposed to valve-regulated lead-acid batteries). They also require that the production capacity of new projects be no less than 500,000 kVA – much more than the 200,000 kVA recommended by industrial experts.

According to a senior official from the China Battery Industry Association, the draft requirements are expected to consolidate the lead-acid battery industry and benefit large producers.

The new requirements are one of the Chinese government's latest efforts to scale back the heavily polluting lead-acid battery industry. Many lead-acid battery producers have been shut down since 2011, when the Ministry of Environmental Protection began to take a tougher stance on regulating the industry. Finally, the new ship and vehicle tax effective this year excludes EVs using lead-acid batteries from any tax reductions.

In the first half of 2011, lithium-ion battery production increased by 19% while lead-acid battery production remained level.

MOST releases Twelfth five year guideline for EV technology development

On March 5th, the Ministry of Science and Technology (MOST) released the Twelfth five-year guideline for EV technology development. This is the first official guideline for EV development. The guideline considers electric powertrain vehicles (including all-electric, extended-range electric, plug-in electric and fuel cell electric vehicles) as the core components of AFV technology development in China. The development of fuel-efficient and hybrid electric vehicles is encouraged to fulfill energy savings and emissions reduction goals in the short and medium run (2008-2015). However, the long run (post-2015) objective is a gradual transition to all-electrics.

The guideline outlines a three-step strategy. The first stage – the 2008-2010 period – was devoted to conducting AFV pilot programs in the public sector of large to medium-sized cities, such as the Ten Cities & Thousand Vehicles program. The objective for the 2010-2015 period is to lay the technological foundations for EV industrialization. Programs designed to achieve this objective include: completing the industrialization of hybrid vehicles; conducting commercialization pilot programs for small-size EVs, as well as pilot programs for fuel cell electric vehicles in the public sector; capturing cutting-edge electric powertrain technology; developing next generation electric power systems, such as fuel cells; and promoting innovation in lithium-ion battery technology. The third stage (2015-2020) will be devoted to industrializing next-generation EVs, optimizing EV business models and developing infrastructure.

Local Level

Beijing adds new EV taxi fleet

Beijing has added 100 Changan E30 all-electric sedans to its taxi fleet serving suburb Fangsha district. The fleet began operating in mid-March and is operated by Beijing Fangan Taxi Co. Fifty additional charging piles were planned to accommodate the new fleet. The vehicles were produced by Changan, and cost RMB 350,000 to 380,000. The EVs have 29KWh lithium-ion battery packs that can be charged using 220 AC electric outlets. The vehicles have a range of 160 km (100 miles) and a top speed is 125 kilometers per hour (78 miles/h). Changan's E30 was the first indigenously designed and manufactured EV to be officially crash-tested and receive a five star safety rating. Beijing Fangan Taxi Co., Ltd. is operating the EV taxi feet.

Hefei to build an AFV experience center for the public

The Director of the Hefei science and technology bureau, Ce Zhu, told reporters that Hefei will focus on promoting AFVs to the public this year, beginning with the creation of an AFV experience center. Jianghuai Automobile Co., Ltd. (JAC Motor) will design the center, which will feature pictures, vehicle models, and test-driving to educate visitors about AFVs. JAC Motor was founded in 1964 and is located in Hefei. The company produces vehicles ranging from sedans to trucks and has an annual production capacity of over 700,000 vehicles. Its subsidiary Ankai Bus Manufacturing produces a range of buses.

Hefei is part of the "Ten Cities & Thousand Vehicles" program. Hefei first introduced electric buses in public transportation in January 2010 with 30 vehicles. An EV taxi fleet was established at the end the 2010. Both the EV taxis and buses are produced by JAC and subsidiary Ankai.

Jiangsu and State Grid Corporation to implement EV battery rental pilot program

Utility State Grid Corporation's Jiangsu Subsidiary is running an EV battery rental pilot program in Yancheng (Jiangsu). Consumers will be able to buy EVs without the battery, while the utility will provide battery rental services. The program aims to dramatically reduce the cost of an EV given that the battery accounts for around one third of the price. This system also addresses concerns about battery life as owners will not have to worry about replacing their car's most expensive component. The program will include the deployment of battery swap stations.

Yancheng is the hub of Jiangsu province's AFV industry. The city is home to several companies with AFV R&D and manufacturing capabilities, such as Dongfeng Yueda Kia Automotive Company; Aoxin New Energy Automobile Co., Ltd., which focuses on the R&D, manufacturing and sale of neighborhood electric cars, mini electric buses and sanitation trucks; Zonda Bus Manufacturing Co., Ltd., which was founded in 1994, has RMB 2 billion in registered assets, a staff of 6,900, and annual production capacity of 15,000 buses, including three AFV bus models; Futeli power control system Co., Ltd.; and Xiexin AFV battery Co. Ltd. On March 1, 2012, State Grid Xiamen Corporation announced a similar program in Xiamen (Fujian).

China's largest EC charging station begins operations in Beijing

China's largest electric vehicle charging station is now in operation. Built by National Grid Corporation, the station is located in the eastern suburbs of Beijing next to a waste disposal plant. The station is primarily powered by a waste-to-energy plant and solar panels installed on its roof. It comprises 1,044 chargers with a total capacity of 10,080 Kw/h. In addition to charging services, the station provides battery swap services through four robot-operated assembly lines that can simultaneously swap batteries for up to 8 EVs. Each swap takes 4 to 6 minutes. Beijing has 15 charging stations and 380 charging piles. State Grid Corporation's Beijing subsidiary plans to build an additional 22 charging stations and 500 charging piles this year.

State Grid Corporation has also recently finished building the first charging station in Longquan city (Sichuan Province). Ningxia province's first charging station has passed its safety inspection and will begin operation shortly.

III. Technology

Hangzhou to introduce EV buses with trolley poles

Hangzhou has announced it will introduce 30 new buses lined with trolley poles produced by China Youngman Automobile Group Co., Ltd. This new type of bus is a combination of an all-electric bus and a trolley bus. Trolley poles mounted on the bus rooftops will allow bus batteries to charge whenever trolleybus wire is available. This innovative design reduces the buses' reliance on charging stations while making use of the existing trolley wire infrastructure in cities such as Beijing and Shanghai.

China Youngman Automobile Group Co., Ltd. consists of a commercial vehicle group, passenger car group and automobile components group. The company is in partnerships to produce and sell the German NEOPLAN passenger coaches and MAN brand heavy trucks, and the British Lotus cars. Youngman is based in Jinhua, Zhejiang province.

Quarterly Developments

REST OF WORLD

South Africa

BMW ends Mini E trial in South Africa

After Mini sales reached an all-time high in South Africa in 2011, BMW South Africa conducted a local trial study of the Mini in the first half of 2012 that ended in June. The results have not yet been reported. BMW South Africa sold 2,584 Minis in 2011, a 42.4% increase compared to 2010. BMW managing director Bodo Donauer explained the trial study was part of the BMW Group's efforts to be the first manufacturer to bring e-mobility to South African roads. No EVs are currently available on the South African market. The Nissan Leaf will be available beginning in 2013 and South African private energy company Optimal Energy's EV model, the Joule, is scheduled to become available in 2015.

BMW has also conducted Mini E trials in the U.S. (Los Angeles, New York and New Jersey in June 2009), the UK (London in December 2009), France in 2010, Germany (Berlin and Munich from 2009 to 2010), China (Beijing and Shenzhen in February 2011), and Japan (Tokyo in 2011).

New Zealand

New EV Standards Released in New Zealand

On May 1, New Zealand's Low Volume Vehicle Technical Association's (LVVTA) new standards for electric and hybrid vehicles took effect. The standards cover all the safety-related certification requirements for electric and hybrid vehicles, both converted and built from scratch. The New Zealand Ministry of Transport requested the update from the LVVTA in response to the increased interest in electric and hybrid transportation. The standards cover three areas:

- Electrical Systems, including electrical wiring, over-current protection requirements and external charging circuits
- Batteries, including the design of a battery restraint and battery compartment forced ventilation
- Basic Vehicle Operation System requirements, including accelerator, transmission and braking systems

The new standards have reviewed and improved on the previously used 1997 guideline, and formalized low volume vehicle standards. The LVVTA started issuing standards for electric vehicles in 1992.

The LVVTA includes ten member associations, most of which are hobbyist groups. It claims that the LVV system in New Zealand has been successful because "the rules are written for enthusiasts, by enthusiasts but governed by the government". Member associations include the New Zealand Hot Rod Association, Motor Sport New Zealand, Sports Car Club of New Zealand, Constructors' Car Club, Vehicle Association of New Zealand for People with Disabilities, New Zealand Motor Caravan Association, Component Car Manufacturers Association of New Zealand, New Zealand Four Wheel Drive Association, Vintage Car Club of New Zealand, and Kiwi Trikers Social Club.

Additional original documents and translations available in **AFVInsider online** edition:

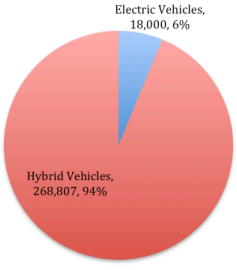
- China's Auto Industry Restructuring and Revitalization Plan
- China's Twelfth Year Plan guidelines for EV technology development
- China's list of energy saving and alternative fuel vehicle models that are eligible for ship & vehicle tax reduction/exemption
- China's Energy Saving and New Energy Vehicle Development Guidelines (2012-2020)
- China's industry entry requirements for lead-acid battery production
- Chinese pilot city AFV targets for 2015

GLOBAL FEATURE STUDY
EV SAFETY IN THE US

A Growing New Market

Still in its infancy, the U.S. electric vehicle market is poised to grow dramatically in the next few years in terms of both sales and models offered. GM and Nissan were the first major automakers to introduce plug-in electric vehicles to U.S. consumers in December 2010, when they respectively sold 326 Volts and 19 Leafs[1]. Sales in 2011 were widely deemed disappointing given that both companies had announced a goal of selling 10,000, but fell short: Leaf sales totaled 9,674 units, while Volt sales only reached 7,671 units. Overall, close to 18,000 EVs were sold in 2011[2]. However, these figures compare favorably with first-year sales of the first hybrid vehicle introduced to the U.S. market, the Honda Insight, which registered sales of 17 units in its first month (December 1999) and 3,788 units in its first full year. Toyota's Prius, the enduringly and by far most popular hybrid in the U.S. appeared on the U.S. market eight months after the Honda Insight and registered sales of 5,562 units in 2000. Yet Prius sales almost tripled the following year, peaked at 181,221 units in 2007, and are projected to reach a record 244,632 in 2012 as Toyota rolls out two additional Prius hybrid models[3]. EV sales are following a similar growth curve thus far, with sales in the first half of 2012 already almost equal to annual sales in 2011[4]. As Chart 1 illustrates, hybrid sales totaled 268,807 units in 2011. Together, hybrid and electric vehicles accounted for 2.25% of the 12,734,356 vehicles sold in the U.S. in 2011[5].

Chart 1: Hybrid & EV Sales in the US, 2011



While total vehicle sales in the first half of 2012 are 15% higher compared to the same period last year, hybrid sales are up 63.5% and plug-in sales have increased over 161%. Hybrid and electric vehicles account for 3.25% of vehicles sold through June this year[6].

