

The Electric Vehicle Market in the USA



Finnode Project 2010

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Finpro Stamford



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- The Obama administration continues to support and encourage the development of EV's. Obama's plan for a million electric cars by 2015; this would amount to just over 1% of the US vehicle market
- The US Department of Energy is lending \$8.5 billion to help car companies, both large and small re-tool plants and develop technologies to manufacture more efficient cars.
- Ernst & Young reported that in Q2/10, EV's led cleantech investment attracting \$1.5 B in VC funding
- Approximately 60% of Americans drive fewer than 40 miles per day, making EV's viable
- The future of battery electric vehicles depends primarily upon the cost and availability of batteries with high energy densities, power density, and long life. This will help alleviate "range anxiety".
- By 2015, access to vehicle charging will be available at nearly one million charge points in the US, but most vehicles in the US will be primarily charged at home as early adopters will prefer convenience.
- According to recent studies, the vast majority (greater than 95 percent) of respondents surveyed in Southern California said they expected to charge their EVs at home.
- Changing the US transportation fleet to electric drive won't happen overnight. It will require substantial investments in technology, manufacturing, infrastructure and market development.
- Nearly 2,000 SF Bay Area (Silicon Valley) residents (6,000 in Cal.) have paid \$99 to reserve a Nissan Leaf (Dec. 2010 release), more than any other region in the country.
- Charging options, convenience and accessibility will be critical" to EV adoption
- Overcoming the barriers will require innovative business models and stable effective public policy
- Will the adoption curve look like a hockey stick or a cross-cut saw blade?

Market Drivers and Challenges

EV Industry and Energy Storage - Macroeconomic Drivers

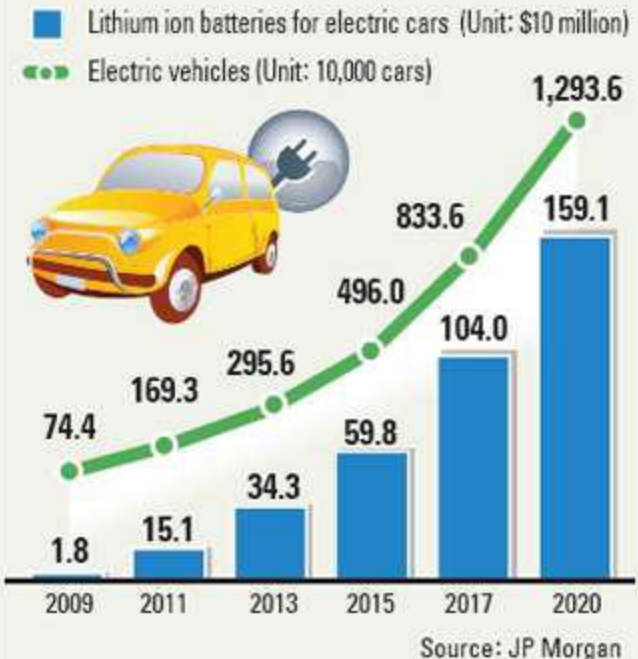
Main technology & demand drivers for large batteries and EVs

- Volatile gas prices spur demand and promote market
- Government policies promote growth
- Consumers driven by need to reduce carbon footprint/emissions

EV/PHEV and large battery development

- New governmental incentives globally are projected to enhance EV adoption and technology development
 - US DOE spending \$25B over 3 years to promote EV technology
- Energy Independence and Security Act (EISA) of 2007 mandates a 40% increase in fuel economy standards for automobiles and light trucks by 2020
 - EV industry expects 3-5 M vehicles with rechargeable batteries on the road globally by 2020

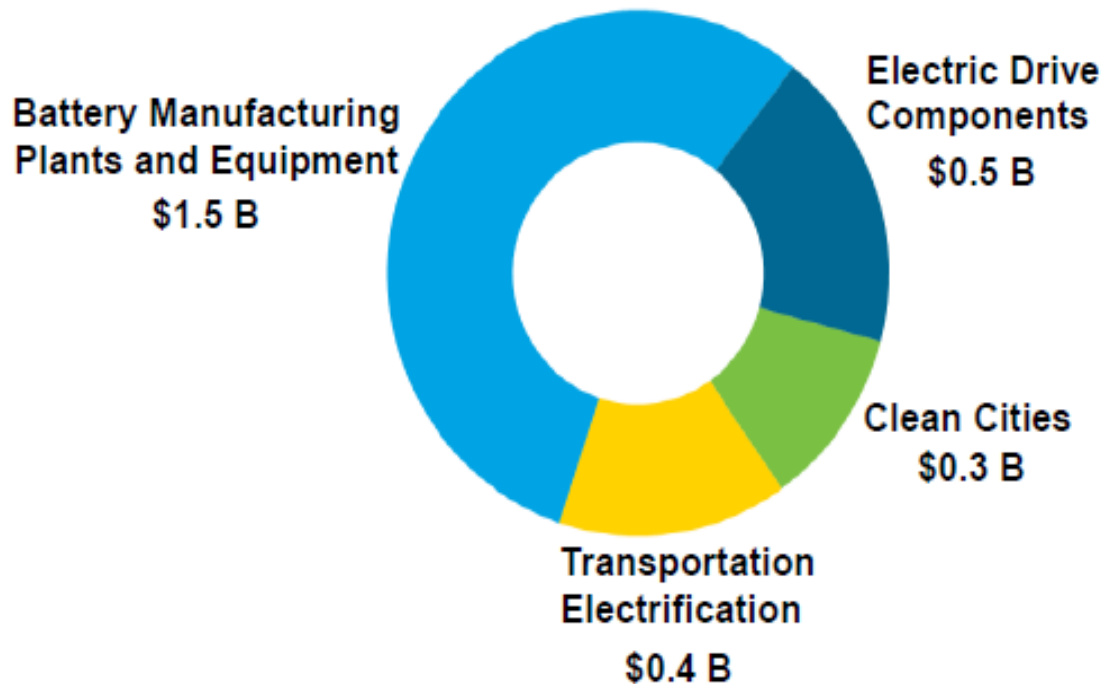
Future of the electric car and lithium ion battery markets



For electric cars to achieve wide-scale deployment in the US, new battery service networks must be competitive with the existing gasoline fueling infrastructure in terms of price, range, and reliability. Initial federal government tax credits of \$7500 will both generate initial demand for EV's while also allowing manufacturers to achieve economies of scale in the production process which will bring down the production costs in subsequent years.

- In 2008 alone, the US spent more than **\$900 Billion** on gasoline, diesel and other petroleum products.
- North America is expected to lead global Plug-in Electric Vehicle (PEV) adoption between 2010-2013, primarily due to the **Corporate Average Fuel Economy (CAFE)** program which mandates fuel efficiency levels across a manufacturer's entire fleet. The standard is set to increase from 27.5 mpg to 35 mpg by 2020, which will achieve almost 90 percent of President Obama's stated goal.
- For electric cars to achieve wide-scale deployment in the US, new battery service networks must be competitive with the existing gasoline fueling infrastructure in terms of price, range, and reliability.
- The cost of electricity for electric cars is on the order of 2c/ per mile, though electricity prices vary by region across the U.S.
- A new generation of buyers

Recovery Act Funds for Transportation Electrification



While electrification has promise as an energy strategy, it can only succeed if Grid Enabled Vehicles (GEV) are attractive to the mass market and can integrate into the grid.

According to the Electrification Coalition, there are 4 principal challenges to the widespread adoption of electric transportation. To overcome these barriers, and reduce “range anxiety” innovative business models and effective public policy will be required.

- **Batteries and Vehicles**

With the advent of lithium-ion battery technology, the largest obstacle to widespread consumer adoption of EV's will be cost, though performance and raw material supply chains are also important to consider.

Needs: Innovative business models, scale in Gen-1/2, & R&D for Gen-3.

- **Charging Infrastructure**

A profitable business model for public charging points has not been reliably demonstrated, and we do not yet know how much public charging will be needed.

Needs - Home and fast, also inexpensive public charging facilities

- **Electric Power Sector Interface**

“Smart” charging will make electric vehicles an asset to the grid, “dumb” charging will make them a liability

Needs - IT infrastructure to support a range of smart grid applications to ensure reliable service to homes and other charging locations

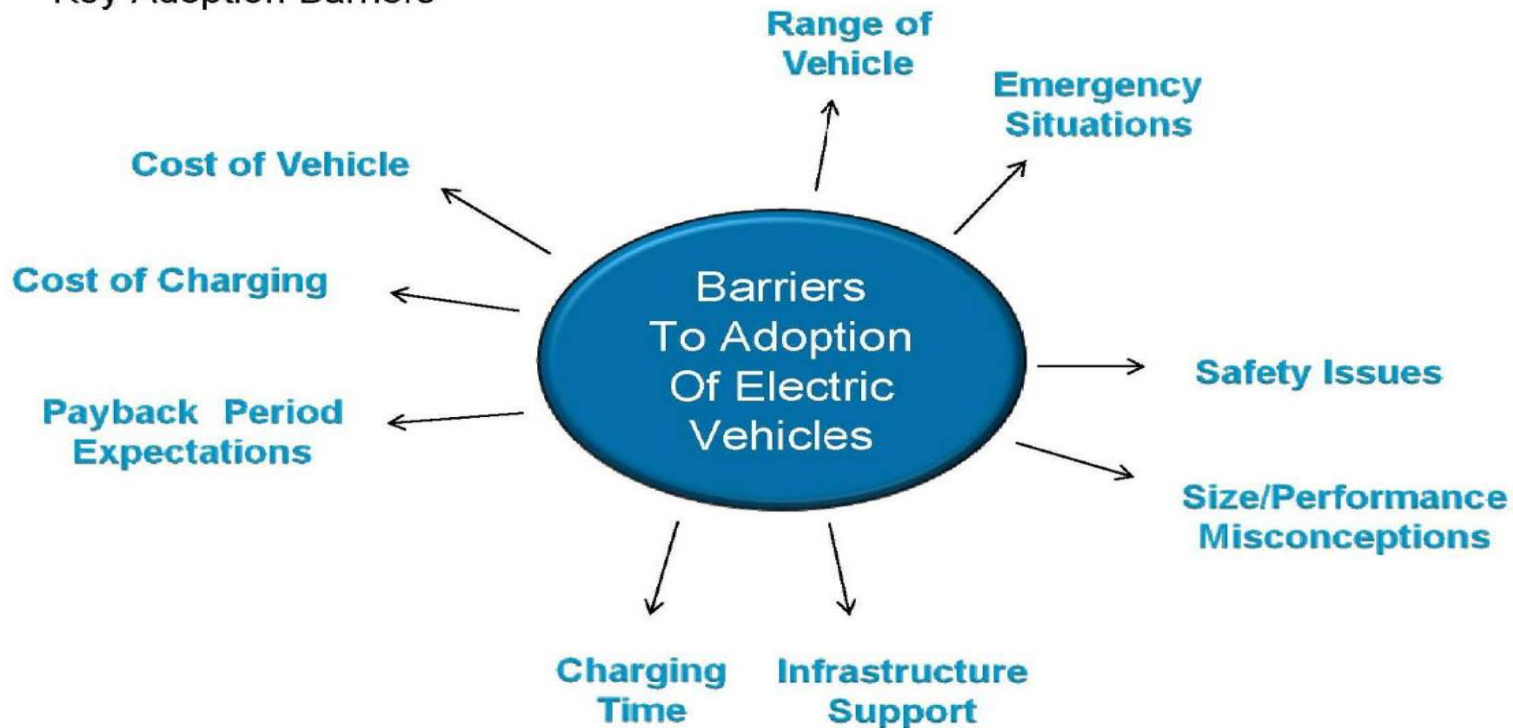
- **Consumer Adoption**

To change mainstream consumer attitudes, EVs must offer a compelling alternative to conventional IC engines

Needs- Lower priced vehicles and continued tax incentives

Key barriers to adoption of PHEVs and BEVs include cost, range, charging concerns, and safety

Key Adoption Barriers



Barrier # 1: Charging Capabilities

- Many consumers are apprehensive. Will the infrastructure support be in place? Will they have difficulty finding a charging station when away from home?
- There are also concerns about the length of time a full charge will take. Many expect charging to take at least a few hours, which creates additional concerns about the vehicle not being usable during an emergency situation.

Barrier # 2: Cost

- Cost for EV is higher than for an ICE vehicle. Some consumers will only purchase a PHEV or BEV if they will save on gasoline compared to owning a standard vehicle.
- There is also concern about how this type of vehicle charging will effect electricity rates. That is, will the rate structure change and will they be charged higher rates.

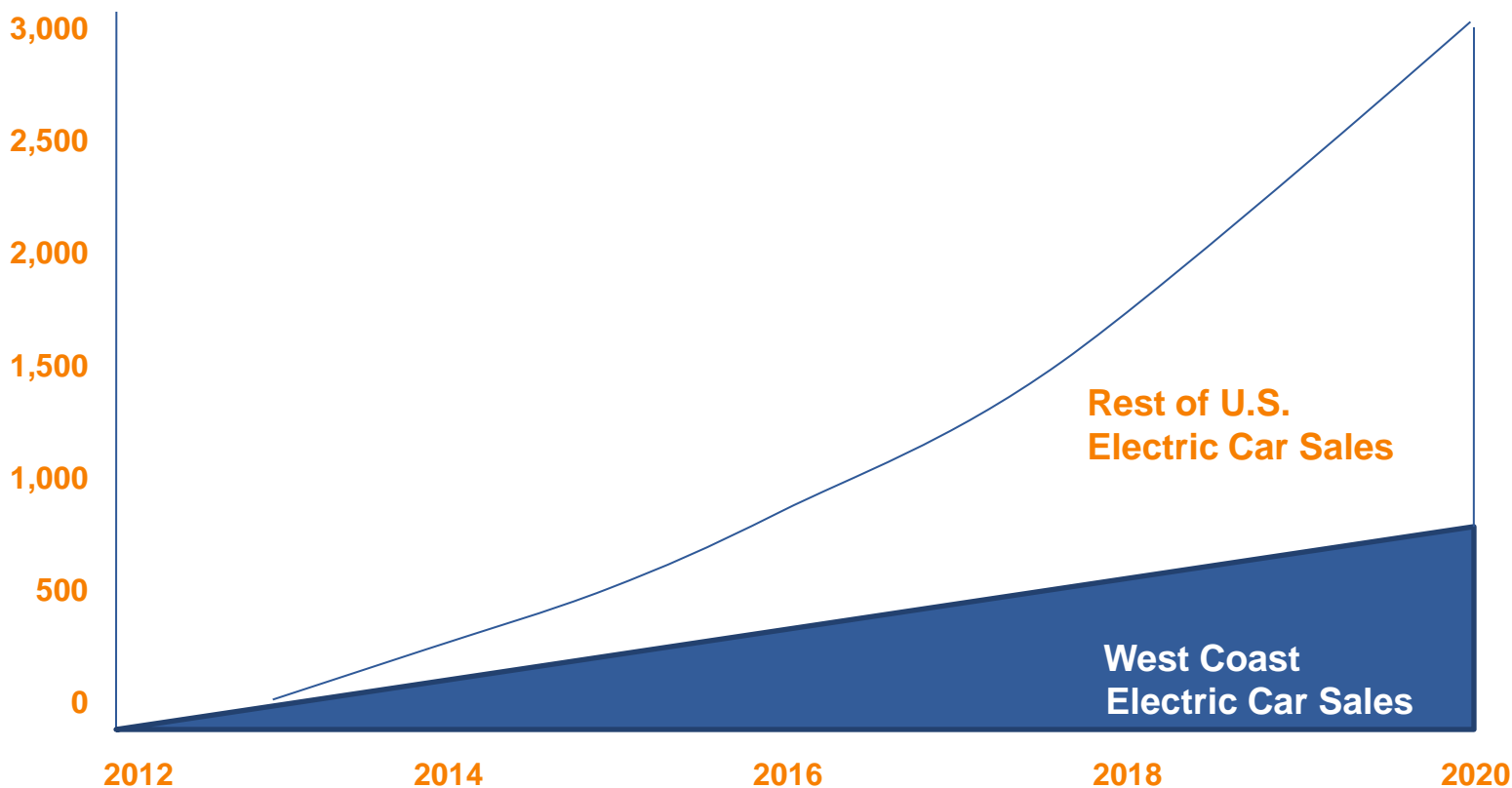
Barrier # 3: Range of Vehicle

- Consumers are concerned about the range of the vehicle, and unsure if it will be less, the same or more than a standard vehicle.
- Again, inexperience causes apprehension as consumers are concerned about the range in an emergency situation. - “Range Anxiety”

Forecasted US Electric Car Sales From 2012 to 2020 by Region

These forecasts of electric car adoption are for the baseline oil price scenario. The West Coast region includes California, Oregon, Washington, and Hawaii. Significant deployment in the West Coast states is forecast to begin in 2012 and in the rest of the United States in 2013.