In terms of number of automakers involved and models offered, the EV market is growing at a faster rate than the hybrid market did in its first years. Charts 2 and 3 show that it took a dozen years for ten automakers to start producing hybrid vehicles, while the EV market included ten automakers this year, just four years after Tesla introduced the first EV to the U.S. market. In their fifth year on the market, hybrid vehicles were only available in three models from two automakers. Chart 3, which includes highway-capable electric vehicles produced for sale, shows that in the same time span, the portfolio of EVs has grown to eleven models from ten automakers[7].

Chart 2: Number of Hybrid Vehicles by Automaker

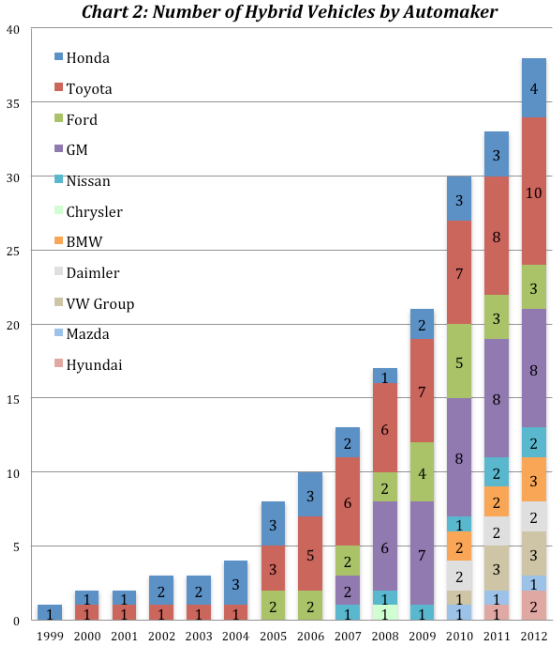
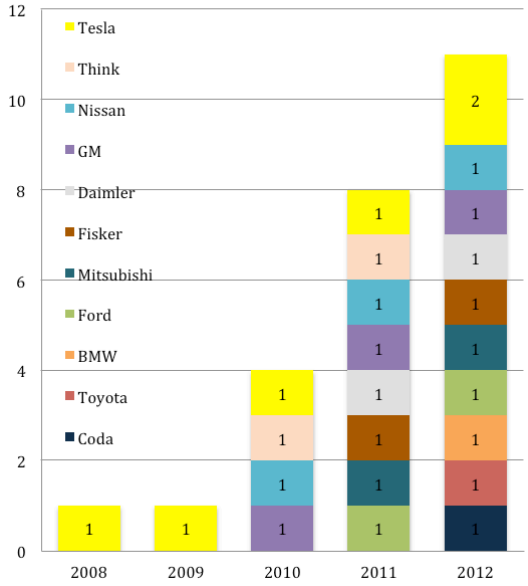


Chart 3: Number of EV Models by Automaker



Considering that EVs were introduced during the Great Recession and face greater adoption challenges linked to limited range and charging infrastructure and to their significant price premium, EVs are faring quite well relative to the hybrid market's experience. However, a series of recalls and the fallout from a Volt catching fire after NHTSA testing have cast a pall over the EV market. Of all the hurdles to the successful deployment of electric vehicles, the safety of EV lithium-ion batteries has recently come to the fore.

EV Recalls for Fire Hazard

To date, the National Highway Traffic Safety Administration (NHTSA) has issued a total of eight EV recalls involving four automakers, as detailed in Table 1[8]. Most of the recalls were for components that are not EV-specific, such as wheels, seat belts, defrosters, transmissions, and steering. In fact, BMW's recall included both an EV model – the Active E, and an ICE model – the Z4. To compare with the ICE safety track record, of the thousands of recalls NHTSA has issued since 1990 the most commonly cited faulty component has been the gasoline fuel system, which accounted for 327 recalls affecting 29,548,405 potentially affected vehicles[9].

Three of the EV recalls cited a fire hazard. In the case of Tesla's 2010 Roadster 2 the issue was not the battery, but the improper routing of low voltage auxiliary cables[10]. The risk was that a cable might become lodged against the wheel well cover, and exposed from repeated rubbing. A short circuit might then result from its contact with the vehicle's carbon fiber armature. This chain of events could end in electrical arcing and a fire in the headlamp area, from which the main battery pack is isolated. Tesla launched a voluntary recall after a customer reported an occurrence of this malfunction, smoking, and "possible fire"[11]. Most recently, Fisker initiated a voluntary recall of its 2012 Karma due to an internal fault in the low-temperature cooling fan located at the front of the vehicle. The fault might cause the unit to overheat and develop a slow burning fire[12]. The recall was announced in the aftermath of an incident that occurred on August 10, 2012, when a Fisker caught fire at the front of the vehicle on the passenger's side (the fire did not spread to the interior).

Only one recall presented an EV battery fire hazard, which was attributable to a defect in the battery pack. Fisker initiated this recall in December 2011 after workers assembling the Karma vehicles at Valmet Automotive's plant in Finland noticed leaking coolant[13]. Incorrectly assembled hose clamps were identified as the cause. Interference with the battery compartment's cover risked creating a coolant leak from the cooling hoses into the battery, potentially causing an electrical short and fire[14]. Fisker expanded the recall in May 2012 after its battery supplier A123 notified it of additional potentially defective batteries[15]. Between the two recalls, Consumer Reports announced that a new Fisker Karma it had purchased for testing broke down during its check-in process[16]. Upon investigation, Fisker found that the battery presented a defect, but one that was unrelated to the battery defect cited in the recalls. In this instance, faulty calibration on one of the welding machines at A123's plant in Michigan produced misaligned cells that could create an electrical short in the battery pack. Likely consequences included battery failure or reduced battery performance and/or life, but not fire. A123 has repaired the Karma batteries with malfunctioning hose clamps and entirely replaced the cell-damaged battery packs supplied to Fisker and several other customers[17].

It is noteworthy that the list of NHTSA EV recalls is entirely composed of start-ups (Tesla, Think and Fisker) and a premium automaker (BMW). These two segments of the automotive market are generally most prone to reliability issues, in the first case due to inexperience and in the second by dint of being at the forefront of new technology. EV start-ups combine both factors. As Consumer Reports conceded with regard to Fisker, "In fairness, the challenges Fisker has surmounted in going from a start-up to a bonafide automaker over a short period are monumental. Some birthing pains are not unexpected, especially as it is presumed the company faced significant timeline challenges to reach milestones necessary to obtain funding. Further, the Karma is a leading-edge car. Check the reliability track record for other companies pushing tech boundaries (ahem, Mercedes-Benz) and you will often find hiccups"[18]. Indeed, while the first two major automakers to introduce EVs – GM and Nissan – have benefited from their experience making limited quantities of EVs in the 1990s and have not issued any recalls for the Volt and Leaf, both have conducted customer service campaigns to address unanticipated issues[19].

Table 1: NHTSA EV Recalls

Auto-maker	Model (potentially affected vehicles)	Report Date	Component	Issue
Tesla Motors	2008 Roadster (345)	5/22/09	Wheels: cap, cover & hub	Under-torqued rear hub flange bolts may become loose and cause driver to lose control of the vehicle.
Tesla Motors	2010 Roadster2 (439)	10/1/10	Electrical system: battery cables	12V auxiliary cable to low voltage system may be improperly routed, rub against the carbon fiber and eventually expose wire, causing a short circuit. A fire might ensue.
Think	2011 City (16)	1/19/11	Seat belts	Seat belts may be improperly installed and fail to restrain a child.
Think	2011 City (23)	1/21/11	Visibility: defroster	Fluid heater malfunctions might cause performance failure of the defroster and compromise visibility.
Think	2011 City (23)	2/15/12	Power train: automatic transmission lever & linkage	Improper adjustment of transmission park mechanism might result in vehicle's failure to hold in park position.
Fisker	2012 Karma (258)	12/21/11 5/25/12	Electrical system: battery propulsion system	Improper installation of hose clamps within the high-voltage battery may cause coolant to leak into the battery compartment, resulting in an electrical short and fire.
BMW	2011 Active E (162, including Z4 2012 models)	6/28/12	Steering: electrical power assist system	Current variations in electric power steering may lead to sudden loss of steering assistance.
Fisker	2012 Karma (2,400)	8/18/12	Cooling fan	An internal fault in the low temperature cooling fan may cause failure, overheating and fire.

Source: NHTSA, Safercar.gov

In sum, no EV model has been recalled in response to a real-world battery fire. Only one EV model has been preventatively recalled because of a battery fire hazard, which was traced back to an A123 battery defect that does not affect any of A123's other customers.

NHTSA Investigations of Battery Fire Hazards

In addition to on-scene examinations that NHTSA's Special Crash Investigation Division has performed after EV accidents, the agency has investigated three fires involving EVs and launched one formal defect investigation into an EV battery fire hazard.

Table 2: NHTSA investigations of fires involving EVs

Vehicle	Date	Location	Status	Investigation result
GM Volt	11/2011	Mooresville, NC	Charging	EV was not the cause
GM Volt	04/2011	Barkhamsted, CT	Charging	EV was not the cause
Fisker Karma	05/2012	Houston, TX	Parked	Ongoing

Table 2 shows that neither of the two first residential garage fires investigated by NHTSA were found to have originated from a charging Volt. NHTSA has not released any results from its third investigation yet. Thus far it appears that the Fisker Karma involved was a post-recall model purchased in April, and that two other, non-EV vehicles were parked in the garage. The chief fire investigator at the scene suggested the fire originated with the Karma, while Fisker claims its vehicle's battery pack was found intact and was unlikely to have caused the fire[20].

NHTSA opened its only formal defect investigation into an EV battery fire on November 25, 2011, citing two Volt battery fires that had occurred after a series of tests. The first fire broke out on June 6 at a testing facility in Wisconsin following New Car Assessment Program (NCAP) crash tests. NHTSA had conducted an oblique side impact test that resulted in a transverse stiffener under the driver's seat piercing the Volt's high-voltage battery and causing battery coolant to leak. Next, a rollover test caused the coolant to saturate the battery and electronic components. The vehicle was then placed in storage, its battery pack cells damaged; an electric shorting produced a fire three weeks later. Four other Volts that underwent side pole tests displayed no battery intrusion (except for minor plastic damage in one case) or coolant leakage[21].

In partnership with the U.S. Departments of Energy (DOE) and Defense (DOD), NHTSA developed a test to replicate the battery damage that had precipitated the Volt fire. In November, NHTSA used this test to intentionally damage three battery packs, which were then placed in storage for observation. The Volt's LG Chem-supplied batteries were tested in isolation, outside of the vehicle. Within a week one battery pack caught fire, destroying another. The third pack was found smoking and sparking. This prompted NHTSA to open an investigation on the Volt. It was an unusual step given the absence of any real-world incidents. NHTSA cited the vehicle's new technology as a major factor in its decision to formally investigate. Another three tests were conducted in December on three new Volt battery packs to isolate the cause. The battery used to isolate the shorting of the battery bus bar to the chassis caught fire 6 days after the test[22].

Although NHTSA did not identify a defect warranting a recall and GM stood by the safety of its battery packs, the automaker initiated a customer satisfaction campaign on January 5 to address three weaknesses raised by NHTSA's investigation. GM offered to make the following modifications to 2011 Volt models: strengthen the vehicle structure where the battery intrusion occurred during NHTSA's testing; add a sensor and control system to monitor coolant loss and prevent battery recharging when excessive coolant is lost; and proof the coolant system from tampering so that consumers are unable to add coolant[23]. The changes have been incorporated into the 2012 model, which cleared NHTSA's side-pole test without any intrusion.

NHTSA closed the Volt investigation on January 20, concluding that the Volt did not present any defects, that GM's voluntary modifications had reduced the risk of a fire-causing intrusion – an event that was highly unlikely to occur in the first place – and that there was no record of real-world crashes involving any electric vehicle model that had produced a battery-related fire. As stated by the agency, "based on the available data, NHTSA does not believe that Chevy Volts or other electric vehicles pose a greater risk of fire than gasoline-powered vehicles"[24].

Safety Standards in Battery Support and System

NHTSA ended its statement on the Volt investigation by noting that EVs require EV-specific safety measures. Yet it did not follow such measures during its testing of the Volt. At a Congressional hearing on NHTSA's handling of the Volt fires, the agency could not provide a convincing explanation as to why it had placed a Volt with a damaged battery into storage without first disconnecting and discharging the battery. NHTSA's own Interim Guidance for EVs provides the following post-incident instruction in all three of its guides – for law enforcement, emergency medical services, and fire departments; for vehicle owners and the general public; and for towing and recovery operators and vehicle storage facilities: "Do not store a severely damaged vehicle with a lithium-ion battery inside a structure or within 50 feet of any structure or vehicle"[25]. The importance of post-crash handling illustrates the need to adopt a systems approach to battery safety. An initially safe battery might become a hazard if it is improperly integrated into a vehicle's structure and electronics, if it is exposed to high temperatures or moisture, or if it is mishandled at any point during its lifecycle.

In general, as Micheal Smyth, assistant director for training and curriculum development at the National Alternative Fuels Training Consortium (NAFTC), a program of West Virginia University, explained in an interview, a key safety measure to follow after any accident involving an electric vehicle is to disable the high-voltage system. The NAFTC's first responder safety training manual recommends that standard first responder procedures be followed when an EV is involved in an accident, i.e. "immobilize, stabilize, and disable". The main difference with EVs is that "disable" refers to not only disabling the vehicle's capability to move, but also refers to the vehicle's high-voltage system, which needs to have the high voltage energy isolated from the vehicle's battery pack by turning off the vehicle's ignition, placing any smart keys more than 25 feet away from the vehicle[26], and cutting the 12-volt auxiliary battery's negative cable. Disabling the auxiliary battery will also result in the high-voltage system's capacitors discharging within 5 minutes in most cases[27]. The NAFTC's training also instructs personnel working with an electric drive vehicle during or after an accident to be aware of the possibility of a damaged high voltage battery overheating, creating the risk of an explosion or fire.

Standards development has a large role to play here in ensuring that best practices are adopted and gaps are addressed. Table 3 details battery-related education and training standards and battery safety standards, the issues addressed, the standards development organizations (SDOs) involved, and the gaps that the American National Standards Institute (ANSI) has identified. Only standards that apply in the U.S. are listed, although not all of the SDOs are U.S.-based. The SDOs that cover battery safety and education standards include the Institute of Electrical and Electronics Engineers (IEEE), International Electrotechnical Commission (IEC) International Organization for Standardization (ISO), National Fire Protection Association (NFPA), NHTSA, Society of Automotive Engineers (SAE), and Underwriters Laboratories (UL).

Table 3: Battery-related safety standards

ISSUE	AGENCY	STANDARD	STATUS	GAP
Education and Training				
Vehicle emergency shutoff	SAE	J2990	In progress To be published in Fall 2012	Safety labeling of batteries, cables & disconnect devices
Battery discharge & recharge in emergencies	N/A	N/A	SAE & NHTSA are potential developers	Standard needs to be developed
First responder training	NFPA	N/A	Complete & growing	None
Safety & Testing Specifications				
General battery safety standard for EV applications	ISO	12405-3	In progress	None
Short circuit, over - charge & - discharge tests	IEC ISO	62660-2 12405-1	Published 2010 Published 2011	None
Protect people in & outside vehicle	ISO	6469-1	Published 2009	None
Protect people from electric shock	ISO	6469-3	Published 2001	None
Safety following crash	SAE	J1766	Published 2005 Under revision	None
Response test to potential abuse	SAE	J2464	Revised 2009	None
Min. criteria for battery use in EV	SAE	J2929	Published 2011 Under revision	- Delayed battery overheating events - Loss of control/dual mode failure
Abuse testing for cells, modules & packs; evaluation of assembly	UL	2580	Published 2009	None
Protect people from electrolyte spillage, electrical shock during crash	NHTSA	FMVSS 305	Revised 2011	None

Source: ANSI Standardization Roadmap for Electric Vehicles

ANSI has not identified any gaps in emergency first responder training standards. However, the institute calls for the development of standards in the safety labeling of batteries, cables and disconnect devices so that first responders can quickly identify them. ANSI also recommends developing guidelines for EV battery discharging and recharging in an emergency to create a consistent user's interface for first responders[28].

With regard to battery safety and testing specifications, ANSI has identified two gaps that should be addressed shortly by the SAE in the revision currently underway of minimum safety criteria for batteries to be used in an EV high voltage power train (J2929). First, battery failure modes are currently designed to address hazards occurring within minutes or hours of a fault. However, over a longer period of time less detectable stray currents might build up a battery pack's temperature to dangerously high levels.

ANSI therefore recommends that the SAE include delayed battery heating in its revised standard[29]. The second gap concerns double fault conditions. For example, a battery's overcharge protection might fail when the battery is overheated. SAE is currently researching this issue in order to address it in the J2929 standard[30].

Finally, new and revised battery safety standards from the ISO, NHTSA, and SAE are in the works and scheduled for publication beginning this year.

The EV Safety Perception Gap

Over a quarter million vehicle fires occur every year on U.S. highways, causing hundreds of deaths. Not one of these has involved an electric vehicle. The DOE's Advanced Vehicle Testing Activity reported almost no adverse events from data collected in 2011 for 6,500 EVs that had covered over 26 million miles[31]. Volts alone have accumulated the same mileage without recording any thermal incidents. Yet in the wake of NHTSA's Volt investigation, the politicization and media magnification of the Volt's safety created a wide gap between consumers' perception of EV safety and the actual safety record of EVs. In the immediate aftermath, the number of consumers who would consider buying a Volt halved[32]. A 2012 Consumer Reports survey showed 28% of respondents deeming EV's to be less safe than ICEs[33]. Furthermore, 42% were concerned about the risk of fires during charging at home, 39% about crash protection, 35% about post-crash protection, and 30% about electric shock.

Ironically, the very same testing that prompted NHTSA to open the Volt investigation was the basis of its decision to award the Volt its highest safety rating. As table 4 shows, the Volt also received the highest safety ratings from the European New Car Assessment Program (Euro NCAP) and the Insurance Institute for Highway Safety (IIHS), which selected the Volt as a top pick for safety. The Leaf received the highest ratings from all three agencies as well. The Mitsubishi i scored very well for a subcompact model, garnering 4 stars from both NHTSA and Euro NCAP. The Tesla Roadster and Model S, Think City, Smart Fortwo ED, Fisker Karma, Ford Focus Electric, BMW Active E, Toyota Prius PHV, and Coda sedan have not been rated by any of the agencies yet. NHTSA has announced plans to rate the 2012 Coda and Focus Electric[34]. In addition, it is planning NCAP and compliance testing of Toyota's Prius plug-in and upcoming RAV 4 Electric[35].

Table 4: EV Safety Ratings

	Nissan Leaf	GM Chevrolet Volt	Mitsubishi i
NHTSA **Scale: 0-5 stars**			
Model year(s)	2011, 2012, 2013	2011, 2012, 2013	2012, 2013
OVERALL RATING	**5**	**5**	**4**
Frontal crash	4	4	4
Side crash	5	5	3
Rollover	4	5	4
Euro NCAP **Scale: 0-5 stars**			
Model year(s)	2012	2011	2011
OVERALL RATING	**5**	**5**	**4**
Adult protection	89%	85%	73%
Child protection	83%	78%	78%
Pedestrian	65%	41%	48%
Safety assist	84%	86%	86%
IIHS **Scale: Good, Acceptable, Marginal, Poor**			
Model year	2011, 2012	2011, 2012	Not Tested
OVERALL RATING	**Top Pick**	**Top Pick**	
Frontal offset	Good	Good	
Side impact	Good	Good	
Roof strength	Good	Good	
Rear crash	Good	Good	

Note: The Euro NCAP's child and adult protection scores are derived from frontal, side and pole impact tests. The safety assist score is mostly based on the presence of electronic stability control.

The consumer perception gap on EV safety is bound to narrow as additional models are tested and rated, standards are firmed, and the number of electric vehicle models and miles driven increases. In the meantime, there is no evidence to suggest that EVs are less safe than ICEs in the U.S.

Additional charts available in **AFVInsider online** edition:

- NAFTC first responder training manual excerpt
- NHTSA recall summaries for EVs

Notes & Sources:

[1] December 2010 Dashboard, HybridCars.com.

[2] The total includes 17,813 sales from the HybridCars.com December 2011 Dashboard for plug-in electric cars, including the Chevrolet Volt, Nissan Leaf, Smart ED, and Mitsubishi i. The total was rounded up to 18,000 to include sales of the Tesla Roadster, Fisker Karma, and Think sedan; these automakers do not release monthly U.S. sales data. In addition, Ford sold 8 Focus Electric vehicles in December 2011 (see Nikki Gordon-Bloomfield, "2012 Ford Focus Electric Won't Be Available Outside NY, CA Until Sept.", GreenCarReports.com, 2/15/12).

[3] The last figure reflects annualized sales data for the first six months of 2012. The two additional Prius models are the Prius c subcompact and Prius v crossover. A third new model – the plugin Prius – is not included in the hybrid total since it falls into the EV category.

[4] The Hybridcars.com June 2012 Dashboard shows a year-to-date total of 17,530 sales for plug-in electric cars, including the Chevrolet Volt, Prius plugin hybrid, Nissan Leaf, Smart for Two EV, Ford Focus Electric, BMW Active E, and Mitsubishi i. Additional models sold include Tesla's Roadster and Model S, Fisker's Karma, and Coda's sedan; these automakers do not release monthly U.S. sales data.

[5] December 2011 Dashboard, HybridCars.com.

[6] Based on data from the HybridCars.com June 2012 Dashboard.

[7] The 1996 GM EV1 and 1997 Toyota RAV4EV and Honda EVPlus, and 1998 Ford Ranger EV were the first highway-capable EVs introduced to the U.S. market, in California, to meet the California Air Resources Board's (CARB) zero-emissions vehicle requirements. However, the vehicles were only available for lease and were destroyed after CARB loosened the requirements. Only Toyota eventually made several hundred of its original EVs available for sale.

[8] NHTSA requested that Fisker label the expansion of its 2012 Karma recall as a new recall.

[9] See Edmunds Auto Observer' data center, "NHTSA Recalls by Vehicle Component" table.

[10] See NHTSA recall summary, campaign ID number 10V458000.

[11]Tesla press release, "Tesla initiates voluntary recall after single customer incident", 10/1/10.

[12] Fisker press release, "Woodside, CA incident", 8/18/12.

[13] Valmet Automotive is a contract vehicle manufacturer that focuses on premium, convertible, and electric vehicles. In addition to Fisker, clients include THINK, Porsche, Daimler, Renault, BMW's Mini division, and VW's Bentley division.

[14] See NHTSA recall summary, campaign ID number 11V598000.