Sales of Electric Vehicles (thousands)



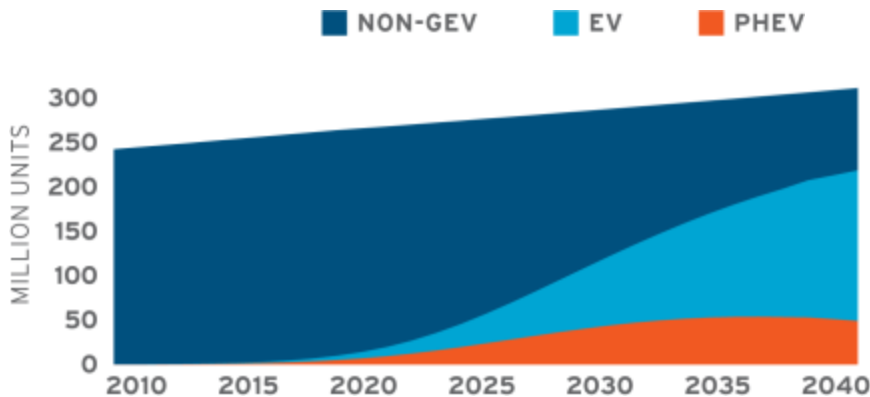
Estimates of US EV & PHEV market size over the next 10 years vary widely

BMW Head of R&D	5-15% of new car sales by 2020
Boston Consulting Group	6% of new car sales in 2020
Deloitte Consulting	465,000 cars by 2020
Ford, Director of Global Electrification	10% to 25% of its sales by 2020
Frost & Sullivan	3% by 2015
HIS Global Insights	20% of global light vehicle market by 2020
J D Powers	0.6% by 2020
Johnson Controls CEO	12-15 % by 2020
McKinsey	60% of new car sales by 2030
Nissan CEO Carlos Ghosn	10% of new cars by 2020 to be electric
Pike Research	610,000 plug-in vehicles by 2015 %??
Volkswagon Head of R&D, Martin Winterkorn	1.5 - 2.0% worldwide by 2020, 300,000 of VW sales
CEO Daimler, Dieter Zetsche	1-5% by 2020

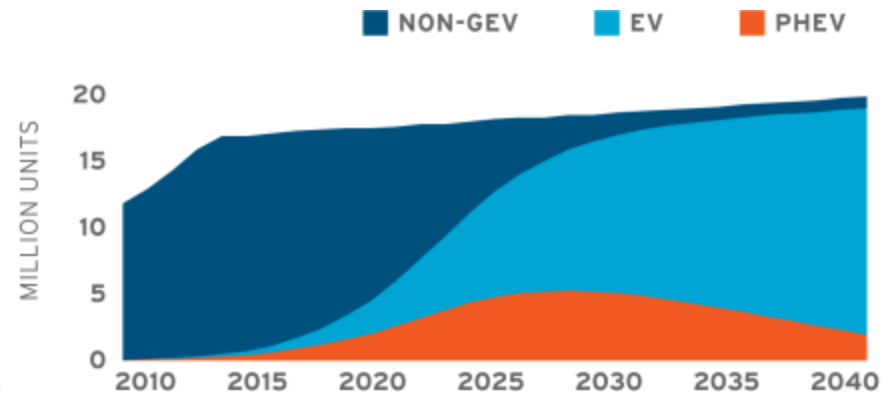
The Goal

According to a recommendation by the Electrification Coalition, a non-partisan, not-for-profit group of business leaders committed to promoting policies and actions that facilitate the deployment of electric vehicles on a mass scale, by 2040, 75% of the vehicle miles traveled in the U.S. should be electric miles.

REQUIRED GEV FLEET PENETRATION



REQUIRED GEV SALES



Source: Electrification Coalition

EV Market & Players

US Electric Vehicle Players



EV Manufacturers

- Aptera
- Bannon Automotive
- BMW
- Chevrolet (GM)
- Chrysler
- Coda Automotive
- Commuter Cars
- Electric City Motors
- Fiskar Automotive
- Ford Motors
- Goss132
- GreenGo Tek, LLC
- Mitsubishi
- Myers Motors
- Nissan Motors NA
- Phoenix Motor Cars
- Smart
- Tesla Motors
- Think North America
- Toyota Motors USA
- Zap



Battery Manufacturers

- A123 Systems
- Celgard
- Ciobasys
- LG/Compact Power, Inc.
- EnerDel
- Johnson Controls-Saft
- K2 Energy
- Kokam America
- Lio Energy Systems
- Lithium Technology Corp.
- Satki3
- Seeo
- Trojan Battery Company
- Valence Technology
- Voltronix USA



NEV's and ELSV's

- Big Man Electric Vehicles
- Club Car
- EnVironmental Transportation Solutions, LLC
- e-ride Industries
- Global Electric Motorcars LLC



EV Charging Stations

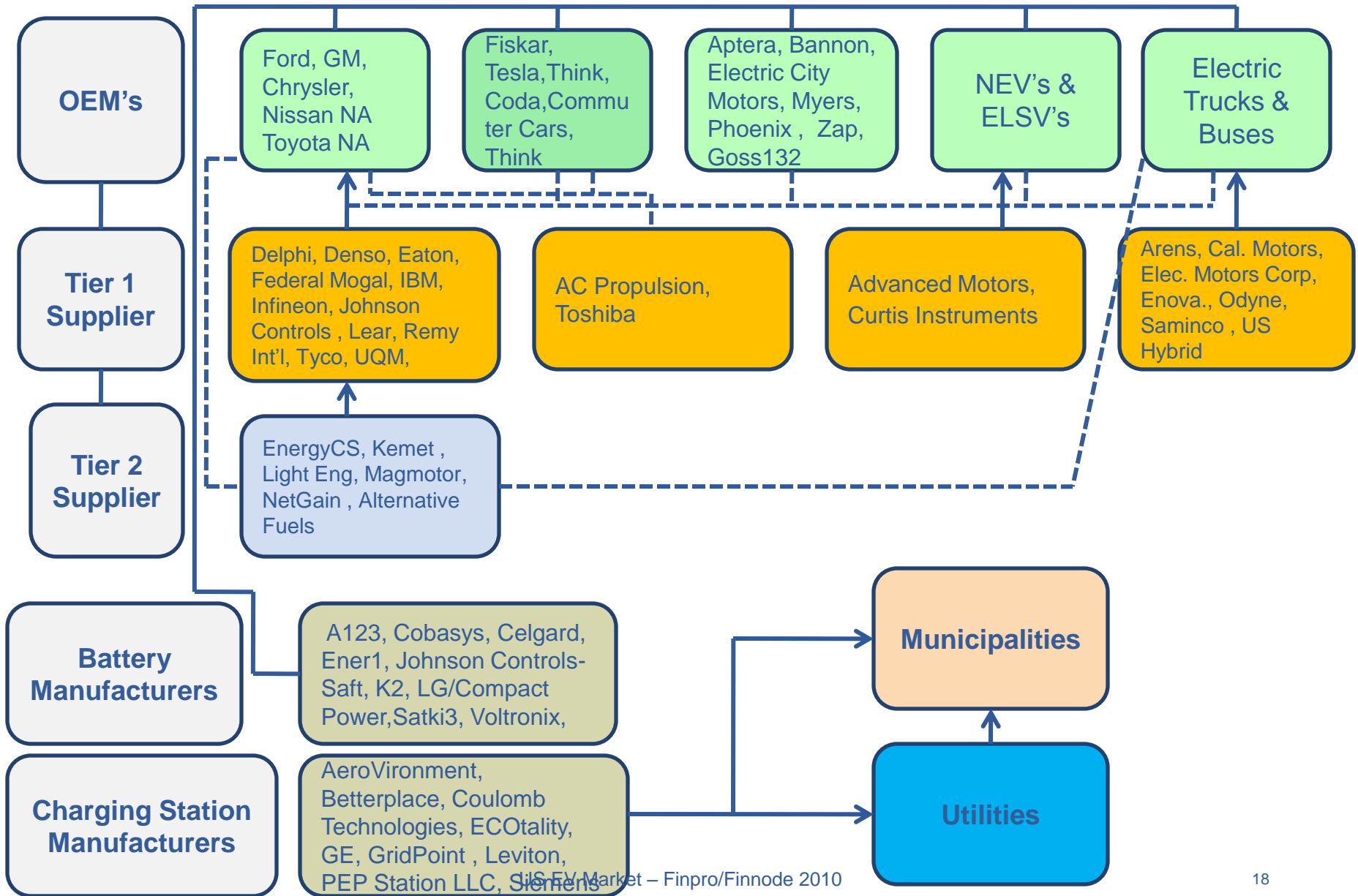
- AeroVironment
- Betterplace
- Carbon Day Automotive
- Car Charging Group
- Clipper Creek, Inc.
- Coulomb Technologies
- Eaton
- ECOtality
- Eetrex
- eTec
- EV-Charge America
- EVOASIS
- GE
- Greenlight AC
- GridPoint
- Juice Technologies
- Leviton
- NovaCharge
- Optimization Technologies
- PEP Station LLC
- SemaConnect
- Shorepower Technologies
- Siemens Energy

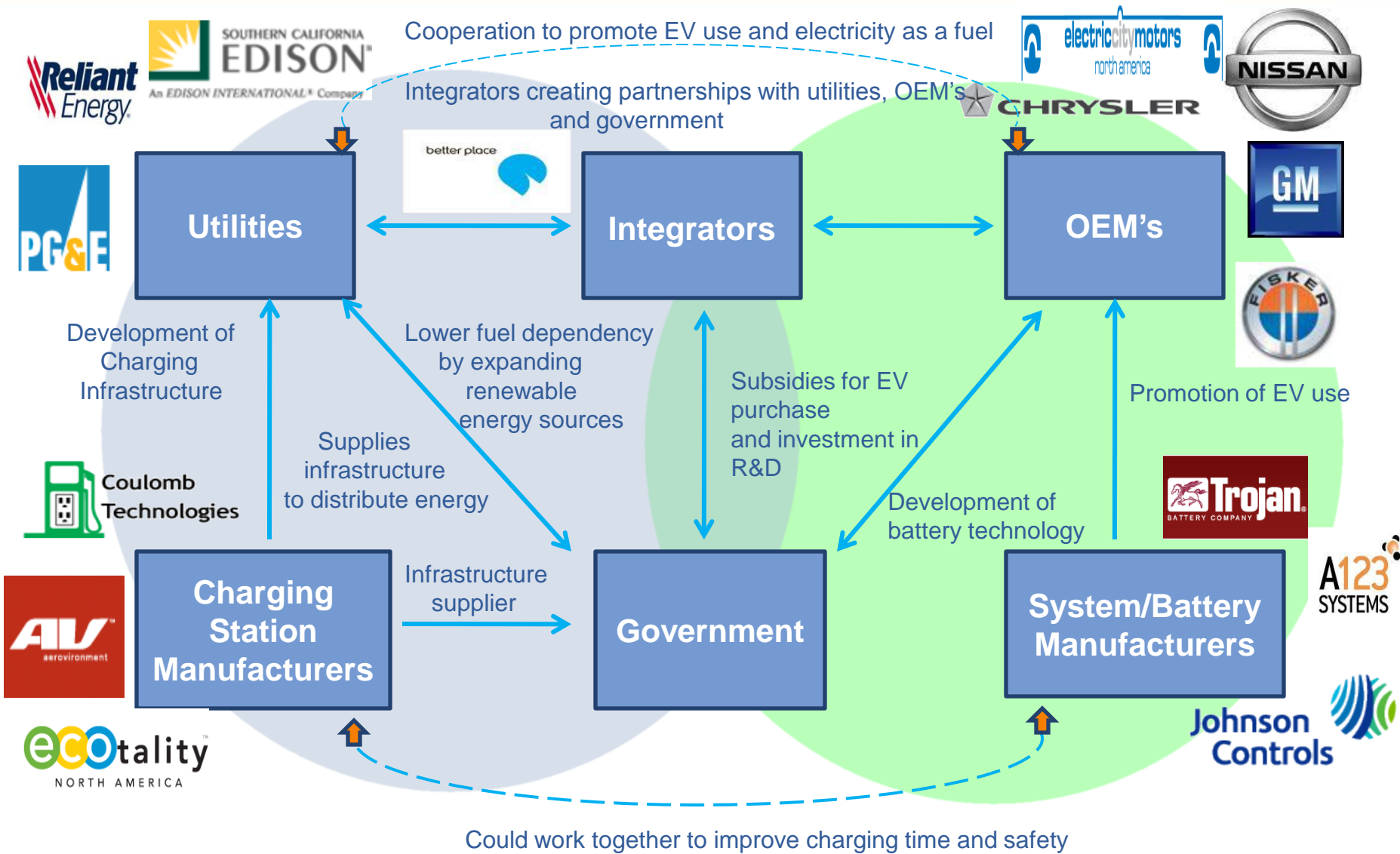
Electric Trucks & Buses

- American Electric Vehicles
- Balqon
- Boulder Electric Vehicles
- Bright Automotive
- Columbia ParCar
- Designline
- Ebus
- Electrorides
- Electric Vehicles Int'l (EVI)
- Foton America Bus Co.
- ICCorporation
- ISE
- Miles Electric Vehicles
- Phoenix Motor Cars
- Proterra
- Roush
- Sinautec
- Smith Electric Vehicles
- Taylor-Dunn Manufacturing



The EV Value Chain





The EV Market Map



Battery Electric Vehicles (BEVs)



Tesla S Model

Examples



Nissan



Mitsubishi iMIEV



Coda



Think City

Plug-In Hybrid Vehicles (PHEVs)

Examples



Aptera



Chevrolet Volt



VW Golf TwinDrive



Ford Escape PHEV



Toyota Prius PHEV



Plug-in hybrid electric vehicle: GM Chevy Volt: Credit: © GM Corporation



Electric city car: Mitsubishi i-MiEV: Credit: <http://media.mitsubishicars.com/>

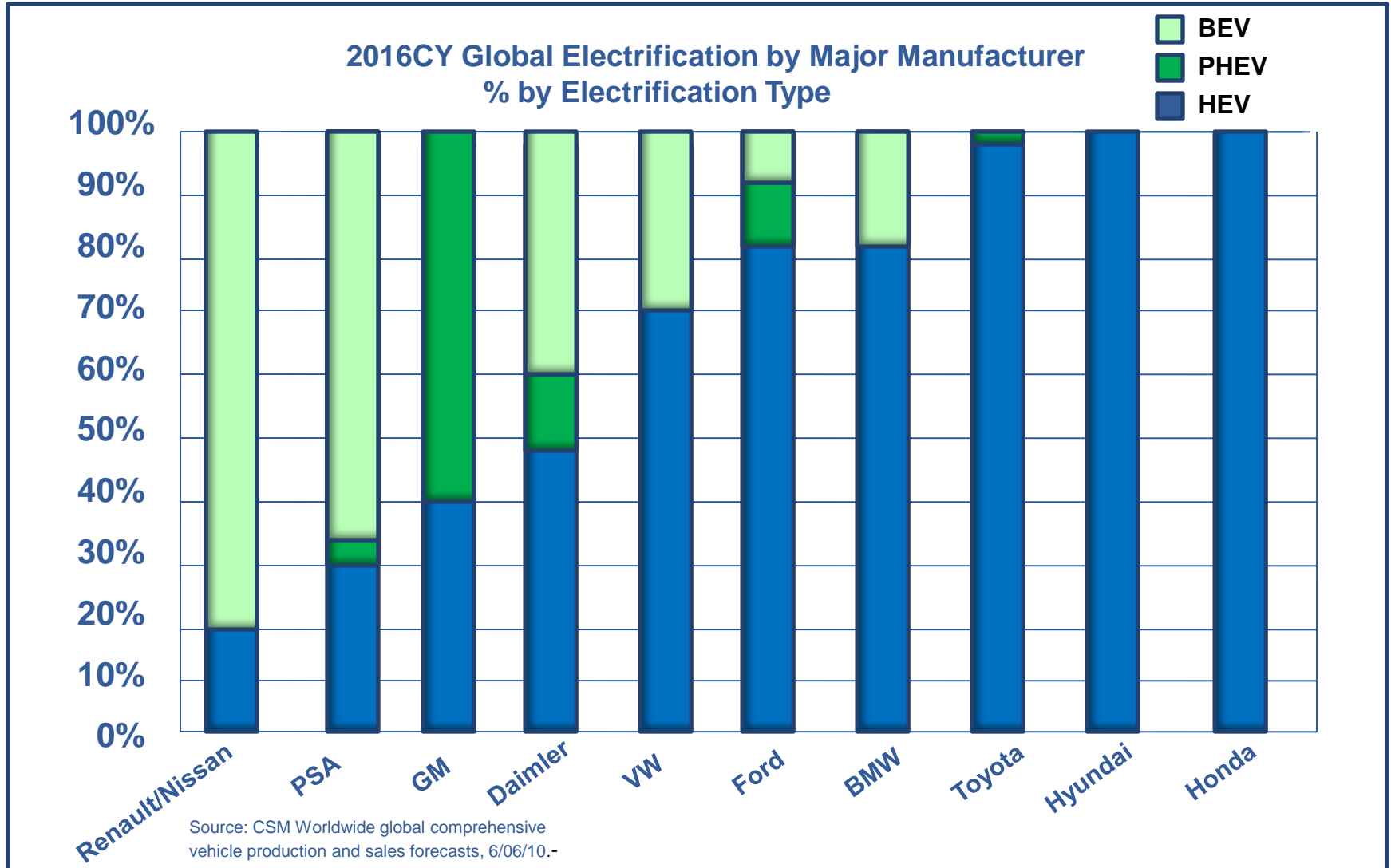


Full-range electric car: Tesla Model S: Credit: www.teslamotors.com

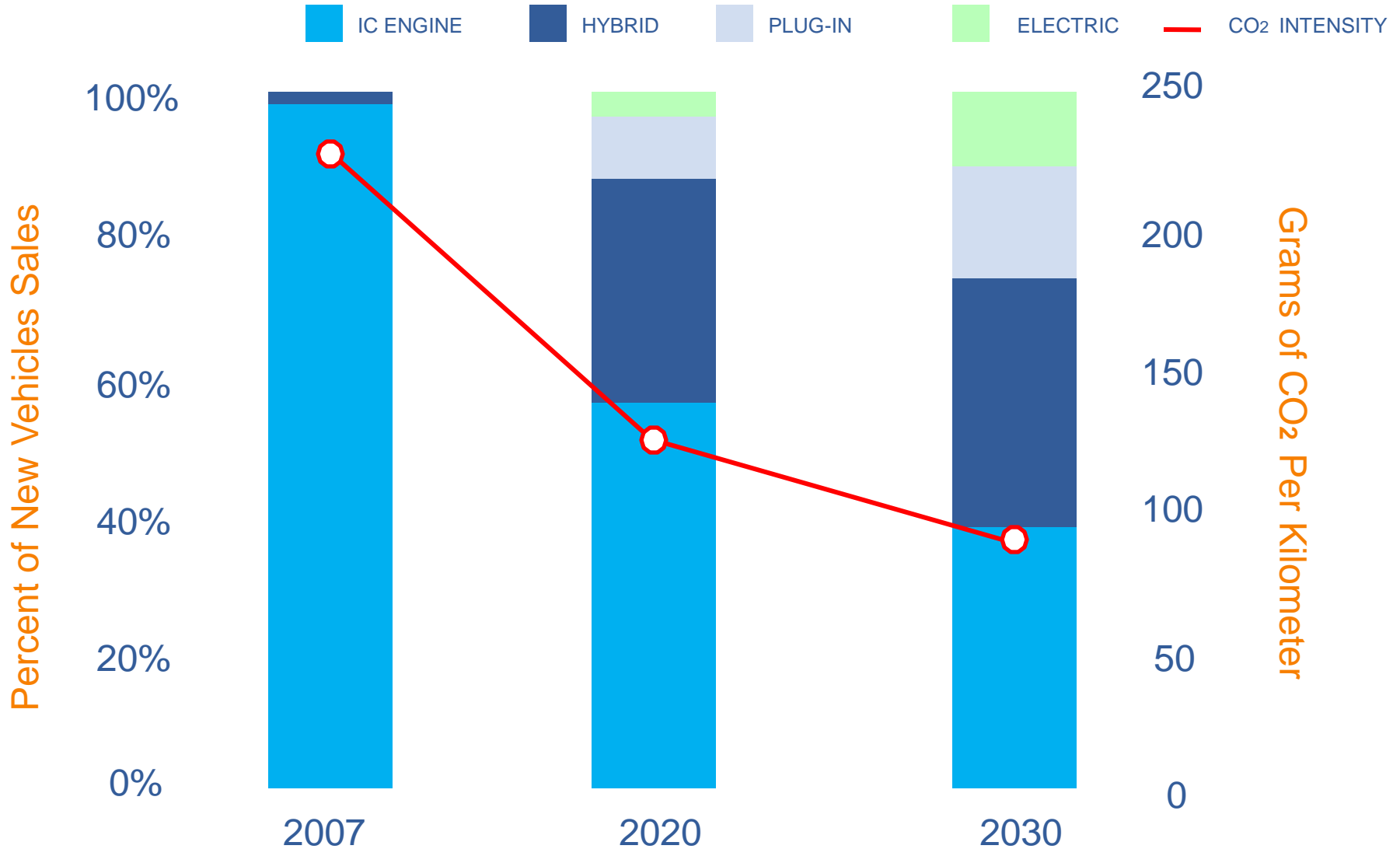
Type	Range	Charging Time for A Full Charge		ACCELERATION	OTHER FEATURES
		240V*	120V**		
Plug-in hybrid electric vehicle (PHEV)	340 miles First 40 miles electric, next 300 miles gas	2 to 3 hours	7 hours	Zero to 60 mph in 8 seconds (comparable or better than conventional cars)	<ul style="list-style-type: none"> • 200+ miles per gallon through combined electricity and gas use
Electric city car (EV or BEV)	40 to 60 miles on a full charge	3 to 4 hours	10 hours	Zero to 60 mph in 10 seconds (better than similar conventional cars)	<ul style="list-style-type: none"> • Low operating cost • Requires less maintenance • Fits into small parking spaces
Full-range electric car (EV or BEV)	100 to 200 miles on a full charge	4 to 5 hours	16 hours	Zero to 60 mph in 6 seconds (better than similar conventional cars)	<ul style="list-style-type: none"> • Low operating cost • Requires less maintenance

Electrification by Manufacturer

2016 CY Global Electrification Volume Projections by Manufacturer (>40K)



US Passenger Vehicle Sales by Technology



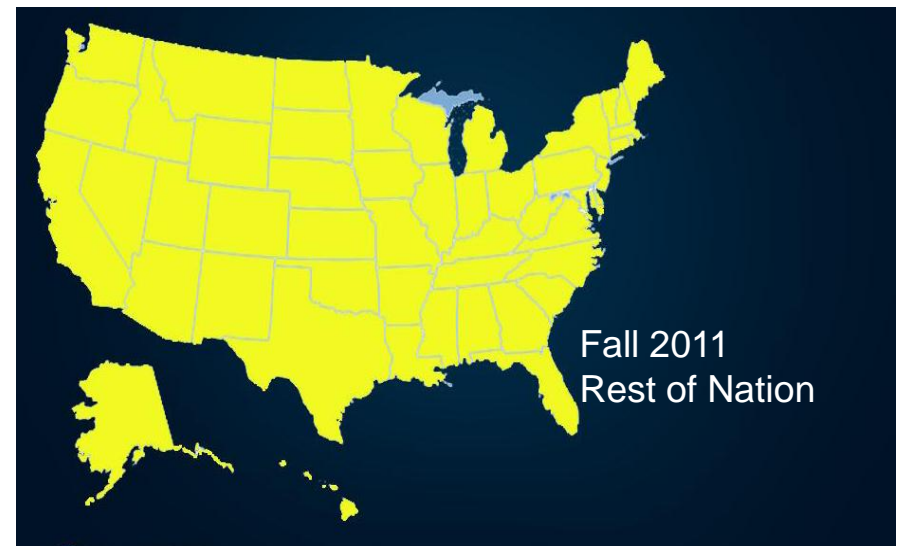
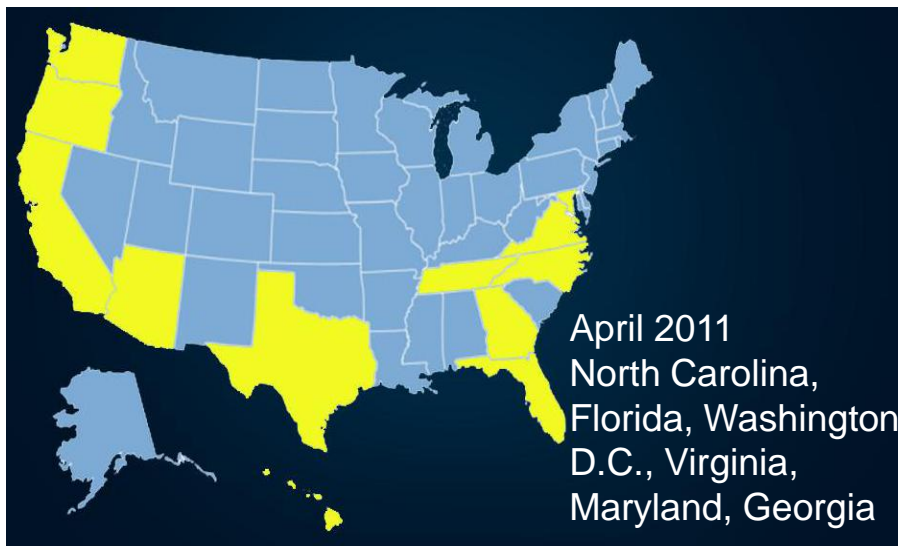
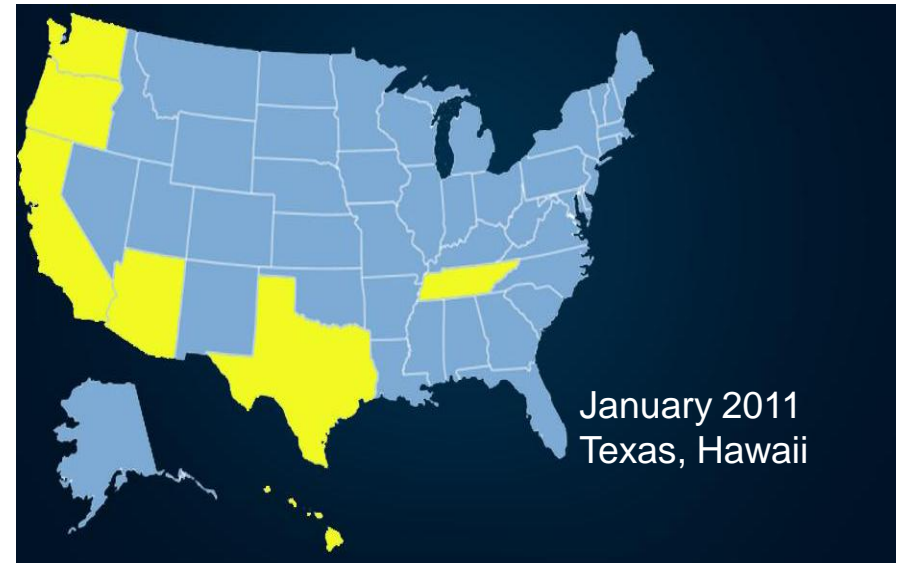
Source: International Energy Agency



- **Zero emission**
- **Lively acceleration + Quietness**
- **100-mile range appropriate for daily use**
- **Advanced intelligent transportation system**
- **Nearly 17,000 National Reservations**
- **Nearly 6,000 Reservations in California**
- **9 out of 10 currently are new to Nissan**
- **Aerovironment home charging station**
- **100% charge w/220-volt charger- 4 - 8 hours**

Spec	Type
Size	5-door hatchback
Capacity	5 Adults
Range	100 miles (US) (160 KM)
Top Speed	90 mph (145 kph)
Battery	Laminated Lithium-ion – 8 year, 100,000mile warranty
Capacity /Power	24 kWh/over 90kW
Motor	High-response synchronous AC Motor (80kW/280Nm)
IT System	Integrated Communication System
Price	MSRP starting at \$32,780 - \$25,280 after \$7,500 Federal tax credit (additional state credits) Tax credit up to \$2,000 toward installation of personal charging dock \$359. month lease for 36 mo

Nissan LEAF Market Rollout



The LEAF is equipped with a Telematics control unit that transmits and receives data allowing for unprecedented convenience. Connected to a global data center, the system can provide support, information and entertainment for drivers 24 hours a day, 7 days a week.

Data Center



Automatic charging spot



NEW charging spots

Leaf's CARWINGS telematics system can identify new public charge locations and will update throughout the year

Remote vehicle access

- Charging/Climate Control
- Charge Status
- Plug-in reminder
- Access by internet and web-enabled phone

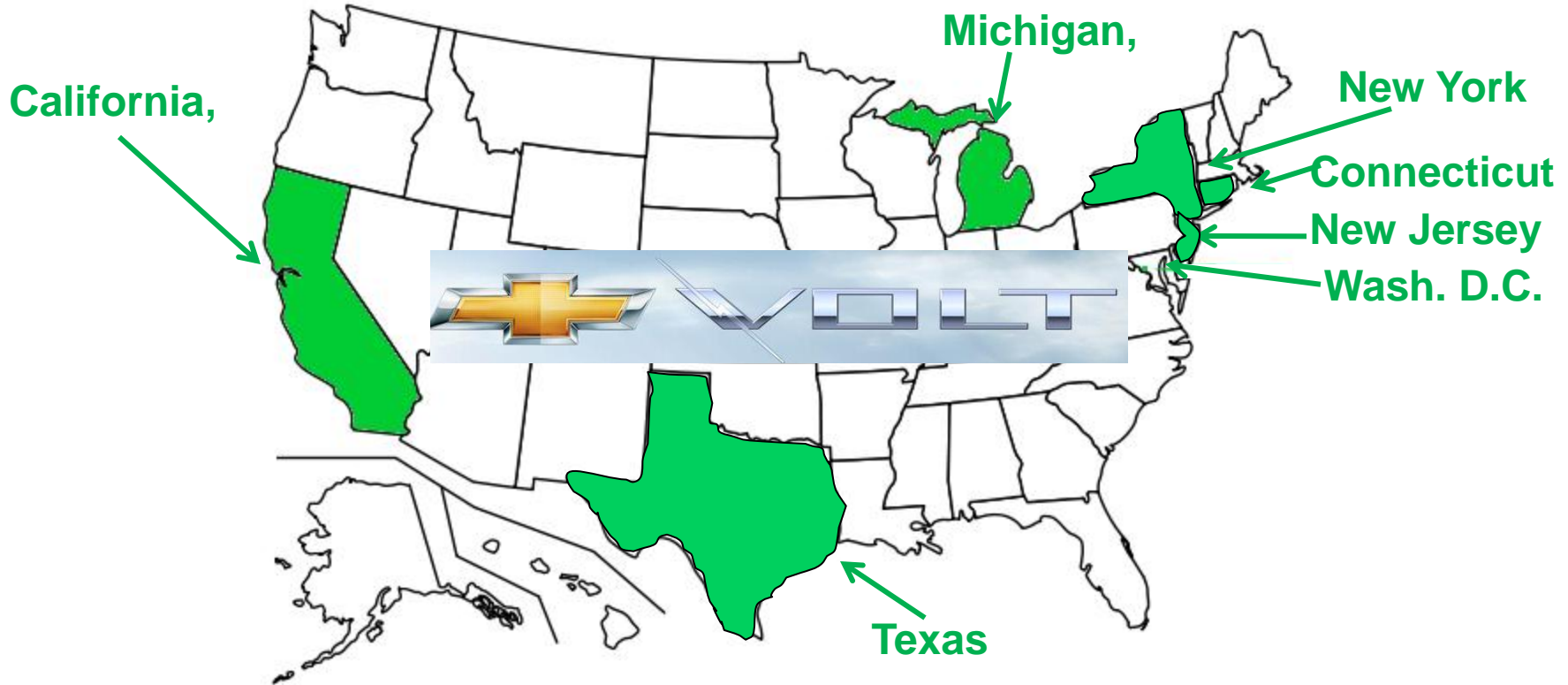


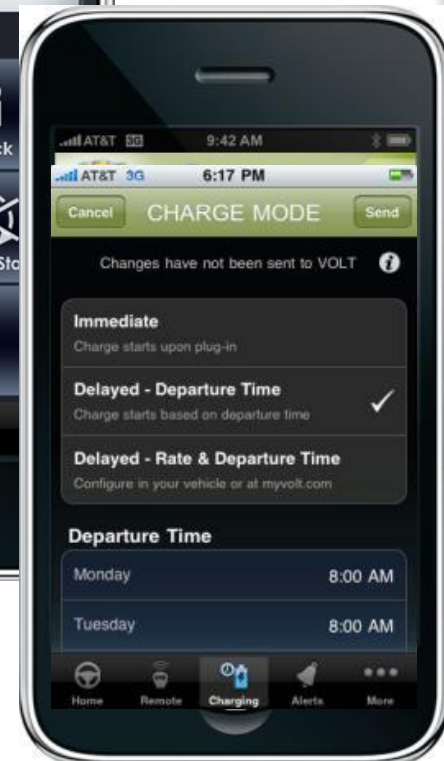
- **Plug-in Hybrid Electric vehicle**
- **Capable of being a family's primary vehicle**
- **40 miles (64 km) of pure electric range plus 300 additional miles with engine-generator**
- **OnStar (GPS) -5 years 24/7 standard service**
Mobile app for smart phones
- **7-inch center console LCD touch screen**
- **120 volt cord set - 100% Recharge 110-volt outlet: 6 to 6.5 hours**

Spec	Type
Size	4 door hatchback
Capacity	4 Adults
Range	40 miles (64 km) electric, 300 miles (482 km) with engine generator
Top Speed	120 mph (192 kph); 0-60-mph sprint of 8.5 to 9 seconds
Battery	16kWh lithium-ion battery; 8 year,100,000 mile warranty
Capacity /Power	149-horsepower (111-Kw) electric motor; gasoline- or E85-powered four-cylinder generator
Motor	111-Kw) electric motor & 1.4-liter four-cylinder internal combustion engine
IT System	OnStar Navigation
Price	MSRP starting at \$41,000 \$33,500 after \$7,500 Federal tax credit \$350. month lease for 36 mo

Volt Market Rollout

Available in California, New York, Michigan, Connecticut, Texas, New Jersey, and Washington, D.C. in late 2010. Followed by nationwide availability in the fall of 2011





- Charge status display - plugged in or not and voltage (120V or 240V)
- Flexibility to "Charge Now" or schedule charge timing
- Display percentage of battery charge level, electric and total ranges
- Ability to manually set grid-friendly charge mode for off-peak times when electricity rates are low
- Send text or email notifications for charge reminders, interruptions and full charge
- Display miles per gallon, electric only miles, and odometer readings
- Shows miles per gallon, EV miles and miles driven for last trip and lifetime
- Remotely start the vehicle to pre-condition the interior temperature



Ford North America – Announced Electrification Projects



2004 CY

2010 CY

2012 CY

2018+ CY

BEV

Battery Electric Vehicles



Transit Connect

(Focus N.A.)
Global C-Platform



PHEV

Plug-in Hybrid Electric Vehicles



New PHEV

HEV

Hybrid Electric Vehicles

Escape

Next Generation HEV

Fusion Milan

Next Generation HEV





Ford Motor Company recently announced the first markets that will sell the Focus Electric, Ford's first all-electric, zero CO₂-emissions passenger car.