[15] Anita Lienert, "Fisker Expands Recall of 2012 Karma for Fire Hazard," Edmunds Inside Line, 6/4/12.

[16] See Tom Mutchler, "Bad Karma: Our Fisker Karma plug-in hybrid breaks down," Consumer News, ConsumerReports.org, 3/8/12.

[17] A123's customers include Daimler, General Motors, SAIC Motor, Smith Electric and Tata Motors. Customers using A123 cells made in China were not affected. See Craig Trudell and Alan Ohnsman, "A123 Replacing Batteries That Led to Fisker Karma Shutdown," Bloomberg, 3/26/12.

[18] Jeff Bartlett, "Consumer Reports is not the only Fisker owner to experience bad Karma," Consumer News, ConsumerReports.org, 3/16/12.

[19] Nissan conducted a customer service campaign April 2011 to reprogram vehicles with an electrical glitch that was preventing them from restarting following the use of air conditioning. This resulted from an oversensitive safety mechanism whereby the AC demand for power triggered a high voltage alert. See John O'Dell, "Nissan Leaf Quality Glitch Detected," Edmunds AutoObserver, 4/12/11. See next section for more on GM's customer service campaign for the Volt.

[20] For a full account of the incident, see David Arnouts, "Official claims Fisker Karma to blame in Texas house fire," Autoweek, 5/8/12.

[21] NHTSA, "Chevrolet Volt Battery Incident Overview Report," January 2012, p. 2.

[22] The factors isolated in the two other tests were cell damage and battery coolant leakage. See NHTSA, "Chevrolet Volt Battery Incident Overview Report," January 2012, p. 3.

[23] NHTSA defect investigation summary.

[24] NHTSA statement regarding the conclusion of its safety investigation into the post-crash fire risk of Chevy Volt (PE11037), 1/20/2012.

[25] See NHTSA, "Interim Guidance for Electric and Hybrid-Electric Vehicles Equipped with High Voltage Batteries," January 2012.

[26] NAFTC, Advanced Electric Drive Vehicle Education Program at West Virginia University, "First Responder Safety Training", sections 2-28 & 2-29.

[27] Smart keys may automatically enable a PHEV's low-voltage system.

[28] Electric Vehicles Standards Panel of the American National Standards Institute, "Standardization Roadmap for Electric Vehicles", Version 1.0, April 2012, pp. 97-100.

[29] Id., p. 58.

[30] Id., p. 59.

[31] David Howell, DOE, "U.S. DOE Perspective on Lithium-ion Battery Safety" Presentation at Technical Symposium: Safety Considerations for EVs powered by Li-ion Batteries, NHTSA, May 18, 2012.

[32] Bill Vlasic and Nick Bunkley, "G.M. Re-examines Volt as Safety Concerns Rise", New York Times, 12/7/2011. The article notes, however, that the Consumer Reports' survey showed 93% of Volt owners would purchase their vehicle again.

[33] See Consumer Reports 2012 Car Brand Perception Survey. Note that 63% deemed them as safe or safer, and 9% did not know. .

[34] NHTSA press release, 10/13/11.

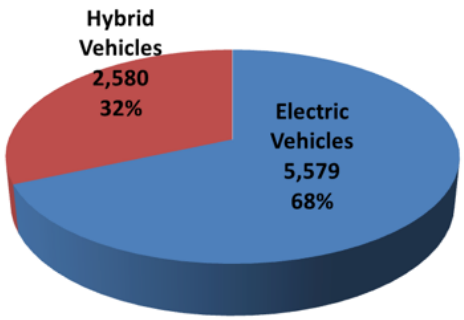
[35] Claude Harris, "Overview of NHTSA EV Safety Testing and Research May," Presentation at Technical Symposium: Safety Considerations for EVs powered by Li-ion Batteries, NHTSA, May 18, 2012.

CHINA FEATURE STUDY
EV SAFETY IN CHINA

Unimpressive Sales

China is struggling to boost sales of new energy vehicles (NEVs)[1] in its domestic market. Despite favorable policies and incentives, sales of new energy vehicles have not been encouraging in the country. In 2011, according to the China Association of Automobile Manufacturers (CAAM), China manufactured 8,368 new energy vehicles, including 5,655 pure electric vehicles and 2,713 hybrid vehicles, while 5,579 electric vehicles and 2,580 hybrid vehicles were sold. Of the total 8,159 sales of new energy vehicles, passenger vehicles accounted for 61 percent, commercial vehicles 28 percent, and other types of vehicles the remaining 11 percent. Compared with a total of 18 million vehicles sold in the Chinese auto market in 2011 – now the world's largest -- new energy vehicle sales accounted for a tiny 0.05% of the total vehicle sales.

Chart 1: Breakdown of NEV Sales in China, 2011



Source: China Association of Automobile Manufacturers

Latest data from China's Ministry of Industry and Information Technology also show there are over 13,000 new energy vehicles registered in the 25 pilot cities. However, the green vehicles on the road are mainly used for demonstration programs in those cities. Inadequate infrastructure, high cost, and the lack of comprehensive safety standards are making Chinese consumers skeptic about purchasing NEVs. Recent EV fire accidents have raised consumers' concern and threaten the reputation of domestic manufactures in China.

Alarming EV Accidents

The safety of Chinese EVs has been worrisome. Since last year, a series of EV fire accidents caused growing safety concerns in the industry. Last April, a Zotye Multipla electric cab caught fire on the streets in Hangzhou, the capital and largest city in Zhejiang Province. The Multipla cab accident was attributed to a battery pack issue. An official investigation determined that the vehicle's battery module had leaked and damaged the pack's insulation, leading to a short circuit that caused the fire. The battery cells, manufactured by Zhejiang Wanxiang Group, did not present any flaws; however, the battery system's integration with the vehicle was faulty.

Following the Hangzhou incident, an electric bus's engine compartment burst into flames while carrying passengers in downtown Shanghai last July. The bus was manufactured by Anhui Ankai Automobile and Leibo New Energy, a joint venture of East China Power Grid Company, Shanghai Electric Power Company and Shanghai Ruihua Co. Ltd. According to Leibo's own investigation, the short circuit of an individual battery cell

led to overheating problem, causing the fire. Since there's no authoritative third party involved in the investigation process, the industry experts are skeptic about the investigation results. Chengwei Xiao, a battery expert of China's 863 national program for Energy Saving and New Energy Vehicles, suggested the vehicle design and its thermal management system might be problematic. It is hard to say battery cell is the single most significant cause[2].

Leibo didn't reveal the battery producer at first and claimed that more than one battery supplier was involved, compounding concerns. According to other industry sources, Annaixin, an energy storage company based in Beijing, is the battery producer. Strangely, Annaixin has moved out of its original office location and disappeared right after the accident[3].

It is noteworthy that Leibo New Energy, Anhui Ankai Auto, and Annaixin were involved in another e-bus spontaneous combustion accident in Urumqi back more than two years ago. On January 7, 2010, an electric bus, jointly produced by Anhui Ankai Auto and Leibo New Energy, caught fire in its garage and the fire spread, causing minor damage to five other e-buses parked close by. According to the investigation done by the city government, malfunction of one battery cell led to spontaneous combustion of the battery pack. While Anhui Ankai Automobile is in charge of the bus assembly, Leibo is responsible for the bus's electrical equipment with the power battery provided by Annaixin. According to the investigation report done by Urumqi's fire department[4], since several companies cooperatively manufactured the e-bus, technical communication might be inefficient among the companies, creating hidden risks and compromising product safety.

On September 10, 2011, another hybrid double-decker bus caught on fire in Shenzhen; fortunately, none of the riders was injured in the blaze due to timely evacuation. The bus was one of the twenty hybrid double-decker buses that the city government put into use during the 26th Universiade which opened on August 12th, 2011. The accident happened less than 20 days after the bus was put into service. The bus was produced by Wuzhoulong Motors, which delivered 1,511 new energy buses to Shenzhen's city government during the 2011 Universiade. Wuzhoulong claimed that the fire started in the distribution box on the bus, and there was a circuit malfunction that led to the fire. So far, there is no third party involved in the investigation. According to Hongbing Cao, Vice President of China Potevio, the twenty new hybrid buses were not included in the city's monitoring network. After the accident, the Shenzhen government required that all new energy buses in the demonstration program join the network to ensure vehicle safety.

Even BYD, the Warren Buffet-backed battery and auto manufacturer, is facing a setback in its electric vehicle business after a recent fatal electric car crash accident. On May 26, a Nissan GT-R sports car slammed into the rear end of one of BYD's electric taxis in Shenzhen, causing a fire and killing the driver and two passengers of the electric taxi. The model of the electric taxi is BYD's e6, a purely electric crossover car rolled out in 2010. This accident, being called "China's first fatal crash involving a high-speed pure electric car"[5], has raised enormous public concern about the safety of electric vehicles. According to the investigation, the e6 was traveling 80 kilometers an hour when it was hit from behind by the sports car racing at a speed of at least 180 kilometers, or 112 miles. Following the accident, an official statement was released by BYD on May 29, claiming "the e6 electric car has been tested by government authorities, and has passed the national regulated collision tests. In an extreme crash situation like the May 26 accident, while involving multiple collisions and spinning, even a gasoline-powered car would have caught fire by the impact."[6] The Ministry of Science and Technology, Ministry of Industry and Information Technology, Ministry of Finance, and National Development Reform Commission were all involved in the safety investigation process of this accident. Released on August 4, the official investigation report indicated the battery pack and distribution box in the e-taxi were damaged in the crash, resulting in short circuits that caused the fire. "The car's battery system was appropriate in terms of installation and layout, insulation and the design of the high-voltage electricity system," said Zhixin Wu, head of the investigation team[7]. The victims were killed by the high-speed impact rather than by the fire as some people had suspected.

Table 1: EV Fire Accidents in China

City	Urumqi	Hangzhou	Shanghai	Shenzhen	Shenzhen
Accident Date	January 7, 2010	April 11, 2011	July 18, 2011	September 10, 2011	May 26, 2012
Vehicle	Leibo New Energy e-bus	Zotye Multipla MPV	Leibo New Energy e-bus	Wuzhoulong hybrid double-decker bus	BYD e6
Automaker	Leibo New Energy; Anhui Ankai Auto	Zotye Auto	Leibo New Energy; Anhui Ankai Auto	Wuzhoulong Motors	BYD Auto
Battery Producer	Annaixin	Zhejiang Wanxiang Group	Annaixin	Not Available	BYD
Cause	Malfunction of an individual battery cell	Battery pack integration with the vehicle was faulty	Malfunction of an individual battery cell	Circuit malfunction of the distribution box	Short circuits of battery pack and distribution box in the crash

Problematic Battery Quality

China is one of the world's major battery producers, manufacturing most of the lithium-ion batteries for consumer electronics, especially laptops and cellphones. Meanwhile, China lags behind US, Japan and South Korea on patents registrations for lithium-ion batteries and is struggling to develop its own vehicular battery technologies. According a UN study, China's battery industry has traditionally relied on hand-made battery cells, which are less desirable for large multi-cell batteries where one bad cell will cause the entire battery pack to malfunction, creating safety risks[8]. Recent EV accidents also raise questions about the quality and design of Chinese power batteries.