The first markets selected for the Ford Focus Electric, available in late 2011, include Atlanta, Austin and Houston, Texas; Boston, Chicago, Denver, Detroit, Los Angeles, San Diego, San Francisco, New York, Orlando, Fla., Phoenix and Tucson, Ariz.; Portland, Ore.; Raleigh Durham, N.C.; Richmond, Va.; Seattle, and Washington, D.C.

Ford will continue to evaluate additional markets and consider making this vehicle available in more cities across the country. As part of the collaboration with dealers, utilities and local governments, Ford will help develop consumer outreach and education programs on electric vehicles as well as share information on charging needs and requirements to ensure the electrical grid can support customers' needs.

Ford Battery Testing

Ford is currently hard at work testing the batteries to be used in electric vehicles. In an attempt to speed up testing, Ford is using the Internet and wireless technology for testing purposes.



The new lithium-ion battery systems to be offered by Ford are being tested by using a secure Internet server and a wireless update system for testing, two technologies which allowed the carmaker to double its testing capacity.

“Remote monitoring allows us to access real-time data and make continuous improvements very quickly. This degree of efficiency would have been unthinkable a few years ago and will help Ford bring more fuel-efficient, low-emission vehicles to market more quickly than ever before.”

“The data we’ve collected have helped us understand how lithium-ion battery cells behave under various temperatures and states of charge, and the monitoring system allows us to make software updates to the fleet vehicles while they recharge. What used to be logistically complicated and time consuming can be accomplished now with a click of a mouse.”

Sherif Marakby, Ford Director, Electrification Program and Engineering

The main goals Ford is pursuing are allowing quick, efficient recharging while at the same minimizing cell deterioration. This in turn will translate into an increased battery life. Recharging in different environmental conditions is one of the focuses of the carmaker.

Chrysler Group Electrification Strategy and Near Term Deployment Plan

Chrysler Group has a broad electrification strategy that fills the gap between minicars and full-sized pick up trucks; and

–Considers the technology trends

–Compliance

–Application

–And is part of a comprehensive best-in-class fuel economy plan

- Chrysler Group's near term deployment includes 140 plug-in hybrid pickups for a three-year demonstration program- after killing its plan to build a hybrid Ram pickup

- Chrysler also says an electric version of the Fiat 500 will roll into American showrooms in 2012. Chrysler will do all the engineering for the vehicle at its HQ in Auburn, Hills, Michigan and will build it specifically for the United States.



Started in late 2009. 150 of 600 vehicles are destined for North America

- **Objectives:**

- Demonstrate plug-in hybrid technology, educate and inform the public, evaluate performance and better understand the technology's benefits to future customers.
- Allow Toyota to gather in-use driving feedback and understand customer expectations for plug-in technology.
- Confirm, in a wide variety of real world applications, the overall performance of Toyota's first-generation lithium-ion battery technology, while spurring the development of public-access charging station infrastructure.
- Dashboard data from the 150 U.S. demonstration programs will be posted to a Web site. As the vehicles gather miles, data such as fuel economy, miles driven, charge incidents and additional content will be viewable online



TOYOTA

Hybrid Electric Vehicles:

2010 Hyundai-Kia Hybrid
2010 Lexus HS 250h
2010 Mercedes E Class Hybrid
2010 Porsche Cayenne S Hybrid
2010 Toyota Camry Hybrid
2010 Toyota Prius Hybrid
2011 Honda CR-Z sport hybrid coupe
2011 Suzuki Kizashi Hybrid
2011 Audi Q5 Crossover Hybrid
2011 Infiniti M35 Hybrid

Battery Electric Vehicles:

2010 Coda Automotive Sedan
2010 Mitsubishi iMiEV BEV
2010 Nissan LEAF
2010 Ford Battery Electric Van
2010 Tesla Roadster Sport EV
2011 Renault Kangoo Z.E.
2011 Renault Fluence Z.E.
2011 Tesla Model S
2011 BYD e6 Electric Vehicle
2011 Ford Battery Electric Small Car
2012 Audi e-tron
2012 Toyota
2016 Tesla EV

Extended Range Battery Electric Vehicles:

2010 Chevy Volt Extended Range BEV

Plug-in Hybrid Vehicles:

Fisker Karma S Plug-in Hybrid
2010 Toyota Plug-in Hybrid
2011 BYD F3DM Plug-in Hybrid
2012 Bright Automotive IDEA Plug-in Hybrid
2012 Ford Plug-in Hybrid
2012 Toyota

Fuel Cell Electric Vehicles:

Honda FCX Clarity
GM Hydro-GEN3
Chevy Equinox Fuel Cell
Ford Fuel Cell EV

The Society of Automotive Engineers (SAE) is a professional organization responsible for developing a wide range of automotive standards

Recommended Practices for Plug-in Vehicles, Charging Equipment and Grid Connectivity

Standard	Description
SAE J1772	Electric Vehicle Conductive Charge Coupler
SAE J2836/1/2/3	Use Cases for Communication between PEV's and the Utility Grid/EVSE/Reverse Power Flow
SAE J2847/1/2/3	Communication between PEV's and the Utility Grid/EVSE/Reverse Power Flow
SAE 2931	Communications Protocols for PEVs
IEC 62196	Plugs, Socket-Outlets and Vehicle Couplers
IEC 61851	Electric Vehicle Conductive Charging System
IEC 61968	Common Information Model –Inter Application Integration
SAE J1711	Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of HEV 's

In addition to the specifications defining the physical connectors, interfaces & power levels, SAE is also developing specifications that will govern the communication between vehicles and the grid

Recent technology breakthroughs now enable more high performance electric vehicles

- Development of high-power, high-energy, dense, high cycle life Lithium-ion batteries
 - LiFePO₄, nanopowders, advanced separators
- Ultra-efficient, high-power electric motors
 - Permanent magnet and hybrid motors, improvements in AC motors, advanced magnetic materials
- Highly efficient high-power transistors
 - Low electric losses, allow design and control of advanced motor concepts
- Availability of commercial-grade carbon fiber
 - Future high-strength, low-weight car bodies, more than offsets battery weight

Microsoft Windows Embedded Automotive 7

Microsoft has announced that the 2011 Nissan LEAF touchscreen information hub is powered by **Windows Embedded Automotive 7** technology, providing drivers and passengers with a navigation system and electricity charging station locator. It also shares power consumption monitoring information with drivers, and enables easy in-car climate monitoring. Other automakers like **Ford, Fiat and Kia are all using software sourced from Microsoft.**

Designed to support the development of new infotainment systems, Windows Embedded Automotive 7 is an industry-leading platform providing integrated services for communication, entertainment, navigation and information for the mass market

With Windows Embedded Automotive 7, car makers and suppliers have access to Microsoft's latest tools and technology, as well as a worldwide partner ecosystem, which allows them to quickly create in-vehicle experiences that are easier to use and more engaging for drivers and passengers. Key features include speech commands, touch input, hands-free Bluetooth phone communications, advanced dashboard systems for access to music, maps, third-party apps and navigation, and streamlined connectivity with other devices.

"Microsoft deeply understands that technology collaboration is paramount to the evolution of integrated, in-vehicle infotainment systems," Kevin Dallas, general manager of the Windows Embedded Business Unit at Microsoft

Silverlight for Windows Embedded

Silverlight for Windows Embedded gives car makers the ability to quickly create rich device user experiences with engaging 2-D and 3-D graphics by using a familiar Microsoft technology and taking advantage of a large ecosystem of Microsoft Silverlight designers. Experiences built in Silverlight for Windows Embedded can be refined rapidly on the desktop and deployed unchanged to the target device facilitating flawless delivery from designer to developer.

Microsoft Tellme Speech Technology

Microsoft Tellme speech technology powers simple and hands-free system commands such as allowing the entire interface to be driven through speech. In addition, new support for SMS reply by voice allows text message replies to be constructed by speech. Windows Embedded Automotive 7 also supports eight languages: U.S. English, U.K. English, German, Mexican Spanish, Continental Spanish, Canadian French, Continental French and Korean.

Next-generation Automotive System Tools

New tools for developers support the stable integration of advanced, high-performance, third-party systems and include improved test modules with easy-to-use product engineering guidelines to help simplify the development process, increase reliability and speed time to market.

US EV Battery Market

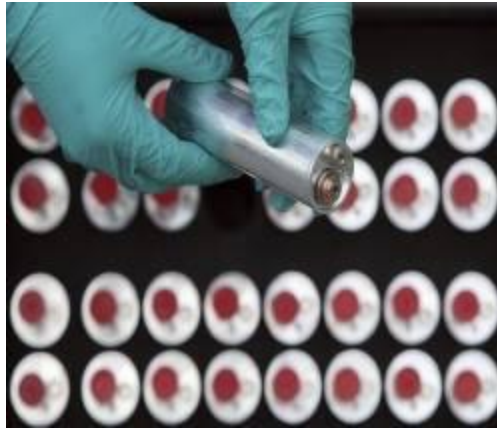
The focus of much of the battery industry is on producing batteries with high energy and power at a cost most consumers will find compelling.

- A range of generic estimates for current battery costs centers on \$600 per kWh.
- **The long-term goal for most market participants is closer to \$200 per kWh.**
- The primary drivers of battery cost are high material costs and lack of scale. Reaching economies of scale will be a big challenge.
- Battery performance is significantly impacted by the charge cycle and temperature, among other factors.
- Market size estimates for electric and hybrid vehicle batteries range widely, from \$2.3 billion to \$10 billion by 2015

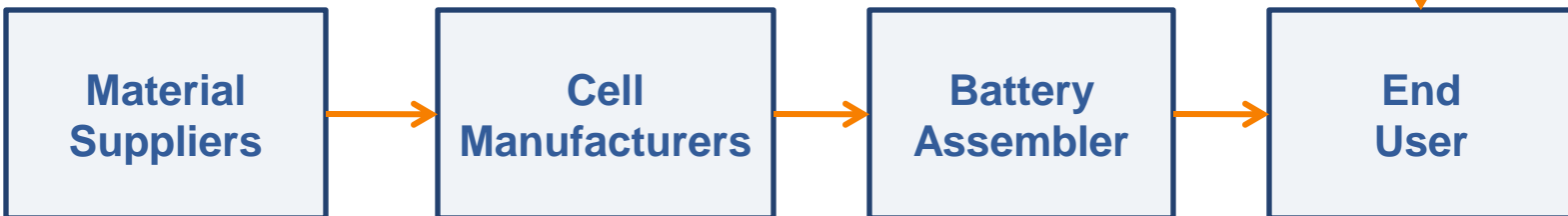
However, according to a report published by the US Department of Energy (DOE) earlier this year on the economic impact of Recovery Act investments in advanced batteries, the US will have the capacity to produce 20 per cent of the world's advanced batteries by 2012 and up to 40 percent by 2015.

Manufacturer	Type of Battery	Relationships
A123 Systems www.a123systems.com	High-power lithium ion batteries based on Nanophosphate™ technology	Fiskar, Chrysler, Think, GM, and BetterPlace
Ciobasys www.cobasys.com	Nickel metal hydride batteries "NiMHax system" for PHEV, HE, EV and heavy duty vehicles.	In discussion with OEM's
Compact Power, Inc (subsidiary of LG Chem, Ltd) www.compactpower.com	<i>Lithium-Ion Polymer Battery Technology</i> for HEV, PHEV, and EV applications	Will provide complete lithium-ion battery packs for a GM Buick PH SUV that will debut in 2011
EnerDel www.ener1.com	Lithium-ion prismatic cells, packs and energy storage systems for EV's and PHEV's.	Think, Volvo, other OEM's
Johnson Control-Saft www.johnsoncontrols.com	Lithium-ion hybrid batteries.	Mercedes-Benz S400 Hybrid sedan, BMW 7 Series ActiveHybrid, Ford's first PHEV available in 2012.
Sakti3 http://sakti3.com	Solid-state rechargeable lithium-ion batteries	Khosla Ventures, GM (Volt)
Seeo www.seeo.com/	Solid state, core polymer electrolyte technology	Khosla Ventures, Motiv Power Systems
Valence Technology www.valence.com	Lithium iron magnesium phosphate U-Charge® system	Smith Electric Vehicles, car OEM's
Voltronix www.voltronixusa.com	Lithium-ion batteries from 10Aha to 7000Aha and Voltronix™ battery technology in the 160Aha to 200Aha range	In discussion with OEM's

Creating an Advanced Battery Manufacturing Base



Integrated Supply Chain



The **US Advanced Battery Consortium (USABC)** is an arm of the US Council for Automotive Research LLC, an umbrella organization for collaborative research among Chrysler LLC, Ford Motor Company and General Motors. Its goal is to further strengthen the technology base of the U.S. auto industry through cooperative research and development.

Mission

To develop electrochemical energy storage technologies which support commercialization of fuel cell, hybrid, and electric vehicles.

Objectives:

For high-energy and high power energy storage technologies and models, the USABC shall continue its focus on understanding and addressing the following:

- Continue development of high-power battery technologies to reduce cost to \$20/kW and extend life to 15 years.
- Develop battery technology to support electric, hybrid and fuel cell vehicles.
- Develop ultracapacitor technology for hybrid electric vehicle applications.
- Conduct benchmarking activities for both high power and high energy batteries and ultracapacitors to validate technologies.
- Publish technical goals and associated test procedures to guide the development of electrochemical energy storage systems.

To view documents and request for proposals see:

[USABC Request for Proposals \(RFPs\) and Related Documents](#) or
www.uscar.org/guest/article_view.php?articles_id=87

Robert Galyen, Chair of SAE's Battery Standards Committee

SAE International is trying to limit the potential for danger by developing standards that cover everything from the design to the recycling of large advanced-technology batteries used in electric vehicles (EVs) and hybrid-electrics of different kinds. Battery standards are useful for several reasons, but safety is paramount.

Besides the safety benefits to consumers and others who interface with EVs and EV batteries, *“standardization helps drive costs down because it allows multiple battery manufacturers to make products of a similar form factor and rating so that vehicle manufacturers can produce lower-cost product, and that lower cost can be passed on to the consumer.”*

The standards also will make it easier for automakers to evaluate one supplier's batteries against another's.