Quanshi Chen, Professor of Department of Automotive Engineering at Tsinghua University, pointed out that the biggest EV safety concerns are the battery itself and the high voltage lines. A leak from one battery cell can affect neighboring cells, causing an internal short circuit, overheating, or even explosion of the battery pack[9]. He explained that battery manufacturers must produce battery cells fit for use in EVs, with appropriate voltage levels, battery module, and thermal management system. To solve the spontaneous combustion problem, the batteries should go thorough systematic and standardized checkup for their reliability and durability before being installed on the vehicle[10].

According to Binggang Wang, an expert from China's 863 national program for Energy Saving and New Energy Vehicles, China has strict automobile standards; however, there are no such standards for power batteries used in EVs[11]. Based on his experience visiting domestic battery producers, many production lines fail to meet the requirements of quality control. For example, some are still using outdated manufacturing equipment with low-grade raw materials[12]. During the manufacturing process battery workers touch electrodes with their hands, which should not be allowed since it can contaminate the batteries. The problematic battery cell, without strict quality control, tends to short circuit and then ignite. He suggests the government should strengthen the management system of the power batteries used in EVs.

Despite the daunting EV fire accidents, Linyi, the most populated city in Shandong province, set the longest record for safely operating electric buses in China last November. Since Linyi's charging station was put in operation on June 23, 2010, the fleet of more than 110 e-buses, equipped with Unipower batteries, traveled over 500 days with a cumulative mileage of 5 million km without any safety failure. Zhijie Cheng, President of Unipower Battery, sees battery safety as the company's top priority. To ensure product safety, the company has set strict standards on the production of batteries and developed a comprehensive battery management system for battery raw materials, structural design, manufacturing and maintenance[13].

Fixing Loose Standards

Last September, the nation's Ministry of Science and Technology, the Ministry of Industry and Information Technology, the Ministry of Finance, and the National Development and Reform Commission jointly released a safety compliance order, calling for safety checks in the 25 pilot cities. The ministries asked the pilot cities to conduct a systematic and comprehensive investigation to identify potential safety risks involving their new energy vehicles. In addition, the pilot cities were required to establish an emergency response mechanism to deal with NEV-related accidents. The ministries also formed a supervisory group to conduct inspections in the pilot cities.

Currently, there are five national safety standards relating to NEVs in China, as shown in table 2. In 2001, China developed three national standards GB/T 18384.1, GB/T 18384.2, and GB/T 18384.3, adopting the standards of ISO 6469, Electric road vehicles—Safety specification. These standards aimed to give specific provisions for the general safety of EVs. In 2005 and 2009, China independently designed GB/T 19751 and GB/T 24549 respectively for the safety of hybrid and fuel cell vehicles.

However, the current EV safety standards in China are too general and lack operation details, according to Rong Zhou, a vehicle standardization expert of the China Automotive Technology and Research Center (CATARC)[14]. Among the five safety standards, GB/T18384.1 and GB/T19751 require collision tests for EVs and HEVs; however, only frontal crash tests are mandatory. CATARC, the most authoritative crash test institution, runs the China New Car Assessment Program (C-NCAP). CATARC is also working on its C-NCAP crash test standards for NEVs and aims to complete NEV crash test standards soon. The new safety standards will include more requirements on battery technology, said Rong Zhou.

Table 2: China's NEV Safety Standards and Regulations

Standard Number	Title	Year Issued	Status
GB/T 18384.1	Electric vehicles-Safety specification Part 1: On-board energy storage	2001	Under revision
GB/T 18384.2	Electric vehicles-Safety specification Part 2: Functional means and protection against failures	2001	Under revision
GB/T 18384.3	Electric vehicles-Safety specification Part 3: Protection of persons against electric hazards	2001	Under revision
GB/T 19751-2005	Hybrid electric vehicles safety specification	2005	Available
GB/T 24549-2009	Fuel cell electric vehicles—Safety requirements	2009	Available

Source: Current Status & Future Development of EV Safety Standards, Liu Guibin and Zhang Yingnan, China Standardization Press

This January, the E30 pure electric vehicle, produced by Changan Auto, China's domestic car brand, scored a five-star rating during an all-direction crash test at the CATARC in Tianjin[15]. The E30 is the first Chinese EV to achieve a five-star rating after crash testing. In addition, Changan is going to test the E30's electric system to ensure its battery's power-off mode initiates following a crash. The E30 compact sedan has a 160 km range and a maximum speed of 126 km per hour. Changan Auto plans to build three hybrid platforms and two pure EV platforms by 2020 to achieve a sales record of 650,000 new energy vehicles, including 150,000 EVs.

In addition, Underwriters Laboratories (UL), a leader in safety testing and certification, signed a Memorandum of Understanding with CATARC on February 10. CATARC will help Chinese battery producers secure UL certificate via EV battery testing.

Conclusion

The NEV sector in China is still policy-driven rather than market-driven. Beijing is pouring massive amounts of money into the NEV industry; however, the government has not clarified the ambiguous and outdated safety regulations and standards yet. Meanwhile, there are still technical obstacles to improving the reliability of domestically produced power batteries. In addition, the lack of enforcement of a safety monitoring mechanism and of a transparent investigation process for NEVs is worrisome. In the face of EV-related safety accidents, local governments and manufacturers have seemed clueless and failed to deliver objective, credible and timely investigation results.

To ease public concerns, China should strengthen the quality control of its NEV-related industry and build effective and efficient safety mechanisms as soon as possible. Otherwise, EV safety will be the biggest stumbling block in the path of Beijing's ambitious campaign for green transportation.

Additional charts available in **AFVInsider** online edition:

- Updated Chinese NEV sales data
- Detailed specs of Changan E30

Notes & Sources:

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CHINA INSIDER PERSPECTIVE

BYD, A ROUGH ROAD TO ELECTRIC DREAMS

Building an EV Business

BYD, a leading Chinese battery and automaker backed by Warren Buffett, looms large in China's plans to build self-brand electric vehicles. Chuanfu Wang founded BYD in 1995 in the southern city of Shenzhen and entered the automobile industry in 2003 by acquiring Tsinchuan Automobile Company Limited, a state-owned car company.

In 2008, Warren Buffet spent $230 million for an initial stake of approximately 10 % in BYD. The investment from MidAmerican Energy Holdings, a unit of Buffett's Berkshire Hathaway Inc., allowed the Hong Kong listed company to expand its battery and auto business. A vote of confidence from Buffet boosted shares in BYD up 42 per cent to a close of HK$11.9 on September 29, 2008, the most since the stock made its debut in July 2002.

As the world's largest supplier of rechargeable batteries, BYD seems to have a special niche for building electric cars and plug-in hybrids. The company's leap from battery components to well-branded vehicles required the creation of a whole new supply chain. In December 2008, BYD's plug-in hybrid compact sedan F3DM was introduced and went on sale to Chinese government agencies.

In May 2009, BYD Auto launched the e6, a pure electric cross over with a range of 186 miles. BYD delivered 50 e6 e-taxis to Shenzhen in May 2010 and 250 more during the 2011 Universiade held in the city last August. On February 17th, 2012, Baoji city of Shaanxi province also introduced the BYD e6 taxi fleet, the first EV taxi fleet in the province.

In July of 2009, BYD's acquisition of Midea Bus manufacturing Co., Ltd allowed the company to enter the bus manufacturing industry, especially for developing its electric bus business. Following the acquisition, the company's first electric bus K9, also called eBus-12, was released in September, 2010. On a single charge, less than 3 hours with a rapid charger, the e-bus can travel around 155 miles. As Table 1 shows, the BYD K9 e-buses have been in service in, Changsha, Shenzhen, Shaoguan, Haikou and Xian. On September 30, 2010, the automaker secured a contract from Changsha before the first K9 rolled off production line to provide 1,000 K9 buses. Shenzhen began to electrify its city bus fleet in January 2011, adding 200 units of BYD K9 on 12 traffic lines, managed by three operators. In addition, BYD won a contract this March to provide 1,500 EVs, including 1,000 e-buses and 500 e-taxis to Shenzhen.

Table 1: Chinese Cities that have introduced BYD's K9

City	Number of K9 Deployed	Number of K9 Ordered	Date of Introduction
Shenzhen, Guangdong	200	1,200	January, 2011
Changsha, Hunan	102	1,000	January, 2011
Shaoguan, Guangdong	5	5	October, 2011
Haikou, Hainan	30	30	October, 2011
Xian, Shaanxi	4	50	August, 2012

Sources: BYD; D1EV.com; Xinhua

International Expansion

The Chinese automaker is taking the lead in expanding its EV business in international markets. BYD established its US headquarters in Los Angeles last October, aiming to bring its e6 model to North America. To enhance the company's international brand awareness, BYD has been actively seeking strategic partners abroad. In September 2011, BYD partnered with Hertz to introduce its all-electric e6 crossover to Chinese consumers in Shenzhen, Beijing, and Shanghai, making Hertz the first global car rental company to offer EVs in the Chinese car rental market. At the same time, Hertz announced the use of e-buses produced by BYD to serve as shuttles between the Hertz Rent-a-Car lot and terminals at Los Angeles International Airport. This year, the two companies also agreed to add the BYD e6 crossover to Hertz's rental fleet in New York City. The BYD e6 is expected to be ready for sale in the U.S. by the end of 2012 and will initially be offered to fleet buyers only.

This March, BYD and German automaker Daimler formed BYD Daimler New Technology Co Ltd and released a new brand for its battery-electric vehicles DENZA. The cooperation is for the Chinese market only, despite Daimler's decision not to use batteries made by BYD in US and European markets. "BYD provides experience in battery technology and e-drive systems, as well as bringing electric vehicles into operation on the streets of China. Coupled with Daimler's design of premium autos, know-how in electric vehicle architecture and safety, and more than 125 years of experience in automotive excellence, DENZA is on the right track to be the leader in the green vehicle market in China," said Chuanfu Wang, chairman and president of BYD[1]. The brand unveiled its EV concept car at the Beijing Auto show in April and the first DENZA EV model slated to release in 2013.

To promote the company's "Green City Solution" plan[2], BYD has inked several agreements in Argentina, Canada, Chile, Denmark, Finland, Germany, Netherlands, Singapore, Taiwan, and Uruguay with plenty of trial operations now underway. Sales of the BYD e-bus K9 have been growing in overseas markets. In June 2011, Frankfurt awarded BYD a contract to supply three K9 and two charging stations for the city's electric mobility system. The e-buses will serve as shuttles at Frankfurt Airport and along public transportation routes that lead to the city's Gateway Gardens. On June 14th, 2011, BYD signed a "Green Technology Cooperation Agreement" with Chile to introduce K9 and e6 to the country's public transportation sector, making Santiago one of the pioneer cities in South America to introduce advanced EV technologies in public transportation systems. Two of the largest public transportation companies in Santiago were looking to move forward in developing a pilot plan that would incorporate BYD's electric vehicles for public transportation. BYD concluded a similar deal last June with SMRT Corporation, Singapore's leading public transport service provider, to distribute BYD's K9 buses and e6 taxis throughout Singapore. Following the agreement, BYD has inked another deal to deliver K9 buses to Taiwan in August 2011.