SAE created the Battery Standards Committee in November in response to the fact that emerging battery technologies are creating a new paradigm in the areas of materials, safety, performance, manufacturability, and shipping/transportation

The Battery Safety task force is moving at “warp speed” to complete **J2929 – Electric and Hybrid Vehicle Propulsion Battery System Safety Standard**. Another standard of high priority is **J1798 - Recommended Practice for Performance Rating of Electric Vehicle Battery Modules**. This is the document that will help automakers better determine which batteries are most suited to specific applications.

This standard and others can be found at: <http://standards.sae.org/wip/j2929/>

SAE -Battery Standards Committee Other standards at the work-in-progress stage include:

Standard	Description
J2758	Determination of the Maximum Available Power from a Rechargeable Energy Storage System on a Hybrid Electric Vehicle
J2936	Vehicle Battery Labeling Guidelines
J2946	Battery Electronic Fuel Gauging Recommended Practices
J2950	Recommended Practices (RP) for Transportation and Handling of Automotive-type Rechargeable Energy Storage Systems (RESS)
J537	Storage Batteries

In partnership with US national labs, **IBM** has started an R&D project that it hopes will lead to the commercialization of **batteries that store 40 times as much energy** as today's within the next 5 years. IBM wants to develop a new technology that uses energy-dense but highly flammable lithium metal to react with oxygen in the air. The potential payoff will be a lightweight, powerful, and rechargeable battery for electric vehicles.

Lithium metal-air batteries can store more than 5,000 watt-hours per kilogram. (A123 M1 cells are around 120 wh/kg) That's more than forty-times as much as today's high-performance lithium-ion batteries, and more than another class of energy-storage devices: fuel cells

IBM is pursuing the risky technology instead of lithium-ion batteries because it has the potential to reach high enough energy densities to vault IBM ahead in the race for EV batteries. IBM say lithium-ion batteries only have enough development potential to double in density. One of the projects stated goals is to build a lightweight battery with 500-mile range for a family car. IBM will devote about five years and 50 to 100 people to the project. IBM will probably license the technology to manufacturers.

Another company, Berkeley, CA based **PolyPlus Battery** has been working on lithium metal-air technology for about six years with a theoretical specific energy of 11,600 Wh/kg for Li-Air chemistry (almost 100x A123 cells).

A new company, called **24M**, recently spun out of the A123, will develop a novel type of battery based on research conducted by Yet-Ming Chiang a professor of materials science at MIT and founder of A123 Systems. He says the battery design has the potential to cut those costs by 85%. The new company has raised \$10 million in venture-capital funding, and about \$6 million from the Advanced Research Projects Agency-Energy

Government EV Initiatives

Recovery Act : \$2.8 Billion Advanced Vehicle Technology Projects

\$1.5 Billion in funding to accelerate the manufacturing and deployment of the next generation of U.S. batteries

\$500 Million in funding for electric-drive components manufacturing

\$400 Million in funding for transportation electrification



SuperTruck and Advanced Combustion R&D \$104.4 Million Solicitation: Heavy-duty trucks are emphasized because they rapidly adopt new technologies and account for 20% of the fuel consumed in the United States

Clean Cities: \$300M for Petroleum Displacement through Alternative Fuel Vehicles and Expanded Alternative Fuel Infrastructure Recovery



There are two bills in the U.S. House and the Senate designed to help spur the deployment of electric vehicles and related charging infrastructure.

Highlights of the Electric Drive Vehicle Deployment Act include:

- The Secretary of Energy will competitively award \$800 million to 5 different deployment communities around the country, with the objective of deploying 700,000 electric vehicles in those communities within six years.
- At least \$2,000 in additional consumer incentives for the first 100,000 consumers purchasing electric vehicles in these communities would be provided.
- All Americans would continue to be eligible for the electric vehicle tax credit, which reduces the prices of an electric vehicle by up to \$7500, and additionally, tax credits of the costs of purchase and installation of electric vehicle charging equipment for individuals (up to \$2000) or businesses (up to \$50,000 for multiple equipment purchases) would be extended.
- Additional research, development, deployment and manufacturing **incentives are provided for technologies that enable the widespread deployment of electric vehicles and charging infrastructure.**



- The **National Plug-in Vehicle Initiative**, promoted by **The Electric Drive Transportation Association (EDTA)** is comprised of automakers, utilities, battery and component manufacturers, associations and government entities dedicated to realizing the potential of the electric drive industry.
- **NPVI Program Elements Include:**
- A web-based clearinghouse for general information on plug-in electric drive technology and opportunities, with portals to NPVI participants for specific information on vehicles, infrastructure and services

A Media Campaign providing a regular and reliable source of industry information to key media outlets – and to respond quickly to misinformation

'Tool-Kits' providing valuable information on 'Best Practices' for legislators, regulators, utilities and others

Create 'content' on electric drive opportunities for billing inserts, newsletters and other communications channels

Programs and demonstrations of plug-in electric drive technology and issues for major conferences and events

- For more info see: www.electricdrive.org/index.php?ht=a/GetDocumentAction/i/13917

The **DOE Vehicle Technologies Program** is developing more energy efficient and environmentally friendly transportation technologies that will enable America to use less petroleum. The aim is to develop "**leap frog**" **technologies** that will provide Americans with greater freedom of mobility and energy security, while lowering costs and reducing environmental impacts.

Recovery Act Funding Opportunities

In August, President Obama announced that the **DOE is offering up to \$2.4 billion** in American Recovery and Reinvestment Act funds to support next-generation plug-in hybrid electric vehicles (PHEV) and their advanced battery components. The new awards cover

- **\$1.5 billion in grants** to US-based manufacturers **to produce batteries and their components** and to expand battery recycling capacity
- **\$500 million in grants** to US-based manufacturers **to produce electric drive components for vehicles**, including electric motors, power electronics, and other drive train components
- **\$400 million in grants** to purchase thousands of plug-in hybrid and all-electric vehicles for test demonstrations in several dozen locations; to deploy them and evaluate their performance; **to install electric charging infrastructure; and to provide education and workforce training** to support the transition to advanced electric transportation systems.

More information about **DOE's Vehicle technology Program** and contacts can be found at:

<http://www1.eere.energy.gov/vehiclesandfuels/about/index.html>

Information about **DOE's Plug-In Hybrid Electric Vehicle R&D Plan** is available at

http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/phev_rd_plan_02-28-07.pdf

Advanced Vehicle Testing Activity (AVTA) is part of DOE's Vehicle Technologies Program. Conducted by:

Idaho National Laboratory (INL)

- Program execution in support of DOE goals
- Conducts engineering, data analysis, and reporting

Ecotality North America (formerly eTec)

- Private company based in San Francisco, CA with access to numerous testing facilities / tracks
- Conducts vehicle test operations and engineering

ANL and ORNL provide AVTA dynamometer testing support and vehicle data acquisition support (ANL)

- AVTA tests light-duty whole vehicle systems and fueling infrastructures that employ:
 - **Electric drive systems**
 - **Advanced energy storage systems**
 - **Advanced control systems (i.e., start/stop HEVs)**
 - **Some ICE 100% Hydrogen and HCNG blended fuels**
- Provide benchmark vehicle data to R&D programs, modelers, OEMs, battery manufacturers, and target/goal setters (DOE)
- Assist early adopter fleet managers and the general public in making informed vehicle purchase, deployment and operating decisions. Presentations to industry groups, including via DOE's Clean Cities Coalitions
- DOE's only light-duty vehicle testing activity of new technologies deployed in whole-vehicle systems operated in real-world fleet environments

PHEV Testing Partners

- **294 PHEVs in 26 states, Canada, and Finland**
- **1.8 million miles**
- **93 PHEV testing partners include:**
 - 38 Electric utilities
 - 9 City governments
 - 10 County governments
 - 10 Universities
 - 4 State governments
 - 2 Clean Air Agencies
 - 10 Canadian government groups
 - 3 Sea ports and military bases
 - 2 PHEV conversion companies
 - 5 Private companies and advocacy organizations
- **2,500+ automated monthly PHEV 3-page summary reports have been generated and disseminated to testing partners**

Testing focus is on the PHEV technology concept and batteries, and driver and environmental impacts on fuel efficiencies and charging rates.

Additional info at:

<http://avt.inl.gov> or <http://www1.eere.energy.gov/vehiclesandfuels/avta/>

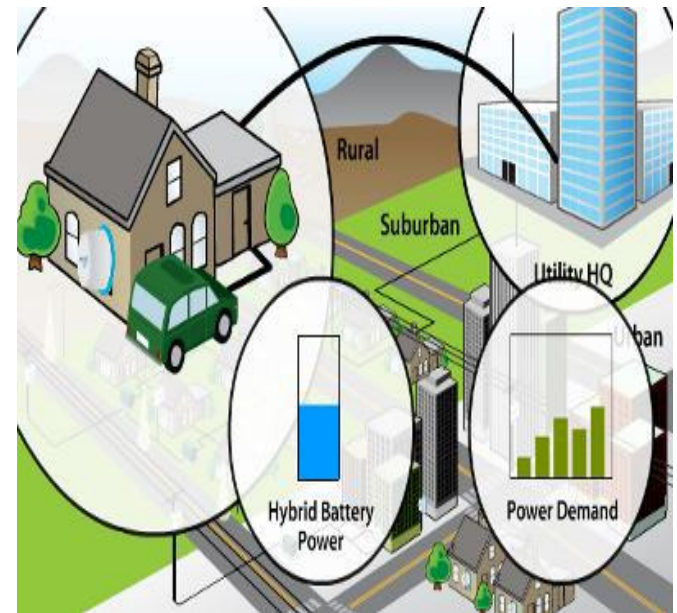
US EV Charging Infrastructure

- The situation as to who will own and operate the charging facilities, who will provide and be paid for the power, or what the rates will be is still not yet clear.
- Most EV charging is expected to take place at home during the overnight hours, but early on, accessible public charging facilities will be critically important in order to increase consumer confidence – especially for those without a garage.
- Consumers may be hesitant to buy EV's in the absence of charging infrastructure, but private companies may be hesitant to build charging locations without assured demand.
- The rise in the number of EVs will open up new opportunities for utilities requiring them to work out new business models for providing a range of new services that encourage energy efficiency and promote the smart grid through EV programs.
- By 2013, utilities will begin investing in EV-related IT systems and services so that the aggregated load of EVs can be managed as an asset and integrated into demand response and other energy management systems.
- It is clear that new innovative firms that can develop unique business models to mitigate the charging infrastructure problems are needed

How will EV's and PHEV's effect the electricity grid?

Smart charging will be key to lowering costs and minimizing impacts. Night time charging will have the least impact on the grid and cost less. It will also be the most logical option to consumers.

- Over 70% of ICE vehicles could be replaced with EV's and PHEV's without any major impact to the grid if charging is during off-peak hours
- Home charging will be key. Consumers must be educated about home charging and the EVSE's must get installation and costs right.
- Utilities must offer some type of discounted rates for off-peak (night) charging.
- EVs and PHEVs will not cause a grid "meltdown," but utilities need to work fast as vehicles are rolled out to reduce impacts.



Leading Electric Vehicle Supply Equipment (EVSE) Manufacturers

Manufacturer	Type of Charger	Relationships
AeroVironment www.avinc.com	Fast charge systems for EVs- PosiCharge™. Partnered with Nissan to supply home charging packages to be sold with EV's	Nissan, Think, EnerDel, US DOD
Betterplace www.betterplace.com	EV driver services, systems and infrastructure; network of charge spots and switch stations	Renault-Nissan Alliance, utilities
Carbon Day Automotive www.carbondayautomotive.com	ChargePoint Networked Charging Stations	Municipalities, utilities, corporations, fleets and property owners
Clipper Creek, Inc www.clippercreek.net	6 UL listed products (3 models, each with 2 configurations). Products meet requirements of standards orgs. including NEC, cUL and SAE.	Telsa Motors, BMW's Mini-E
Coulomb Technologies www.coulombtech.com	Vehicle-charging infrastructure, with an open system driver network. Stations ranging in capability from 120 Volt to 240 Volt AC charging and up to 500 Volt DC charging	Municipalities, corporations and organizations
ECotality www.ecotality.com	ECotality North America Blink residential and commercial Level II Smart chargers.	Partnered with Nissan to supply 11,000 chargers in AZ, CA, OR, WA and TN. (see EV Project)
Evatran www.pluglesspower.com	Plugless Power™, first "hands-free" proximity charging system for EVs. Utilizes a unique dual-component system based on inductive technology	Consumers, corporate
EV-Charge America www.ev-chargeamerica.com	Fast -EV charging stations and Smart Vehicle-to-Grid Infrastructure	Parking lots, apartment buildings, malls, schools, government and private fleets
EVOASIS www.evoasis.com	EVSTAT™ electric vehicle charging stations	Utilities, public and private sector

Leading Electric Vehicle Supply Equipment (EVSE) Manufacturers (cont'd)

Manufacturer	Type of Charger	Relationships
Greenlight AC www.greenlightac.com	The ChargeBar™, accommodates both 120v and 240v charging;	Washington, DC; Residential apartments, fleets
Juice Technologies www.plugsmart.net	Chargers integrate GE's smart meters with Juice Technology's Plug Smart™ engine to help consumers charge their cars during low-demand, lower cost time periods	Partnering with GE; Utilities.
Leviton www.leviton.com	Complete solution for home and public EV charging, provide charging stations & installation	Coulomb Technologies on the ChargePoint network.
Liberty Plugins www.libertyplugins.com	"Synchronous Codes" Level I (110V) or Level II (220V) charging	Municipal and corporate garages
NovaCharge www.novacharge.net	Provides sales, installation, commissioning and support for the ChargePoint System	Partnering with Coulomb & Car Charging Group
Optimization Technologies www.opconnect.com	OpConnect System offers pedestal-mounted or wall-mounted charging stations suitable for commercial, fleet, and public applications.	Rockwell Collins, Honeywell, Sandia Aerospace, Aerosonic
PEP Station LLC www.pepstations.com	PEP Stations (Plug-in Electric Power), the smart and simple charging station for EV's	Businesses, movie theaters, apartments, hospitals
Shorepower Technologies www.shorepower.com	Electrified Parking Spaces (EPS) at truck stops, rest areas, warehouses, shopping malls, businesses & other parking areas	Fleets, Truck stops, Government
Siemens Energy www.energy.siemens.com	EV charging stations solutions for residential, public and commercial applications, including integration into the Smart Grid	Coulomb Technologies' ChargePoint® Network. Also SAP software
SPX Service Solutions www.servicesolutions.spx.com	EV Home charging equipment US EV Market – Finpro/Finnode 2010	GM - will sell and install their chargers to Volt buyers

The EV Project



- **The EV Project** was awarded a \$99.8 million grant from its sponsor, the [U.S. Department of Energy](#) to embark on this project which was officially launched on October 1, 2009 and will last roughly 36 months. On June 16, 2010, the project was granted an additional \$15 million by the U.S. DOE. With the partner match, **the total value of the project is now approximately \$230 million.**
- **ECotality North America** will deploy nearly 15,000 home and commercial charging stations in 16 cities located in six states (Oregon, Washington, California, Arizona, Tennessee and Texas) and the District of Columbia. This will include 8,300 Level II charging stations in homes and 5,500 Level II chargers for public access in cities and corridors cited above. Two hundred fifty Level III quick chargers will be installed in the market areas and in corridors between major cities. Beginning in March 2011, The EV Project will install ECotality's Blink electric vehicle (EV) DC Fast Chargers at 45 BP and ARCO locations in and around the major pilot markets
- **Nissan NA and General Motors/Chevrolet** are partners in The EV Project. Drivers of the Nissan LEAF zero-emissions EV and the Chevrolet Volt plug-in hybrid who qualify to participate in The EV Project, will be provided with a free residential charger, and most if not all of the costs of installation will be paid for by The EV Project.
- The EV Project will collect and analyze data to characterize vehicle use in diverse topographic and climatic conditions, evaluate the effectiveness of charge infrastructure, and conduct trials of various revenue systems for commercial and public charge infrastructure. The ultimate goal of The EV Project is to take the lessons learned from the deployment of these first 8,300 EVs, and the charging infrastructure supporting them, to enable the streamlined deployment of the next 5,000,000 EVs. For more info see: <http://www.theevproject.com> ,



- 8,300 Level 2 (240 Volt AC 6.6 kW) residential and fleet EVSE (chargers)
 - 5,700 Nissan Leafs in market areas included in EV project
 - 2,600 Chevrolet Volts in market areas included in EV project
- 5,500 Level 2 Commercial EVSE in market areas
- 125 additional Level 2 in Oak Ridge National Laboratory Solar Project
- 750 Level 2 Public EVSE in market areas
- 260 DC Fast Chargers (480 Volt AC, 40-60 kW) in market areas
- 50 DC Fast Chargers for corridors between major cities



Charging Infrastructure Locations

In 2010, charging infrastructure will be deployed in the following major population areas: Phoenix (AZ), Tucson (AZ), San Diego (CA), Los Angeles (CA), Portland (OR), Eugene (OR), Salem (OR), Corvallis (OR), Seattle (WA), Nashville (TN), Knoxville (TN) and Chattanooga (TN), Washington D.C., Dallas (TX), Fort Worth (TX), and Houston (TX).