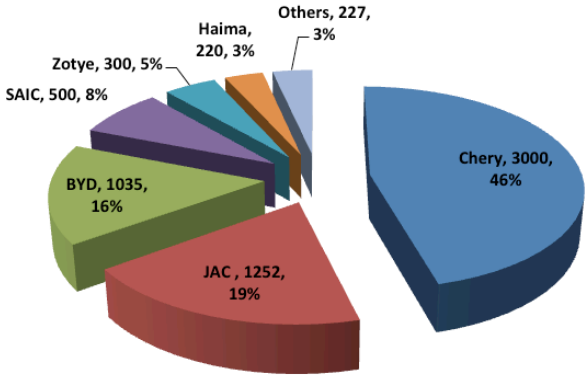
BYD successfully continues to put its EVs into public transportation sectors worldwide. This March, Finland Veolia Transport reached an agreement with BYD to purchase K9 buses for trial operation in the country. At the same time, BYD reached an agreement with Movia, the largest public transportation operator in Demark, to trail two BYD K9 e- buses in the Danish capital Copenhagen. In May, the City of Windsor, Ontario, signed a letter of intent to buy ten K9 buses this year. BYD won another contract in June to deliver six of its e-buses to Schiermonnikoog, a 10-mile-long island that's home to the Netherlands' first national park, by early 2013. In addition, Uruguay and BYD have signed a contract in July to bring 500 electric buses to the country by 2015.

BYD announced on November 3rd, 2011 the signing of an agreement with the Argentine government to build an EV plant in Argentina. With Argentina's lithium reserves, the plant will be a platform for BYD's exports in South America, Mexico and rest of the world.

Gloomy Performance

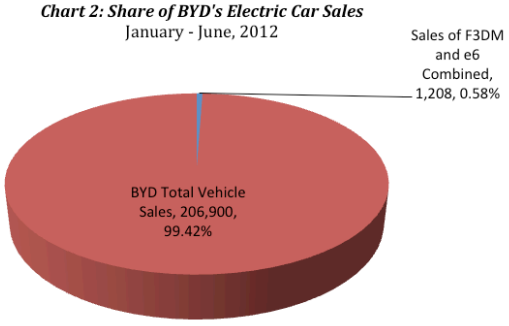
Despite BYD's efforts in pushing its EVs onto the global stage, its EV sales in China have been disappointing. The overwhelming majority of BYD's sales are still gas-powered cars, with the slow-growing EV industry in China underperforming expectations. In 2011, the total sales of BYD's F3DM and e6 amounted to over 1,000 units, only 0.2% of the company's total car sales. As shown in Chart 1, BYD's total sales of new energy cars ranked third in 2011, accounting for 16% of the domestic made NEV market share in China. In the first half of 2012, the share of BYD's plug-in car sales rose to 0.6 %, with over 1,200 units F3DM and e6 being sold, as shown in Chart 2.

Chart 1: Market Share of Domesticaly Manufactuerd New Energy Passengers Vehicles in China, 2011



Sources: BYD; D1EV.com; Xinhua

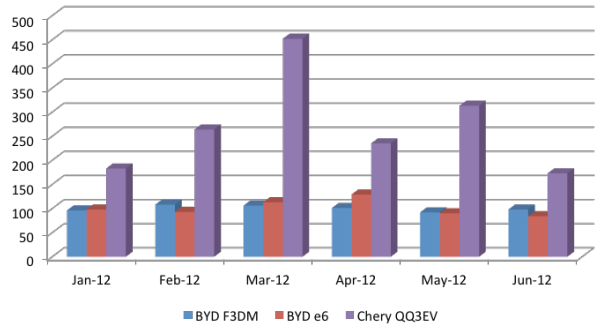
Chart 2: Share of BYD's Electric Car Sales
January - June, 2012



Sources: CAAM; China Daily; SOHU.com

During the same period, BYD sold 601 units of FD3M and 607 units of e6, falling behind the sales of the low end Chery QQ3EV. The BYD e6, priced at 369,800 RMB ($56,900) with subsidies, costs seven times higher than the QQ3EV. The domestically made QQ3EV, with a sales price of 50,000 RMB ($7,800), has a silicon battery with limited top speed of 43 mile per hour. As shown in Chart 3, the sales of Chery QQ3EV have amounted to 1,620 this year, surpassing the sales of both FD3M and e6 combined. In addition, Changan Auto's newly launched pure electric E30 sedan, the Coda sedan's identical twin in China, might start to penetrate the comparable e6's market. On the other hand, the sales of the imported upscale Lexus CT200h hybrid car model reached 1,456 units in March, accounting for 25 percent of the Lexus sales that month. After its debut in November 2011, average monthly sales of the CT200h have constantly been exceeding 1,200 units, becoming the most popular hybrid car in China[3]. Meanwhile, the Toyota Prius has accumulated sales of 1,628 in the first half of 2012.

Chart 3: Major EV Sales in China
January-June, 2012



Sources: CAAM; China Daily; SOHU.com

In the first half of 2012, BYD's total vehicle sales declined 11 percent year-on-year to 206,900 units, causing BYD to fall from the top 10 bestselling automakers list, according to data released from China Association of Automobile Manufactures. The company is expecting its net profit from January to June to plummet 75 percent to 90 percent from a year ago. According to BYD, the end of tax breaks in China for buying low emission cars and lower sales in BYD's mobile phone components are undermining the company's performance[4]. Currently, BYD's auto business accounts for 47.8% of its overall business.

BYD's overall performance has continued to decline since 2009. BYD reported net profits of 3.79 billion yuan (US$596.3 million), 2.52 billion yuan (US$396.5 million) and 1.385 billion yuan (US $217.9 million), respectively, in 2009, 2010 and 2011[5]. As the Chart 4 shows, BYD's stock price has dropped more than 80% from its 2010 peak of HK$77.35 to HK$14.66 as of August 10, 2012.

Chart 4: Declining Stock Price Since 2010
BYD Stock Chart, Hong Kong Stock Exchange

Source: MarketWatch.com

The Chinese automaker's net profits dropped about 90% in the first quarter year-on-year. Suffering from sliding sales and lower profits, BYD has to cut its employers' performance bonuses by 18% between June and September, reducing its human resources cost by 240 million yuan. In August 2011, the company has planned to cut staff in its sales department. Thousands of employees have already left or are going to leave BYD.

Quality Concerns

In addition to its weak EV sales and market performance, BYD is facing another setback in its EV business. A recent BYD e6 taxi accident has raised eyebrows over the safety of BYD's electric vehicles[6]. As "China's first fatal crash involving a high-speed pure electric car", the high-profile accident has shaken the investors' confidence, making the stock price plunged to the down limit in Hong Kong Stock Exchange on May 28. In July, facing mounting challenges, BYD's stock fell 28 percent in Shenzhen and 9 percent in Hong Kong. The company's top executives and shareholders have sold $135 million of shares during the past month.

Chart 5: Mounting Challenges, Lackluster Stock Performance in Past Three Months
BYD Stock Chart, Hong Kong Stock Exchange

Source: MarketWatch.com

There had been speculation that the e6's lithium-ion battery led to the explosion. However, a prolonged investigation conducted by the Chinese government determined that the battery did not explode in the crash. Released on August 4, the official investigation report indicated the batteries and the high-voltage distribution box in the e-taxi were damaged in the crash, resulting in short circuits that caused the fire. "The car's battery system was appropriate in terms of installation and layout, insulation and the design of the high-voltage electricity system," said Zhixin Wu, head of the investigation team[7]. In addition, the report shows that the victims were killed by the high-speed impact rather than by the fire as some people had suspected. Following the release of the positive news, the stock price jumped up 5.91 percent in Hong Kong and 7.22 percent in Shenzhen on August 6. Though the official investigation is good news for BYD, the Chinese automaker's long-term challenges remain.

Last September, China's state broadcaster CCTV reported BYD's F3, the company's top selling gas-powered compact sedan, has failed to deploy its safety airbags in a number of crashes, causing serious injuries and at least one death. Since 2007, there have been more than 20 complaints filed against BYD, alleging failed activation of airbags upon collision. However, BYD refused to give compensation to its customers and insisted there is no quality problem. According to China New Car Assessment Program (C-NCAP), the F3 model received a score of zero in two crash tests. The F3 received an overall rating of 3 stars, ranking seventh to last out of more than twenty Type-A passenger vehicles sold in China[8]. Last November, Chuanfu Wang publicly admitted the company paid insufficient attention to its product quality and committed to improve it.

Future Prospects

According to Chuanfu Wang's remarks in 2011, BYD was aiming for a 20 to 30 percent sales increase each year and to become the largest automaker in China by 2015. Facing a series of negative events and a shrinking market, the Shenzhen based company may have to scale back its ambitions. Like most domestic automakers in China, the mainstream of BYD's lineup is low-cost models, which helped the company grow rapidly over the past five years. However, the domestic automaker is now facing fierce competitions from its domestic and global rivals, who are offering more all-electric and hybrid models in both mid-price and luxury-car ranges. The share of Chinese-branded passenger vehicles dropped 3 percentage points in the first half of 2012 to 41.39 percent, compared with more than 50 percent in 2010, according to the China Association of Automobile Manufacturers[9].

Being the most advanced Chinese EV developer does not guarantee success in the auto market. Even with generous government subsidies, BYD's relatively pricey plug-in cars have so far failed to woo wary consumers in China. The growing Chinese middle class consumers are prone to choose more sophisticated and better quality models made by multinationals such as the Toyota Prius and Lexus CT200h. The current economic slowdown and uncertainty over the future trajectory of China's growth seem likely to add to BYD's challenges. Meanwhile, the company's recurring problems with product quality remain. With relatively poor brand image, BYD is having a difficult time luring middle class buyers who are able to afford its electric models. Hopefully, BYD's recent cooperation with Daimler will provide a great opportunity for the Chinese automaker to rebuild its brand image and improve its product quality.

On the other hand, BYD has been very active in cooperating with local governments to deliver it green vehicles worldwide. However, most EV orders BYD received are for trial operations, limiting quantities and profit potential at the current stage. As more and more cities are demanding lower or zero emission vehicle options, focusing on the expansion of fleet sales to the public transportation sectors might be the best bet for BYD. To fulfill its electric dreams, BYD has a long and apparently a bumpy way to go.

Additional charts available in **AFVInsider** online edition:

- BYD company profile
- BYD chronicle: major achievements
- Detailed specs of BYD's F3DM, e6 & K9

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CRITICAL PERSPECTIVE

"ELECTRIC VEHICLES IN CHINA: EMISSIONS AND HEALTH IMPACTS" STUDY CRITIQUE

Can electric vehicles have a worse environmental and health impact than gasoline vehicles? According to a study by lead author Christopher Cherry from the University of Tennessee and co-authors from the University of Minnesota and Tsinghua University, the answer is affirmative in China. The "Electric Vehicles in China: Emissions and Health Impacts" study, published in Environmental Science and Technology journal, compared four emissions – carbon dioxide (CO2), fine particles (PM2.5), nitrogen oxide (NOx), and hydrocarbons (HC) – from five vehicle technologies in 34 major Chinese cities[1]. The vehicles included electric bikes, which form the primary mode of transportation in China; electric vehicles; gasoline vehicles; diesel cars; and diesel buses. The environmental health impact of each vehicle type was primarily determined from PM2.5 emissions. Because their diameter is smaller than 2.5 micrometers, fine particles such as nitrates formed from NOx emissions can penetrate deeply into the lungs; studies have conclusively associated PM2.5 with respiratory and cardiovascular illness and premature death[2]. The study found that the range of CO2 emissions was highest for electric cars and lowest for e-bikes. Next, after accounting for the lower intake fraction[3] of EVs compared to ICEs, the authors found that in most cities the environmental health impact of PM2.5 emissions per passenger-km was highest for diesel cars, followed by equally polluting electric cars and diesel buses. On average EVs had a 3.6 times greater impact than gasoline cars. E-bikes had the lowest impact (half that of ICEs).