ChargePoint America Program

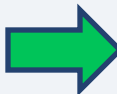

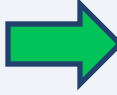




- **ChargePoint America** is a program sponsored by **Coulomb Technologies** to provide electric vehicle charging infrastructure to nine selected regions in the US. The program is made possible by the American Recovery and Reinvestment Act through the Transportation Electrification Initiative administered by the Dept. of Energy. Coulomb announced a \$37 million initiative to install 5,000 free electric-charging stations in the nine metropolitan areas by September 2011.
- Charging stations will be installed in public spaces, businesses and homes in Austin; Detroit; Los Angeles; New York; Orlando; Sacramento; San Jose/San Francisco; Redmond, Wash.; and Washington DC. Two thousand EV owners will get free Level II charging installed at home.
- Coulomb Technologies' **ChargePoint® Network** is an advanced software system that is open to all drivers of plug-in vehicles. Advanced features of the network include: 24/7 driver assistance, the ability to locate a charging station from any smart phone, the ability to detect charging station availability from a smart phone or Google Maps, EV trip mapping and driver billing.
- Coulomb's **ChargePoint America** program is working with **Chevrolet, Ford, and Smart USA**. The automakers have agreed to supply electric vehicles to those nine markets, and others
- The ChargePoint America web site also provides a way for drivers to suggest public locations for charging stations. <http://www.chargepointamerica.com/>

Solution Based on a Mass Market Approach

better place



Customer Need	Solution
Ease of use	 Install personal and public charge spots, making it easy to charge up wherever you are
Unlimited range	 Provide instant-range via battery switch stations to enable longer distance driving without tradeoffs
Affordability	 BP pays for and owns the battery, minimizing the upfront cost and risk of EV ownership for drivers
Driving satisfaction	 Enable a zero-oil, zero-emission driving experience for the mass market
Smart energy use	 Manage charging on the network to align electricity supply with EV charging demand

US Electrification Architecture

Coal Generation

Dominant US fuel source for power generation. Abundant resources but concerns regarding emissions

The US transportation system and the electric power sector are completely separate today. The emergence of grid-enabled vehicles (GEV's) offers the possibility to synergize the two systems for the first time

Workplace

During the day, while GEV's sit idle at the workplace, a network of lithium-ion batteries could function as a source of peak power supply for the electric grid

48%



Natural Gas Generation

Advances in technology have unlocked substantial natural gas resources. Burning CNG emits less CO₂ than coal.

22%



Transmission & Distribution

Electricity from a diverse set of US sources is delivered to consumers via an existing widespread network

20%



Nuclear Generation

Emissions-free source of power. Some uranium imported from Canada and Australia



Residential Home

The primary charging location for most non-commercial grid-enabled vehicles will be at home. By encouraging off-peak charging policymakers can ensure that GEV's take advantage of substantial capacity in the power sector



30 Miles (50 km)

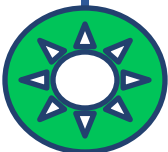
90% of US vehicle trips are < 30 miles



Retail Locations

Access to electric vehicle supply equipment at retail locations could allow drivers to charge while shopping, and provide retailers with a marketing opportunity

9%



Renewable Generation

Renewable sources, solar, wind, & hydro are emissions-free domestic sources of power.



Power Storage

Because wind & solar are intermittent, they require augmentation. Today CNG turbines often provide this, but stationary lithium-ion batteries may prove more cost-effective.



Charging Options

Chargers are classified by the level of power they can provide to the battery pack:



Level 1: Common Household

circuit rated to 120 volts AC and 15 amperes. These chargers use the standard three-prong household connection. **Cost: \$0-\$200**



Level 2: Permanently Wired

electric vehicle supply equipment used especially for electric vehicle charging; rated up to 240 volts AC, up to 60 amps, and up to 14.4 kW. **Cost: \$2000 – \$2500.**



Level 3 or DC: Permanently

Wired EV supply equipment used especially for EV charging; rated greater than 14.4 kW. Fast chargers are rated Level 3, but not all Level 3 chargers are fast chargers. Designation depends on the size of the battery pack to be charged and how much time is required to charge the battery pack. A charger can be considered a fast charger if it can charge an average EV battery pack in 30 minutes or less. **Cost: \$30,000 - \$50,000**

Target overnight charging: less than 8 hours – assumption that Level 2 installation will be required for BEV's, and optional for PHEV

Electric Vehicle owners will typically install an Electric Vehicle Supply Equipment device in their garage, carport, or near their dedicated overnight parking spot. Most homes will use a Level 2 charger operating at 220 volts. These can be mounted on the wall of a garage and plugged into an existing 220 volt outlet or wired directly into a home's electrical panel.

The EVSE may be sub-metered so that electricity used to charge a vehicle may be subject to different rates. A sub-meter could also be integrated into an EVSE or even the vehicle. The cord will run from the EVSE to a J1772 standard plug, allowing any vehicle to charge at any Level I or II charger.

It will generally take two to six hours to recharge a car with a Level 2 station, depending on how far the battery is depleted.

But how much will this cost?

Wiring Upgrades, Permits to Charge - How Much Will it Cost?

Most consumers will charge their EV at home. However, connecting an EV, like the Nissan Leaf to a standard 110-volt wall outlet (Level 1) in the US will take about 16 hours to charge the lithium ion battery. To cut charging time to 8 hours - the overnight charge that carmakers believe owners will tolerate - requires the installation of a special home charging dock (Level 2) that operates on 220 to 240 volts. This will require electrical upgrades, approvals from municipal building inspectors and permit offices in most cities



\$33,720 before \$7,500 tax credit



Home Wiring Inspection = \$\$\$



Electrician to install Home Charging Station = \$\$\$



Home Charging Station \$2,200 before tax credit



Municipal Inspector = \$\$\$

**5 - 30 Days
\$\$\$???**

There are over 3,000 electric utilities in the US. Although many utilities consider EV's to be an important source of new business for the electric power industry, they will need to have a "smarter" electrical grid with two-way communication between the utility and users, so they can better monitor and influence usage.

Some utilities will have to upgrade distribution level transformers to ensure reliable service to homes and other charging locations. Along with investments in smart meters and smart charging software, utilities will need to invest in IT infrastructure to support a range of smart grid applications that includes EV's. They will also need new rate plans to reliably serve the EV market

Some will own their own charging stations, others will not. However most are still waiting to see what the EV market will look like a year or two down the road before deciding on their course of action.



Reliant Energy is NRG's retail electricity business, providing electricity and energy related products to more than 1.6 million customers in Texas.

Reliant Energy is working together with Nissan Motor Co. and the City of Houston to promote broader adoption of EVs. Plans are underway to establish the largest public charging infrastructure in Texas to support EV owners and Houston is positioned to become a leader in EV technology.

Reliant is unique in the U.S. in plans to own and operate many charging stations.

- It will offer monthly plans for "all you can eat" EV charging (\$60- \$80) and is considering an integrated billing plan where charging done at home or away would be combined on a single bill.
- Rate to include leasing and installing a home recharging station, charging at stations around town and emergency charging
- Stations will be at national chains such as coffee shops and electronic stores
- At home charging will take 3-4 hours; charging at public stations, 15 minutes



Charging Infrastructure – Utility Case Southern California Edison



SCE has been providing reliable electric service to central, coastal and southern California for over a century. On an average day SCE provides power to more than 13 million people & 180 cities in 50,000 square miles of service area

SCE is partnering with Ford and other EV manufacturers to bring plug-in EVs to consumers in California. They will attempt to track market adoption through an outreach program that uses its website, bill inserts and its relationship with EV manufacturers to connect with EV buyers. Connecting with EV buyers will allow SCE to communicate its three-step advice: understand charging options, which may require work by a third party at your home; understand your charging rate options from SCE; and have any needed infrastructure installed before you bring a new EV home.

The utility plans to provide an online bill-estimation tool to help calculate the impact an EV might have on your utility bill. SCE offers

- a "standard residential rate,"
- a "whole house 'time-of-use' rate" and:
- an "electric vehicle-only 'time-of-use' rate,"

All with differing per-kilowatt-hour charges. The latter requires a separate meter, provided by the utility, but the work must be done by a third party and paid for by the homeowner. SCE does not get involved in home retrofits to accommodate charging technology, nor will it be involved in public charging stations, at least until the California Public Utilities Commission rules on the question

“Part of our customer education is to clearly communicate the benefits for consumers of charging during off-peak hours”



TVA SMART Station

Smart Model Area Recharge Terminal



The first prototype will feature power generation by solar photovoltaic panels, stationary battery storage and key elements of smart grid technology. The technical design is available to use at no charge by TVA and the Electric Power Research Institute.

http://www.tva.gov/environment/technology/transportation_qa.htm

The “TVA SMART™ Station” project is managed through the Electric Power Research Institute (EPRI).

- Project provides the base design to fully integrate solar generation, stationary battery storage, electric vehicle supply equipment (EVSE) and smart controls to effectively link electric vehicles and the power grid.

- TVA, EPRI and the Oak Ridge National Laboratory (ORNL) will use the design to deploy multiple stations in Tennessee to supplement non-solar electric vehicle charging equipment placement by the EV Project .



Austin Energy is the 9th largest community-owned electric utility in the US with more than 400,000 customers serving a population of more than 900,000 in the City of Austin and surrounding area. The Utility created the Plug-in Partners National Campaign and has been a leader in the promotion of electric vehicles.

Austin Energy is working aggressively to have a pilot program in place by the end of the year where the utility will provide a home charging station and other benefits to EV owners. The municipally owned utility wants to **own and operate the infrastructure** and provide **a subscription-based service to plug-in car owners for about \$60 to \$80 a month**, including power, charging units and roadside assistance for a fixed price.

AE has set up several internal efforts to get the City ready for Plug-In electric vehicles.

- Working to establish a grid of public charging stations throughout the area so that people will be able to top off their batteries conveniently.
- Efforts are being aimed at updating Austin's building codes and adjusting the permitting process so that vehicle owners will be able to work with the city to have a charging station placed in their garage with no more than a two-day turn-around.
- AE is working nationally on the vehicle communication software to help the utility/customer schedule the best time for charging and has several other groups considering the development of business models, marketing and outreach.
- AE and Ford will work together to develop consumer outreach and education programs on EV's and share information on charging needs and requirements to ensure the electrical grid can support the necessary demand. They also plan to work with state and local officials around permitting and regulations to support electric vehicle infrastructure.

Consumers Energy provides natural gas and electricity to nearly 6.5 million of Michigan's 10 million residents.



To meet the needs of its customer who intend to purchase an EV , CE has set up a website featuring six different areas, covering items ranging from PEV basics to details of the Company's "time-of-use" pricing program for charging PEVs.

Consumers Energy's PEV rate program includes a \$2,500 incentive toward the installation of an in-home station for faster charging (Level 2), available for up to 2,500 customers

CE has developed three new residential rates to help customers reduce and manage the cost of charging their EV.

Option 1 - Residential Home and Plug-in Electric Vehicle Time-of-Day Rate (REV-1) – This rate combines charging your electric vehicle with all of your other household electric use (such as lighting, cooking and water heating). This rate provides a low-cost option for off-peak electric use, including charging your vehicle at night (specific timeframes). No additional metering is required.

Option 2 - Residential Plug-in Electric Vehicle Only Time-of-Day Rate (REV-2) – This rate solely will be for charging your electric vehicle. It provides a low-cost option for charging your vehicle at night (specific timeframes). A second meter as well as charging station will be required for this rate. Electric use for your household will continue to be billed under the traditional residential RS or RT rate schedules.

Option 3 - Residential Plug-in Electric Vehicle Only Monthly Rate (REV-3) – This rate solely will be for charging your electric vehicle. It is based on a monthly fee that covers electric use up to 300 kilowatt-hours (kWh). A second meter as well as charging station will be required for this rate. Electric use for your household will continue to be billed under the traditional residential RS or RT rate schedules. The REV-3 Rate is limited to 250 customers.

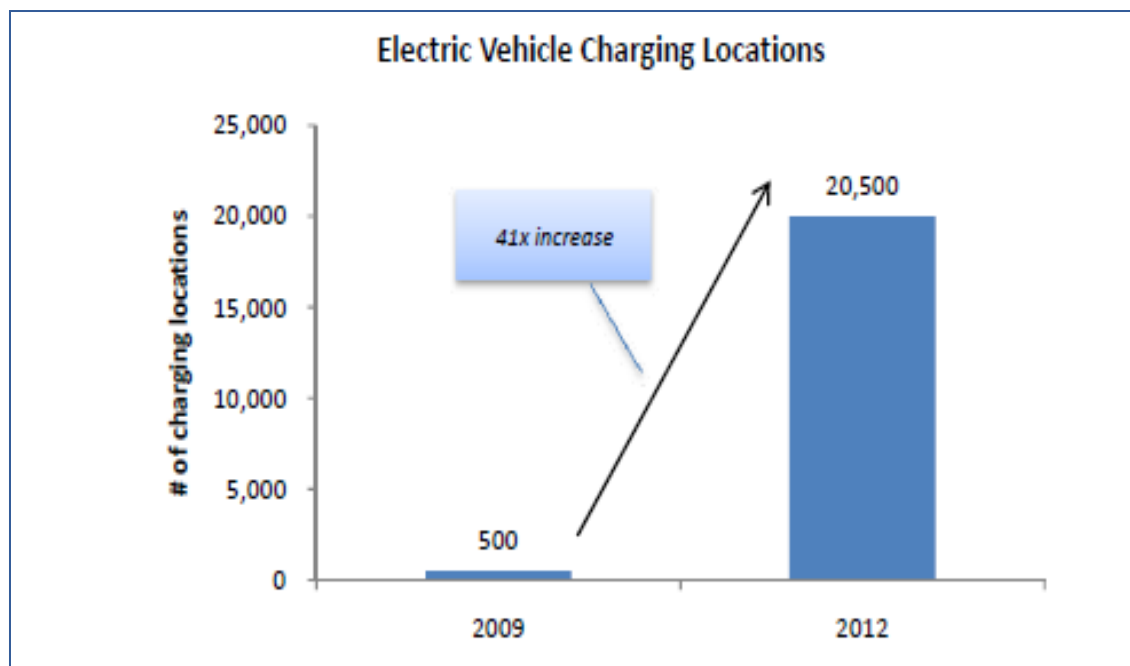
- **Smart vehicle to grid integration is necessary to minimize the impact of plug-in vehicles on the grid and to achieve charging efficiencies**
 - Time of use (load leveling)
 - Renewables (charge when the turbines are spinning)
- **Additional communication protocols/standards are necessary**
 - National, Regional & Global solution
 - DC Charging Connector & Communication Protocol
 - Communication between EVSE & Connector/Car
 - Open Standards for Communication to Utility “Clouds”/Servers
 - Consideration for Roaming Charges
 - Public Charge Point Database
- **Open architecture**
 - Ability to charge anywhere, anytime?
- **Faster charging will be a key enabler of broader adoption (i.e., <15 minutes)**
- **Need for a Streamlined & Universal Permitting Process**
- **Encourage infrastructure developers to develop “reservation” system, “roaming” agreements, and interfaces with utilities**

According to a new report from **Pike Research** entitled, “**Electric Vehicle Information Technology Systems**” significant IT investments will need to be made when EV adoption in a utility's service territory reaches a critical mass. However, that's utility-dependent and there's no universal rule of thumb for when that happens. Planning must begin now, however, so that utilities make the right choices when EV adoption catches up with them.

- ❑ Utilities are likely to outsource and partner to develop systems for optimizing EV charging. But most utilities that are currently evaluating the impact of EV charging on the grid do not view investment in IT as an urgent priority today.
- ❑ Early on, EVs will not see adoption at a level that will challenge utilities' capacity, but as adoption rates increase some utilities eventually will need to make significant IT investments to enable various systems to talk to each other
- ❑ By 2013, utilities will begin investing in EV-related IT systems and services so that the aggregated load of EVs can be managed as an asset and integrated into demand response and other energy management systems
- ❑ The move to invest in IT resources for EV adoption and integration will be slowed by a lack of standards for sharing information between utilities and external systems
- ❑ Strong regulation of utilities in the United States, which require the establishment of ratepayer benefits for cost recovery, may also slow IT spending

EV Charging Locations

Under the Recovery Act's Transportation Electrification program, grantees will deploy 20,000 additional electric charging locations, up from 500 locations in 2009.



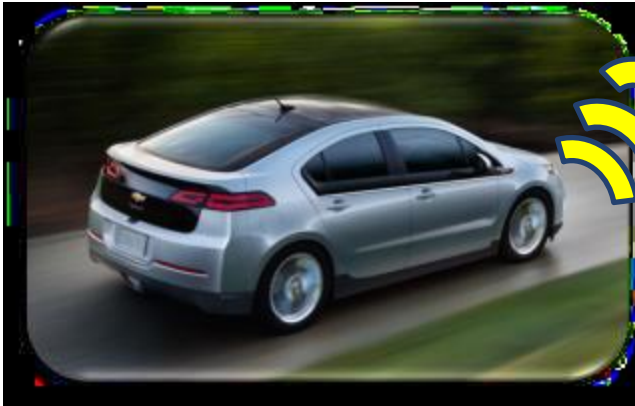
Source: DOE

Utilities will have to upgrade their IT equipment and software to support advanced billing schedules and control chargers in order to maintain reliable operation of the grid once significant volumes of Grid Enabled Vehicles (GEV's) are deployed.

- Level III fast chargers will be needed but are expensive. Drivers will likely be willing to pay extra for them especially when travelling longer distances. The question is, how to develop a business model around Level III charging? New, creative approaches to pay for the charging infrastructure are needed.
- As EV adoption increases, utilities will have to upgrade distribution level transformers to ensure the reliable delivery of power to homes and other charging locations
- IT management systems for monitoring, analyzing, and controlling vehicle charging are needed. A systematic approach to identifying the residential charging locations will be required so that utilities can make the necessary upgrades to maintain reliable service. In order to charge vehicles and bill efficiently, utilities will have to collect data about when and where vehicles are charging. However, this will need to be collected in way that protects and maintains consumers privacy.
- Utilities will need “price signals” software to manage the demand from GEV's. Utilities will need the capability to either bill GEV customers at a rate schedule different than other customers or offer time-of-day pricing. Smart meters may address this, however utilities will still need IT infrastructure to allow for communication with grid-enabled devices to allow customers to access advanced billing rate structures.
- Vehicle to Grid (V2G) applications that allow electrical power stored in vehicle batteries to provide power to the grid during peak demand periods will be needed. Bi-directional chargers and software to control the process in real time
- Secondary applications and the recycling of battery raw materials from GEV's will present opportunities to offset high upfront battery costs.

As the GEV market continues to grow, innovative firms that can develop unique business models and technology to mitigate infrastructure issues will see opportunities.

EV's & Charging Infrastructure require connectivity



- Locate and reserve charging points
- Remote control & diagnostics
- Vehicle & user authentication
- Billing and payment
- Load control and demand response
- Ancillary services

- **Cellular to play key role in EV ecosystem**
 - Mobility
 - Coverage
 - Standards-based
 - Real-time Communications
- **3G presents advantages over 2G, multi-mode / mix & match aggregate benefits from both**
- **Well established standard bodies exist**
 - 3rdGeneration Partnership Project (**3GPP**)
 - GSM, UMTS, LTE
 - 3rdGeneration Partnership Project 2 (**3GPP2**)
 - 1xRTT, EV-DO (Rev. 0 / A / B)
- **Concerns exists, but can be addressed with right architecture and business approaches**

Founded in June 1995; First customer in September 1996

- **Mission: Create an industry-defining business based on vehicle communications services by:**
 - Providing unique safety, security, and peace of mind for drivers and passengers with thoughtful wireless services
 - Leverage powerful technology to create a simple customer experience
- **More than 5.6 million active subscribers**



OnStar advantages:

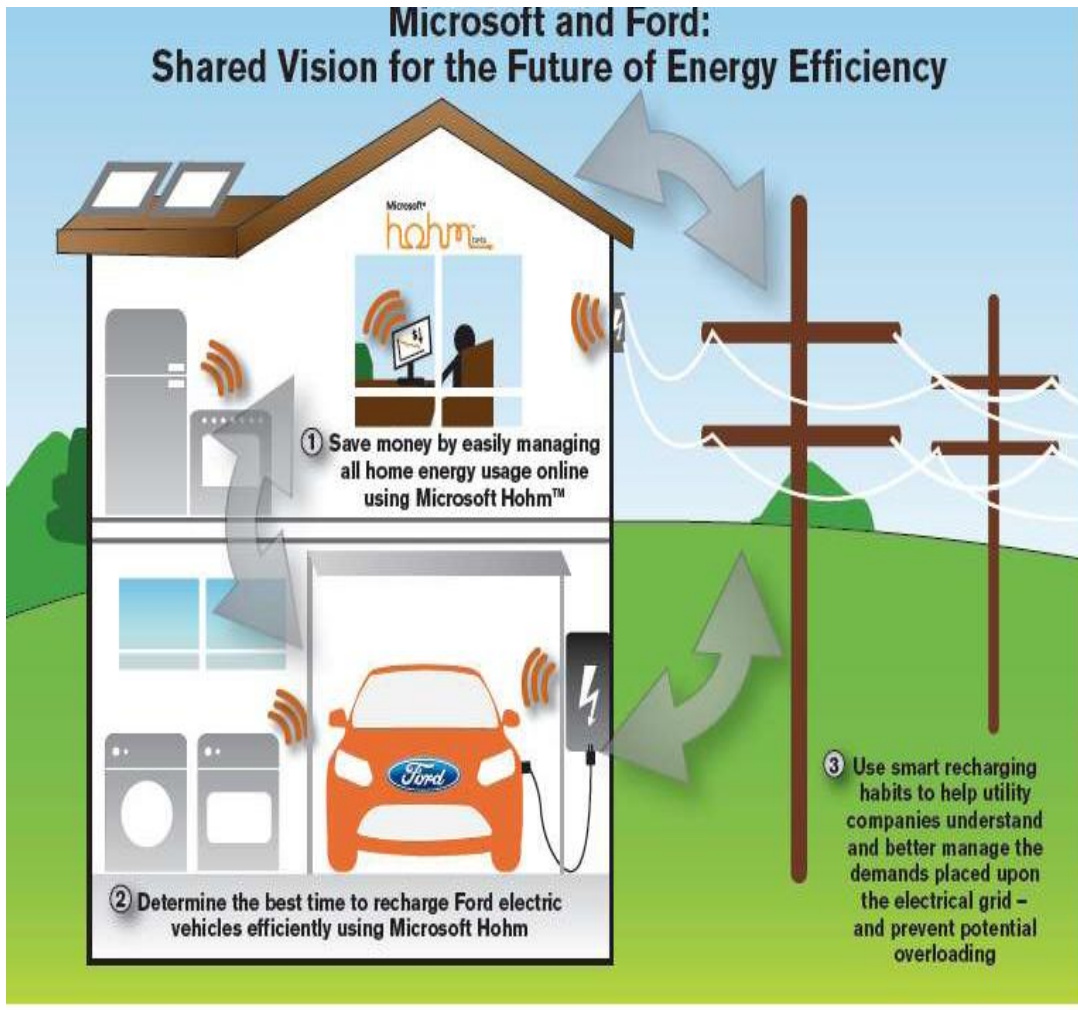
- **Hardware and secure connectivity included in vehicle purchase**
 - No incremental hardware required
- Customer relationship exists via OnStar retail channel
- Capability to support vehicle charging knowledge when vehicle is not home (Roaming)

What opportunity exists?

- **All the technology required exists today in one form or another**
 - Chevrolet Volt and OnStar capability to support utility beneficial services will be available for launch
 - Time of Departure Charging – Simple, clever solution for the customer and utility
- **Interoperability methods and standards for communicating data still need to be defined**
 - Creating new standards should not preclude existing solutions
 - Open standards is the only viable solution for quick adoption of Smart Grid technologies

As telematics has become more mainstream, providers are searching for more ways to bring value. Many are beginning to explore the potential for improving efficiency and safety in EV's through telematics.

- Wireless communications can provide up-to-the-minute data from a wide range of sources alerting drivers of road construction, congestion and speed. OEMs and Tier 1's are developing strategies that let them run apps approved for automotive use, though developers are controlling access to approved software.
- Telematics can help drivers of EV's extend their range by providing information such as elevation data. This is particularly important for pure EV's, where range anxiety will be a key concern. An EV can extend its range by shifting at the bottom of a hill, reducing battery drain, and possibly preventing drivers from being stranded by dead batteries.
- Many in the telematics industry feel that leveraging cell phones is the best approach, since it eliminates the cost of installing modems in the vehicle. However, there are concerns that this approach will not be effective for anything that is tied to safety. If you forget your phone or it's battery dies the safety system won't work.
- Ford Motor Co. is moving forward with its demonstration project involving Escape plug-in hybrids using an intelligent vehicle-to-grid communications and control system. This new technology—which builds on Ford's advancements such as SYNC, SmartGauge with EcoGuide, and Ford Work Solutions—allows the vehicle operator to program when to recharge the vehicle, for how long, and at what utility pricing rate.



Ford plans to integrate **Microsoft Hohm** technology into upcoming electric vehicle models, beginning with the Ford Focus Electric in 2011 and additional models following in 2012 and 2013. The Microsoft Ford collaboration will help consumers drive greener miles at lower cost by helping them recharge smarter based on their schedule and charging rates.

As more EV's become available, the demand placed on the energy grid will be significant. Addressing the challenge of how to manage that demand in a smart and affordable way—from energy utilities down to everyday consumers—is going to be critical.

Electric Buses in California

The **California Energy Commission** approved 11 awards that leverage \$20 M in state funding with \$9.3 M in federal stimulus money and \$39 M in private funds. The projects will demonstrate the possibilities for cutting-edge natural gas-powered, hybrid, and electric trucks and buses to reduce petroleum use, cut pollution and provide jobs.

- **San Bernardino Associated Governments (SANBAG)**, a council of 24 city governments which serves as the area's transportation planning agency is partnering with **Ryder Truck Transport Services** to purchase and deploy up to 262 heavy-duty natural gas trucks and to construct two liquefied natural gas (LNG) refueling stations
- The Energy Commission will provide \$2,1M in funds from its Alternative and Renewable Fuel and Vehicle Transportation program to develop a hybrid, heavy-duty commercial vehicle that operates on both electricity and natural gas. **Daimler Trucks**, the largest commercial heavy-duty truck manufacturer in North America, will install the hybrid drive system on a Freightliner M2 heavy-duty commercial frame.
- The Energy Commission will provide \$750,000, and **Coca Cola Enterprises** and other participants will supply \$1,250,000 in matching funds, for a project to demonstrate four heavy-duty hydraulic-hybrid delivery vehicles. The hydraulic-hybrid system stores braking energy in urban driving, and could potentially match the fuel-saving benefits of an electric-hybrid vehicle.
- For heavy-duty class 8 trucks, the **Kenworth Truck Company** will demonstrate a hybrid electric drive system that uses a natural-gas powered micro-turbine. **FedEx** will use the natural-gas powered hybrid in their on-going operations starting in 2012.
- The **Gas Technology Institute (GTI)** and **Cummins Westport** will demonstrate a unique, low-emission, high efficiency natural-gas engine designed for regional hauling and heavy vocational truck applications. **Swift Transportation** will demonstrate one engine in a class 8 highway tractor for 12 months

- **ISE Corporation** will receive \$888,595 in Energy Commission funding to produce a battery-electric 45-foot transit bus for the Los Angeles Metropolitan Transportation Authority (LAMTA). ISE will replace the engine and fuel tank with an electric drive system and lithium ion batteries.
- In another public transit project, the Energy Commission will provide \$1,345,552 for **Motiv Power System** to incorporate its electric-drive system in a class 4 shuttle bus, giving it a 100-mile all-electric range. Motiv's system uses battery packs designed by Berkeley-based Seo Inc. for medium- and heavy-duty vehicle fleets.
- **Terex** will demonstrate its innovative HyPower™ Hybrid system in 12 medium and heavy-duty PG&E utility service vehicles.
- **Electric Vehicles International, LLC** will create a medium-duty electric vehicle that uses an LNG-powered motor and generator to extend its range. The powertrain will be integrated into 10 medium-duty pickup trucks owned by PG&E.
- In the central San Joaquin Valley, **the City of Lemoore and the Lemoore School District** will partner to develop a compressed natural gas (CNG) fueling station that will be open to the public 24 hours a day and serve both the City and School District's vehicles.
- The Energy Commission will provide \$500,000 to the **Sacramento Regional Transit District** to install three CNG dispensers at its bus maintenance facility.

Zero Emission Vehicle (ZEV) Requirements in California(+ 11 other states)

Years	2012 –2014	2015 –2017
Required Vehicles	25,000	50,000
Allowable Option	7,500 FCVs or 12,000 BEVs, plus about 60,000 PHEVs	At least 25,000 pure ZEVs and ~80,000 PHEVs

Partnerships, Alliances,
Contacts & Research

Key Partnerships & Alliances

- **Ford and Microsoft** are teaming up to introduce Microsoft Hohm™, a free online application, to help future owners of Ford's electric vehicles better manage their home's energy use and vehicle recharging. They also will work with utilities and municipalities to help develop an energy ecosystem that manages energy usage as consumer demand for electric vehicles grows
- **BetterPlace and Renault-Nissan** have announced that it will produce its first electric car with switchable batteries in 2010 and will have a lineup of electric cars by 2012.
- In April 2010, **Project Get Ready**, a non-profit initiative led by **Rocky Mountain Institute** to help communities prepare for electric vehicles, named **GE** a technical advisor focusing on design and planning of the local and regional electric grids for electric vehicles.
- **GE Global Research and Nissan** signed a three-year MOU in May 2010, to explore new technologies that are needed to build a reliable, dynamic smart-charging infrastructure.
- **LG Chem (Korea) and Compact Power** (Michigan) are building a \$300 M, 650,000-sqft plant in Michigan that will be able to produce enough cells for up to 200,000 electric vehicle batteries and will create 300 jobs by 2013. The plant will make battery cells for electric vehicles -- including the **Chevrolet Volt**. Half of the funding came from the \$2.4 billion federal grant program announced in August to boost battery and EV research and production.
- **Tesla and Toyota** have agreed to develop an electric version of the RAV4 SUV. The companies are aiming to market the RAV4 electric version in the U.S. in 2012, combining a Toyota RAV4 body and a Tesla electric powertrain. Toyota invested \$50 million in Tesla for the initiative.
- **A123 Systems** received \$249 million in federal funding to build batteries for **Chrysler, Navistar, and Fisker Automotive** at its facility in Ann Arbor, Michigan
- **Kokam America** will partner with **Smith Electric Vehicles US** to supply large format prismatic lithium ion polymer batteries for Smith's plug-in battery-electric powered truck
- **Coulumb Technologies and Leviton** - Through the agreement, Leviton's Electric Vehicle Supply Equipment (EVSE) product family, including home and public charging stations, will be network-enabled by the ChargePoint® Network through an open interface architecture that provides Leviton customers advanced features similar to all charging stations on the ChargePoint network.
- **GM and Bright Automotive (Indiana)**-the Bright IDEA, the van can travel up to 40 miles on electric power from a fully charged battery pack. For longer distances, the van switches to a gasoline/electric hybrid mode in which it can get up to 36 mpg. Under the terms of the agreement, GM will take a minority stake in Bright. At the same time, Bright will gain access to GM technologies, including advanced engine and transmission systems.

- **Enerdel** which owns a 31% stake in **Think** will provide lithium-ion batteries for Think's EV at their plant in Elkhart, Indiana.
- **Eaton Corporation** announced its collaboration with the **Electric Power Research Institute (EPRI)** and the **Tennessee Valley Authority (TVA)** for a prototype integrated solar-assisted electric vehicle charging station to be erected at EPRI's research laboratory in Knoxville, Tenn
- **General Motors and ABB Group** will work together to develop pilot projects for re-using the batteries from the Chevrolet Volt. The two companies are collaborating to determine how the Volt's 16-kWh lithium-ion batteries can be used to provide stationary electric grid storage systems once the batteries have fulfilled their usefulness in customers' vehicles.
- **GE and Better Place**, announced a technology and financing partnership to accelerate the global deployment of electric vehicle infrastructure through collaboration in four key areas: standards-based technology development, battery financing, joint fleet electrification programs and consumer awareness.
- **Ford Motor Company** and the New York Power Authority (NYPA) today announced they are coordinating efforts to help prepare the state of New York for the operation of electric vehicles. Ford and NYPA will work together to develop consumer outreach and education programs on electric vehicles as well as share information on charging needs and requirements to ensure the electrical grid can support the necessary demand.
- **Microsoft and Nissan** announced that the 2011 Nissan LEAF touchscreen information hub is powered by Windows Embedded Automotive technology, providing drivers and passengers with a navigation system and electricity charging station locator. It also shares power consumption monitoring information with drivers, and enables easy in-car climate monitoring.
- **Siemens and Coulumb Technologies** – Siemens' EV charging stations will offer Coulumb Technologies' ChargePoint® Network. that will provide Siemens charging station owners remote management, flexible billing, fleet management, maintenance and other on-demand software applications. Each unit is equipped with an ANSI C12 communications compliant meter. By incorporating connectivity options, metering capabilities and an open architecture, Siemens' EV charging stations can be integrated into the rapidly evolving Smart Grid.