While EV skeptics were quick to add the study to their arsenal of critiques of efforts to promote alternative fuel vehicles, limitations in the study's methodology skewed its results in favor of gasoline vehicles while its true implications were misrepresented. In an interview, Mark Z. Jacobson, professor of civil and environmental engineering and director of the Atmosphere/Energy Program at Stanford University explained how factoring in some additional metrics might change the results. For example, since an EV's plug-to-wheel efficiency is around 85% (versus less than 20% for ICEs) it takes 4-5 times less energy to move an EV than an ICE. In the U.S. this translates into 30% lower CO2 emissions from an EV, even assuming a 60% coal grid. Given China's higher use of coal, and the more polluting type of coal used in China, the result would be closer to 15% lower CO2 emissions from EVs than ICEs. With regard to PM2.5 emissions, the intake fraction from the exhaust of a coal-powered plant is one tenth to one thirtieth that of vehicle exhaust. One would therefore expect the environmental health impact per passenger-km to be highest for diesel and gasoline cars.

A similar study by the Union of Concerned Scientists (UCS) on CO2 emissions from EVs in the United States provides a useful starting point to contextualizing the Chinese study. In "State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-cost Savings Across the United States," the UCS showed that in the U.S. any EV runs cleaner than the average compact gasoline car[4], even if the EV is charging from an electric grid that is solely powered by coal. The study found that greenhouse gas (GHG) emissions from a coal-powered EV are equivalent to those of a 30-mpg gasoline vehicle[5]. The report furthermore found that almost half the U.S. population lives in areas where EVs produce less global warming emissions than a 50 mpg gasoline vehicle; more than a third reside in regions where EVs compare to 41-50 mpg gasoline vehicles; and less than a fifth live in regions where EVs compare to 31-40 mpg gasoline vehicles. Assuming the same well-to-wheels emissions from a gasoline vehicle in the United States and China as in the U.S.[6], the UCS study can be applied to China and checked against the "Electric Vehicles in China" study. While China's electric grid is more coal dependent and less efficient in comparison to the U.S. grid, a common metric that can be used to determine the Chinese and U.S. grids' environmental effect is their global warming emissions intensity[7]. The U.S. has 26 regional grids with intensities ranging from 293 to 991 gCO2e/kWh[8]. The following table shows the carbon intensities for China's seven regional grids, ranging from 613 to 1,026 gCO2/kWh[9].

Grid	Share of Chinese electricity production	Emissions intensity
Northeast China	25.4%	1,026
North China	7%	984
East China	23.2%	743
Central China	19.4%	634
Northwest China	8%	765
South China	16.6%	613
Hainan	0.3%	705

All but one of China's grids – Northeast China – fall within the range of U.S. grids, of which the dirtiest would still allow EVs to produce lower emissions than a 31-mpg gasoline vehicle. The Northeast China grid's emissions are just slightly higher that the highest-polluting U.S. regional grid (the Rockies grid): a Northeast China grid-powered EV would be equivalent to a 30-mpg vehicle. Given that the average fuel economy of China's light-duty vehicle fleet is 29 mpg[10], EVs run cleaner than the average gasoline-powered light-duty vehicle across China. Of course, this does not mean that any EV will produce fewer emissions than any gasoline vehicle. In the U.S., hybrids and the most fuel-efficient subcompacts can outperform EVs in areas with the dirtiest grids[11]. In China, EVs might even be outperformed by their gasoline equivalent in the Northeast. Compared to fleet averages, however, EVs would be considered part of the solution in reducing pollution.

Because the margins are so small, using a different methodology to calculate the emissions intensity of electric grids can easily tip the scale for EVs in China and make them appear to be part of the pollution problem instead. For example, in the same vein as the "Electric vehicles in China" study, the United Nations report on "Electric vehicles in the context of sustainable development in China" concluded that vehicle electrification should not be pursued in areas covered by the North and Northeast China grids, which include major Chinese cities Beijing, Changchun, Dalian, Shenyang, Tangshan, and Tianjin[12]. When calculating the "well-to-tank" GHG intensity of China's power grids, the UN study assumed more efficiency losses than the UCS study. In addition to transmission and distribution losses, it included a charger efficiency loss of 12% and 4% heat loss from the battery, bringing the total emissions intensity for the Northeastern grid to 1,288 gCO2e/kWh. Under this scenario EVs become more polluting than the average gasoline-powered light-duty vehicle in China.

It is important to note that regardless of the methodology, study, and conclusion one accepts, the facts remain that the environmental health impact of EVs can only improve over time as that of ICEs deteriorates. At current production rates, China has 38 years of coal reserves left, but since most of it is inconveniently located and difficult to extract the country is increasingly importing coal[13]. China is also a major oil importer. China therefore has a growing incentive to shift its electricity generation away from coal, and its vehicle fleet away from gasoline. While the U.S. has much larger coal reserves – 245 years' worth – old and inefficient plants are being retired and new ones will have to comply with the EPA's new higher standards[14]. Furthermore, the mix of energy sources is changing in both countries, with a slew of nuclear plants coming on line in China, a glut of natural gas in the U.S., and slow but steady rise in renewable energy sources in China and the U.S. In both countries power plants and EVs will therefore become cleaner over time. The ability to reuse EV batteries beyond the lifespan of the vehicle further enhances the environmental value proposition of EVs. Even in situations where a power grid is so dirty that an EV would be more polluting to run than its gasoline equivalent, electrification would still make sense because of the vehicles' zero tailpipe emissions, probability of lower emissions over time, and potential for zero well-to-wheels emissions.

Notes & Sources:

[1] Christopher R. Cherry, Shuguang Ji, Matthew J. Bechle, Ye Wu, and Julian D. Marshall, "Electric Vehicles in China: Emissions and Health Impacts," Environmental Science and Technology, 2012, 46 (4), pp. 2018–2024.

[2] See the U.S. Environmental Protection Agency's basic information on fine particle designations at: http://www.epa.gov/pmdesignations/basicinfo.htm.

[3] The intake fraction can be defined as "the integrated incremental intake of a pollutant released from a source or source category (such as mobile sources, power plants, and refineries) and summed over all exposed individuals during a given exposure time, per unit of emitted pollutant." See Deborah H. Bennett, Thomas E. McKone, John S. Evans, William W. Nazaroff, Manuele D. Margni, Olivier Jolliet, and Kirk R. Smith, "Defining Intake Fraction," Environmental Science and Technology, 2002, 36, p. 208.

[4] The average compact gasoline car in the U.S. has a fuel economy of 27mpg.

[5] Union of Concerned Scientists, "State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-cost Savings Across the United States", 04/12/12 revision, p. 9. Available at: http://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/advanced-vehicle-technologies/electric-cars/emissions-and-charging-costs-electric-cars.html

[6] Union of Concerned Scientists, "State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-cost Savings Across the United States", 04/12/12 revision, p. 9. Available at: http://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/advanced-vehicle-technologies/electric-cars/emissions-and-charging-costs-electric-cars.html

[7] Measured in grams of CO2 emitted per kWh (gCO2e/kWh).

[8] Union of Concerned Scientists, "State of Charge: Technical Appendix", p. 8.

[9] The emissions intensities for China were calculated based on data from the 2011 UN study "Electric Vehicles in the Context of Sustainable Development in China". The figures were recalculated to be compatible with the methodology used in the UCS study.

[10] Calculated from International Energy Agency, Working Paper Series, "International comparison of light-duty vehicle fuel characteristics", 10 May 2011.

[11] Paul Stenquist, "How green are electric cars? Depends on where you plug in," New York Times, April 13, 2012.

[12] United Nations Department of Economic and Social Affairs, Commission on Sustainable Development, 19th Session, New York, 2-13 May 2011, "Electric Vehicles in the Context of Sustainable Development in China."

[13] "Burning ambitions: What is good news for miners in bad news for the environment", The Economist, January 27th 2011.

[14] The U.S. Environmental Protection Agency (EPA) has issued greenhouse gas New Source Performance Standards (NSPS) for electric generation units that run on coal or natural gas. Any new plant with more than 25 MW in output will be held to a 1,000 pounds/MWh standard. Standards for existing coal plants are forthcoming.

Vehicle Review

FOCUS vs. I

VEHICLE TYPE

The Ford Focus Electric and Mitsubishi i reflect their companies' different approaches and target markets for electric vehicles. While both are all-electric vehicles based on an ICE model's platform, offering similar ranges and the highest fuel efficiencies (MPGe) in their respective vehicle class, they differ in all other respects.

The Focus Electric is the first unostentatious electric vehicle, as one of several variations on the Focus platform, in line with Ford's portfolio approach. Ford is not placing any strong bets on electrification and has set a modest goal of selling 5,000 Focus Electrics in 2012. The bet Ford has made is that customers are ready for mainstream EVs without any distinctive design. This is not to say that the Focus Electric is uninspired. On the contrary, it is the first all-electric vehicle from a Big Three automaker, it offers a higher range than the Leaf and i, and Level-2 charging is twice as fast for its battery than for any other EV on the market. The Ford Focus Electric caters to customers who want a top-of-the-line Focus and an electric vehicle that compares favorably with its competitors.

The Mitsubishi i is the ultimate electric city car. While the Focus handles better than the i on highways, the i has better driving and parking maneuverability in congested areas. The subcompact is based on a tried and true platform that has been internationally deployed: the iMiev, of which an electric version has been available in Japan and Europe since 2009. The cartoonish design stands out and appeals to a niche market of city dwellers. At the same time the i has mass appeal as both the most affordable and most efficient EV on the U.S. market, achieving a combined 112 Mpge.

	Focus Electric	***i***
EV Type	Battery Electric Vehicle (BEV)	Battery Electric Vehicle (BEV)
Total Range *(EPA measure)*	76 miles	62 miles
Mpg Equivalent *(EPA measure)*	City: 99 Highway: 110 Combined: 105	City: 73 Highway: 62 – 138 Combined: 112

PRICING

Price is the Focus Electric's greatest drawback and the i's greatest selling point. Ford has priced its EV much higher than its most luxurious Focus model, the Titanium, and almost on par with the Volt, which features an extended range and longer battery warranty. The i is three quarters of the Focus Electric's price and over $6,000 less than the more comparable Leaf, bringing the i into a highly affordable price range after the $7,500 federal tax credit (and additional tax credits in some states). However, Ford is offering a more affordable leasing option for its EV while Mitsubishi is not.

	Focus Electric	***i***
Base Price 2012	$39,200	ES $29,125 SE $31,125
Lease 2012	$3,529 down $436 for 36 months	N/A

DRIVETRAIN

The Focus Electric has more battery and power than the i. In line with its mainstream approach, the Focus does not offer additional driving modes; the i provides an eco mode.
The i is covered by the same 100,000-mile or 8-year battery warranty as the Volt and Leaf, while the Focus Electric has significantly less coverage: 60,000/5 years.

	Focus Electric	***i***
Battery pack	23 kWh lithium-ion	16 kWh lithium-ion-manganese-graphite
Battery warranty	60,000 miles / 5 years	100,000 miles / 8 years
Motor	Permanent electric magnetic traction 107kW/143-horsepower 184 lb.-ft. of torque	Permanent magnet AC synchronous electric motor 49kW/66 horsepower @ 3,000 rpm-6,000 rpm 145 lb.-ft. of torque @ 0-300 rpm
Top speed	84 mph	81 mph
	0-60 in 9.7 seconds (Autoweek estimate)	0-60 in 13.4 seconds
Additional Driving Modes	N/A	Eco: more efficiency
Regenerative braking	Yes	Yes
Tires	17-inch aluminum	15-inch steel (ES) or alloy (SE) 145/65 R15 low rolling resistant front tires 175/60 R15 low rolling resistant rear tires

CHARGING

The Focus Electric is the first EV to offer a 6.6 kW onboard charger, allowing the vehicle to fully charge in only 4 hours of level-2 charging. This also means it is cheaper to fully charge the Focus than any other EV at charging stations, which currently bill by the hour rather than electricity used. A level-3 charging option is not available for the Focus, but is for the i at an additional cost. At level 3 the i's battery can reach an 80% charge in less than half an hour.

	Focus Electric	***i***
Charger	Left side front Level 1 & Level 2	Right side back Level 1, 2 (Level 3 optional for SE)
Full charge @ 240V	4 hours	7 hours (< 30 min. with level 3)
Onboard charger	6.6 kW	3.3 kW

EXTERIOR DESIGN

The 2012 Focus platform was redesigned to optimize aerodynamics. The i weighs less than the Focus Electric but has a higher drag because aerodynamics were sacrificed to give the small vehicle a more spacious feel.

	Focus Electric	***i***
Curb weight	3,624 lbs.	2,579 lbs.
Drag coefficient	0.295	0.35

INTERIOR DESIGN

The Focus Electric's interior is more spacious, refined and quieter than the i, but its battery takes up half of its cargo space. The i's limited cargo space can be expanded to 50.4 cubic feet with the back seats folded down. The i's interior is plasticky, but its relatively tall design and large window coverage make it feel more spacious.

	Focus Electric	***i***
Seating	5-passenger hatchback	4-passenger hatchback
Seating room	- Head front 38.3 in/ rear 37.9 - Hip front 53.9 in / rear 52.7 - Leg front 43.7 in / rear 33.2 - Shoulder front 55.6 in / rear 53.7	- Head front 35.6 in / rear 34.3 - Hip front 49.4 / rear 47.8 - Leg front 33.8 in / rear 30.0 - Shoulder front 54.8 in / rear 54.8
Battery location	One under cargo area and one under rear seats	Under floor boards
Cargo volume	14.5 ft^3	13.2 ft^3
Other	100% of cloth seat fabric is made of recycled materials; cushions are made of bio-based foam	

ELECTRONIC FEATURES

The Focus is much more electronically advanced than the i, featuring LCD screens that track distance and driving efficiency and provide eco-coaching, and a smartphone application that can be used to start and stop charging from a distance and pre-condition the vehicle's temperature. The i has a conventional interior without any of these features.

	Focus Electric	***i***
LCD screens	2 screens track distance, energy used & driving style; eco-encouraging blue butterfly display; brake coach; Ecoroute (with Mapquest); SYNC & MyFord Touch technology	N/A
Smartphone application	MyFord State of charge, start/end charge, vehicle & charging station locations, AC system	N/A

SAFETY

The Focus Electric and i have not yet been comprehensively tested. The only available ratings are the NHTSA and Euro NCAP's assessments of the i, which received 4 stars – the maximum a subcompact vehicle might expect, be it an ICE or EV. While the Ford Electric has not been rated, other variations on the 2012 Focus platform have received high ratings from NHTSA, Euro NCAP and IIHS.

	Focus Electric	***i***
NHTSA	N/A (4 stars for ICE Focus)	4 stars
Euro NCAP	N/A (4 stars for ICE Focus)	4 stars
IIHS	N/A (ICE Focus is 2012 Top Safety Pick)	N/A

RATINGS

The Focus Electric and i have not been on the U.S. market long enough to be ranked by many associations and organizations. The Focus Electric received the 2011 Green Car Vision Award at the Washington Auto Show before the final version was released. The i was awarded the 2012 Greenest vehicle designation by the American Council for an Energy Efficient Economy after its EPA ratings were released. The i also ranked third on KBB's list of 10 best green cars of 2012, behind the Prius c and Nissan Leaf. The i received a 6/10 Kelley Blue Book rating; it scored highest for safety, but received lower marks for interior and exterior design.

	Focus Electric	***i***
Accolades	2011 Green Car Vision Award (Washington Auto Show)	Ranked third on KBB's 10 Best Green Cars of 2012 list
Kelley Blue Book rating	N/A (7.3/10 for ICE Focus)	6/10

MARKET POSITION

The Focus Electric and i will both be available nationwide by the end of this year. The i has already been rolled out in 17 states and Washington, D.C., and is available for pre-order in all states. Sales of the i reached 79 units in April, bringing the total for this year to 295 vehicles. The Focus Electric is currently available in only four metropolitan areas; 12 vehicles have been sold to date.

	Focus Electric	***i***
Manufacturing base	Wayne, Michigan	Mizushima, Japan
Current availability	16 states/19 metropolitan areas: Phase 1 -California (Los Angeles, San Diego & San Francisco), New York (New York City) & New Jersey; Phase 2 - Arizona (Phoenix & Tuscon), Colorado (Denver), Florida (Orlando), Georgia (Atlanta), Illinois (Chicago), Massachusetts (Boston), Maryland, Michigan (Detroit), North Carolina (Raleigh-Durham), Oregon (Portland), Texas (Austin & Houston), Virginia (Richmond), Washington (Seattle), Washington, D.C. 9 additional states by end of fall: Connecticut, Hawaii, Indiana, Maine, New Mexico, Ohio, Rhode Island, South Carolina, Vermont Nationwide by end of 2012	17 states & D.C.: California, Connecticut, Delaware, Hawaii, Illinois, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, Vermont, Virginia, Washington, Washington, D.C. Available for pre-order in remaining states
July 2012 U.S. Sales*	38	33
Total U.S. Sales To Date*	135	366

*Source: Hybridcars.com

Film of the Quarter

Reflections on Revenge of the Electric Car

Chris Paine's Revenge of the Electric Car, like its 2006 prequel Who Killed the Electric Car?, shows the importance of three main actors in the successful deployment of electric vehicles:
1) Government through the regulatory framework it creates
2) Automakers through the vehicles they choose to produce
3) Consumers through their purchases

The documentary conveys how all three actors are now on board, in contrast to the situation five years ago:
1) The federal and many state governments have decided to invest in EVs as a technology of the future using DOE loans, tax credits, and goals like having a million EVs on the road by 2015.
2) The automakers are no longer being dragged into producing EVs. Thanks to strong leadership at the very top, they are actively competing with one another to bring stylish, technologically advanced EVs to the market.
3) Consumers have recently experienced the effects of high and volatile oil prices, and are increasingly enthusiastic about the new technology.

However, the big elephant in the room remains the hold of oil. For decades, the U.S. has subsidized the production of oil and failed to factor in its geopolitical and environmental negative externalities. As a result the price gap between conventional and electric vehicles remains too high for most consumers, especially in the aftermath of the recession. Revamping our energy policy thus is crucial to narrowing this gap and continues to be perhaps the biggest challenge to completing the revenge of the electric car.

Trivia of the Quarter

What is consumers' no. 1 priority when purchasing a vehicle?

Last quarterly trivia answer: The U.S. spends around $1 billion a day on imported oil. In 2011, the U.S. spent $421 billion to import 4.2 billion barrels of energy-related petroleum products[1]. The 2011 total was $100 billion more than the 2010 total; the U.S. is on track to spend even $50 billion more this year[2].

[1] The U.S. Census Bureau defines energy-related petroleum products as crude oil, petroleum preparations, and liquefied propane and butane gas.
[2] Data from the Congressional Research Service, U.S. Trade Deficit and the Impact of Changing Oil Prices, by James K. Jackson, April 13, 2012.

Word of the Quarter

NHTSA

The National Highway Traffic Safety Administration (NHTSA) is an agency of the Department of Transportation that was established by the Highway Safety Act in 1970 to administer highway safety and consumer programs. Its mission is to "Save lives, prevent injuries and reduce economic costs due to road traffic crashes through education, research, safety standards and enforcement activity."

- NHTSA is involved in a number of administrative, investigative, educational and research programs. The agency:
- Sets and enforces vehicle and vehicle equipment safety standards, as well as corporate fuel economy (CAFE) standards
- Administers safety-related grants to state and local governments
- Investigates vehicle defects and odometer fraud and oversees recalls
- Administers the vehicle identification number (VIN) system
- Educates consumers about safety, providing comparative data through its New Car Assessment Program [NCAP]
- Researches traffic safety and driver behavior at its Vehicle Research and Test Center (VRTC) in Ohio. Driver behavior is researched using the University of Iowa's National Advanced Driving Simulator (NADS). Data is also collected and analyzed by NHTSA's National Center for Statistic and Analysis (NCSA), which administers the National Automotive Sampling System (NASS), Special Crash Investigations (SCI) and Fatality Analysis Reporting System (FARS).
- Coordinates with its international counterparts on best practices and standards harmonization

NHTSA's FY 2013 Budget Request totals $981 million and includes $188 million for Vehicle Safety, $150 million for Behavioral Safety, and $643 million for State Grants and High Visibility Enforcement Support. NHTSA received a budget of $800 million in 2012.

NHTSA has been criticized for its handling of the crash-testing of the Volt.

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Calendar

AFV Events from Around the World

EVENT NAME	DATE AND LOCATION	HOSTED BY	LINK
Hybrid, Electric, and High Efficiency Truck Users Forum (UTUF) 2012	September 17 – 20 Charlotte, North Carolina	CALSATRT	http://www.calstart.org/Projects/Hybrid-Truck-Users-Forum.aspx
2012 Paris Motor Show	September 29 – October 14 Paris, France	Paris Motor Show	http://www.mondial-automobile.com
INTERMOT - International motorcycle, scooter and bicycle fair f-cell 2012	October 3 – 7 Cologne, Germany	INTERMOT Cologne	http://www.intermot-cologne.com/en/intermot/home/index.php
BIT's 1st Annual World Congress of GreenAuto	October 19 – 21 Guangzhou, China	TEFL in China; BIT	http://www.bitcongress.com/greenauto2012/default.asp
eCarTec Munich 2012	October 23 – 25 Munich, Germany	4th International Fair for Electric Mobility	http://www.ecartec.de/index.php?id=3&L=4
BATTERIES 2012	October 24 – 26 Nice, France	Avicenne Energy	http://www.batteriesevent.com/
CIAPE China New Energy Auto Expo	October 26 – 28 Beijing, China	Ministry of Commerce, China	http://www.evs-expo.com/en/
2012 US-China Clean Truck and Bus Forum	October 30 – November 1 Beijing, China	CALSTART	http://register.chinacleantrucksummit.org/
The Battery Show	November 13 – 15 Detroit, Michigan	Smarter Shows	http://www.thebatteryshow.com/
Charging Infrastructure Expo	November 13 – 15 Detroit, Michigan	Smarter Shows	http://www.chargingexpo.com/
European Electric Vehicle Congress 2012	November 19 – 22 Brussels, Belgium	Electri-city.mobi	http://www.eevc.eu/
FISITA 2012 World Automotive Congress and Exhibition	November 27 – 30 Beijing, China	FISITA; Society of Automotive Engineers of China	http://www.fisita2012.com/

NEXT IN AFVINSIDER

Next issue for Fall 2012 will be out in November. Upcoming issues will focus on:

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