- Lizabeth Ardisana, Director Sales& Marketing, **Think North America**
- Micky Bly, Executive Director of Electrical Systems, Hybrids, Electric Vehicles and Batteries, **General Motors**
- Scott Becker, Vice President of Administration, **Nissan**
- Dan Bowermaster, Manager Clean Air Transportation, **Pacific Gas & Electric**
- Kenneth Brown, Director Engineering Power Solutions, **Leviton**
- Mike Brylawski, EVP Corporate Strategy, **Bright Automotive**
- Paul A. Camuti, President of Smart Grid Applications, **Siemens Energy, Inc**
- Chris Chen, EV Market Development Manager , **San Diego Gas & Electric**
- Sunil M. Chhaya Senior Manager, PHEV Development Programs, **Electric Power Research Institute (EPRI)**
- Ignacio Contreras, Manager, Corporate New Business Development **Qualcomm**
- Kevin Dallas, General Manager Windows Embedded Business Unit , **Microsoft**
- Dan Davids, President , **Plug In America**
- Patrick Davis, Program Manager, Vehicle Technologies Program, **US DOE**
- Robbie Diamond, CEO, **Electrification Coalition**
- Ron Durst, EV Program Manager, **Portland General Electric**
- Mark Duvall, Director, Electric Transportation and Energy Storage, **Electric Power Research Institute (EPRI)**
- James Ellis, Sr. Manager Transportation Infrastructure. **Tennessee Valley Authority**
- Joel Ewanick, VP US Marketing, **Chevrolet Motors**
- Jason Forcier, Vice President Automotive Solutions Group, **A123 Systems, Inc.**
- Nancy Goia, Director, Global Electrification , **Ford Motor Co.**
- Greg Haddow, Clean Transportation Manager, **San Diego Gas & Electric**
- Kristen Helsel, VP EV Solutions, **AeroVironment**
- Ed Kjaer, Director of Electric Transportation, **Southern California Edison**
- Gery J. Kissel, Global Battery Systems Engineering, **General Motors and SAE J1772 task Force Leader**
- Doug Kim, Director of EV Readiness, **Southern California Edison**
- Jeff LeBrun, Principal Analyst for Electric Transportation and Infrastructure, **DTE Energy**

- Austan Librach, Director, Emerging Transportation Technologies, **Austin Energy**
- Sherif Marakby, Director of Electrification Programs and Engineering, **Ford Motor Co.**
- Roland Matthe, Manager of VOLTec Battery Development, **General Motors Corporation**
- Hugh McDermott, VP Global Alliances, **Better Place**
- Kevin Morrow, Executive Vice President, **ECotality**
- Mary Nickerson, National Manager, Advance Technology Vehicles, **Toyota**
- Efrain Ornelas, Senior Program Manager, Electric Drive Technologies, **Pacific Gas and Electric**
- David Packard, President, **ClipperCreek**
- Paul Peebles, Service Line Manager, **OnStar**
- Mark Perry, Director of Product Planning and Strategy, **Nissan North America**
- Chris Pick, Manager of Vehicle Electrification and Infrastructure, **Ford Motor Co.**
- Joel Pointen, Manager of Electric Transportation, **San Diego Gas & Electric**
- Steve Powell, Manager Electric Vehicle Readiness, **Southern California Edison**
- J. Christopher Preuss, President, **OnStar LLC**
- Bill Reinert, National Manager, **Toyota Advanced Technology Group**
- Lee Slezak, Manager, Advanced Vehicle Systems Simulation & Evaluation **US DOE**
- Dan Sperling, Director, Institute of Transportation Studies, **Uni. Cal, Davis**
- Rich Steinberg, EV Operations & Strategy, Mini-Eprogram, **BMW**
- Karl Stracke, Vice President, Global Vehicle Engineering, **General Motors Corporation**
- Dean Taylor, Senior Program Manager, Electric Transportation Division, **Southern California Edison**
- Tom Turrentine, Director, Plug In Hybrid Research Center, **University of California, Davis**
- John Vogt, Global OEM Accounts, **ECotality**
- Scott Williams Vice President of Business Development, **Coulomb Technologies**
- Jim Winkleman, VP Engineering, **Efficient Drivetrains, Inc.**
- Jason Wolf, Vice President of North America, **Better Place**
- Brian Wynne, President, **Electric Drive Transportation Association**

University of California Davis Plug-in Hybrid & Electric Vehicle (PHEV) Research Center at The Institute of Transportation Studies

The Center coordinates with existing research organizations including:

- South Coast Air Quality Management District
- Electric Power Research Institute
- Southern California Edison, PG&E, and other California utilities
- United States Department of Energy

The PHEV Center will conduct or administer funding for research in five distinct areas:

- Modeling alternative PHEV designs and battery performance testing
- Impacts of PHEVs on the electrical grid
- Consumers and PHEVs
- Environmental impacts of PHEVs
- Lifecycle costs of PHEVs

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EPRI is an independent, non-profit company performing research, development and demonstration in the electricity sector for the benefit of the public

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[http://www.swri.org/4org/d03/vehsys/
advveh/avt/hybrid.htm](http://www.swri.org/4org/d03/vehsys/advveh/avt/hybrid.htm)

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USDOE National Labs and Institutes

[http://www.afdc.energy.gov/afdc/vehicles/
electric_research.html](http://www.afdc.energy.gov/afdc/vehicles/electric_research.html)

CalCars

Palo Alto, CA

www.calcars.org

Electric Auto Association (EAA)

San Jose, CA + various state chapters

www.eaaev.org

Ron Freund, Chairman

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Electric Drive Transportation Association

Washington, DC

www.electricdrive.org

Brian P. Wynne, President

Electric Vehicle Association of Washington, DC

Washington, DC

www.evadc.org

International Lithium Alliance

Potomac, Maryland

www.lithiumalliance.org

Plug In America

San Francisco, CA

www.pluginamerica.org

Marc Geller, Director

Plug In Hybrid Development Consortium

www.hybridconsortium.org

Seattle Electric Vehicle Association

Seattle, WA

www.seattleeva.org

Finpro/Tekes is developing potential EV program ideas to be carried out in 2011. These include:






Roadshow (s) to US for Finnish EV industry Players

- 1) Roadshow would involve Finnish companies that have Smart grid applications or those that can provide technology and /or software related to the charging infrastructure. Visits could include US utilities, companies that manufacture charging equipment and cities and municipalities deploying charging infrastructure. These would be key players and cities where the EV market is being launched and could include California, Washington, Oregon, Texas or Wash DC.
 - **Goal:** market understanding, knowledge transfer and exploring possible business development opportunities in both the US and Finland.
 - **Schedule:** Kick-off workshop in Helsinki in late spring; roadshow to US in early fall 2011

- 2) Roadshow would involve Finnish companies active in the EV component and/or telematics market. This roadshow would visit with US EV OEM's, electric truck and bus manufacturers, Tier 1 and Tier 2 suppliers and other industry players. This would likely include visits to Michigan, California and Colorado.
 - **Goal:** meet with players to learn needs, buying criteria, value chain, and other components of the EV OEM market in the US.
 - **Schedule:** Kick-off workshop in Helsinki in late spring; roadshow to US in early fall 2011

Both could also include visits to EV research institutes and key EV industry trade shows. Additional project ideas will continue to be explored.

Appendix 1: EV's & PHEV's to Launch in US

<p><u>BMW</u> MINI E EV</p>	<p>Conversion of MINI 2-door hardtop to 2-seat EV with drivetrain & battery from AC Propulsion, range 100 mi, top speed 95 mph, 35 kWh Li-ion battery pack uses 5000+ laptop style batteries, 150kW electric motor, 220Nm torque, 2.5 hr recharge on fast charge (240V 50A), 26.5 hr on 120V 12A, wt 3230 lbs</p>	<p>Target Intro: no plan announced for mass production Progress: Now Testing in US, EU, and Asia. Probable US launch in 2012</p> <p><i>source: BMW</i></p>	
<p><u>BYD Auto</u> e6 EV</p>	<p>4 door crossover, 5 passenger, range 330 km (205 mi), 0-60mph 8 sec, top speed 100 mph, BYD Li-ion Fe battery, 10 min recharge to 50% SOC, 4 power combinations using front & rear motors on some models: 75kW, 75+40kW, 160kW, 160+40kW</p>	<p>Target Intro: China & US 2010, Europe 2010 Progress: demo units now</p> <p><i>source: BYD</i></p>	
<p><u>Coda</u> <u>Automotive</u> CODA Sedan EV</p>	<p>Formerly the Miles Electric Vehicles XS500, 4-door, 5 seater, mid-size sedan, range 90-120 mi, top speed 85 mph, 333V Li-ion battery, onboard charger 120V/240V, recharge < 6 hr at 240V. Coda is a new company formed to develop & market a re-engineered sedan from the Hafei Saibao, to be built in China by Hafei, Coda in JV with Lishen Battery, price \$45,000</p>	<p>Target Intro: California test fleet mid-2010, public delivery fall 2010 Progress: now accepting reservations</p> <p><i>source: Coda Automotive</i></p>	
<p><u>Commuter</u> <u>Cars</u> Tango T600 EV</p>	<p>Unique 2 passenger car, inline seating, range 40-200 mi depending on battery choice, 0-60 in 4+ sec, retail price \$108,000 for kit with some assembly required by customer, located in Spokane, WA</p>	<p>Now Available in US </p> <p><i>source: Commuter Cars</i></p>	

<p><u>Daimler</u> Smart ED EV</p>	<p>Conversion of Smart Fortwo to all-electric., range 72 mi (sodium/nickel chloride battery) & 90+ mi (Li-ion battery), 0-37 mph 5.7 sec, top speed 70 mph, 30 kW / 41 hp, now upgrading w Li-ion batteries from Tesla Motors. Product manager Pitt Moos says Daimler will "start to produce 5-digit-volumes as of 2012"</p>	<p>Target Intro: 2012 Progress: testing 100 cars in London, will test up to 1000 in Italy & Germany late 2009, USA 2nd half 2010. Nov 2009 announced start of 1000 unit build in Hambach, France <i>source: Daimler</i></p>	
<p><u>Fisker</u> Karma PHEV</p>	<p>50 mi AER, 0-60 mph < 6 sec, 150 mph top speed, luxury 4-door, base price \$87,900, electric drivetrain by Quantum Technologies, battery deals with EnerDel & Advanced Lithium Power, GM supplying 260-hp, 2.0L turbocharged Ecotec engine, Manufacturing by Valment Automotive of Finland. Karma Sunset hardtop convertible due 2011, company located in Irvine, CA</p>	<p>Target Intro: Late 2010 Progress: prototypes in test now, 1400 pre orders & 26 dealerships signed up. Sales forecasts 7,500 in 2010 & 15,000 in 2011. <i>source: Fisker, Washington Times & Autocar</i></p>	
<p><u>Ford</u> Escape PHEV</p>	<p>Based on 5-seater Escape SUV, AER 40 mi, top speed 102 mph, Li-ion 10kWh battery pack, 6-8 hr recharge time on standard 120V/15A outlet, 120 mpg over first 30-40 mi range in mixed city/hwy driving, 3,900 lbs</p>	<p>Target Intro: US 2012  Progress: Fleet testing now <i>source: Ford</i></p>	
<p><u>Ford</u> Focus EV</p>	<p>Based on next generation Focus, converted by Magna International, range 100 mi, Ford converting SUV factory to build Focus models, including Electric Focus. In Jan 09, Ford announced "Ford will start out by producing 10,000 cars"</p>	<p>Target Intro: US 2011  Progress: prototype <i>source: Ford</i></p>	

General Motors
Chevrolet Volt PHEV

4-door hatchback, 4-seater, front wheel drive, AER 40 mi, total range 340 mi, top speed 100 mph, 16kWh Li-ion battery from LG Chem, 149 hp electric motor, 1.4L gas engine generates electricity only (no mechanical connection to wheels), first year production 7-10k units, cost \$41,000

Target Intro: US Nov 2010 
Progress: First pre-production car on the road June 2009

source: GM & [GM-Volt](#)



Mitsubishi
iMiEV EV

4-door hatchback model, range 100 mi, top speed 81 mph, 330V 16 kWh Li-ion battery from Yuasa & Mitsubishi JV, offboard 200V 50 kW charger 30 minutes 80% SOC, onboard charger 120V/240V 15A for 7-14 hr recharge, 47 kW motor, weight 1,100 kg, LED headlamps, MSRP approx \$47.5K, target 1,400 cars in Japan in fiscal 2009 and 5000 cars for US & EU (sales via Peugeot Citroen PSA) in 2010

Target Intro: Private sales in Japan Apr 2010, US & EU 2010
Progress: Lease program announced June 2009, fleet testing in Japan & US now

source: [Mitsubishi](#)



NICE & Fiat
Micro-Vett e500 EV

Joint effort between Fiat and NICE, 4 seater, range 75 mi, top speed 60 mph, Li-ion polymer batteries

Target Intro: UK then Europe
Progress: US debut in 2012

source: [Autoblog Green](#) & [TheGreenCarWebsite](#) & [Inside Line](#)



Nissan
LEAF EV

5-seater, 4-door hatchback, low drag coefficient, range 100 mi, top speed > 90 mph, 80kW electric motor, proprietary Nissan/NEC Li-ion battery, recharge < 8 hr on 100V, fast charge to 80% SOC in 30 min, \$32,780 including charging station. Planning for mass production for US & Japan in 2010, with initial sales in 5 states deploying charging infrastructure.


Target Intro: US & Asia in fleets & limited areas fall of 2010, globally 2012
Progress: publicly unveiled prototype Aug 2, 2009.

source: Nissan



SABA Carbon Zero EV

2 door, 2 seater, convertible roadster, 0-60 in 5 sec, 120-140 mi per charge, price not officially announced, will be "affordable"

Target Intro: Q2 2010 
Progress: prototype at SEMA 2009

source: SABA



Tesla Motors Roadster EV

High performance 2-seater sports car, range 220 mi, 0-60 mph 3.9 sec, top speed 125 mph, liquid cooled 56 kWh Li-ion battery module using 6831 laptop cells, recharge @ 3.5 hr using high power charger, can also recharge at 120V & 240V lower current, 375V AC induction air-cooled electric motor, 248 peak hp, 276 ft/lbs of torque, restyled Lotus Elise, body built in UK, drivetrain integration in US. Base price \$109,000 +

Target Intro: Available now in US, Canada & EU 

Progress: Opened stores in London, Munich, Monaco + 7 US cities in 2009


CVRP Eligible

source: Tesla Motors



Tesla Motors Model S EV

New ground-up 4-door, 7-seat design, range 150 mi, 230 mi & 300 mi (based on battery option), 0-60 in 5.5 sec, top speed 130 mph, recharge @ home in 4 hr, fast charge ability in 45 min, drag coefficient of 0.25, base price of 150 mi model \$57,400 & weighs 4,000 lbs.

Target Intro: USA & EU 2011 from new unbuilt factory.  To begin in 2011 with 2,000 cars; 12K in 2012 and full capacity 20K cars/year by 2013

Progress: taking pre-orders, demo car, approved for \$365M D.O.E. loan

source: Tesla Motors



Th!nk City EV

City car, 2+2 seating, range 180km (based on MES DEA Zebra battery), top speed 100km/hr, other battery options to include Li-ion from A123 & EnerDel, ABS brakes, airbags, ABS recycled plastic body, steel & extruded aluminum frames; to build factory in US for 2010 volume of 2500 cars, raised \$47M to resume production. Partnering with Aerovironment to develop fast charging for Th!nk vehicles

Target Intro: USA 2010, now shipping in Norway, selling now in Europe to Th!nk rated "EV friendly cities"

source: Th!nk & Venture Beat



**Toyota
Prius
Plug-in
PHEV**

Based on 2010 model (3rd generation Prius), AER 20-30km (12.4-18.6 mi), using Li-ion batteries, charge on standard home outlet. Toyota hopes to sell at a price comparable to Mitsubishi's i-MiEV (around US\$47,500) and start mass producing in 2012, with first-year output 20,000 to 30,000 cars


Target Intro: end 2009 thru 2010 to release 500 test fleet cars in Japan, EU & USA, Mass production 2012
Progress: currently testing in several public areas

source: [Reuters](#), [Autoblog Green](#)



**Aptera
Motors
Aptera 2e
3 wheel
EV**

Composite body, aircraft-like shape, gull-wing doors, 2 side-by-side seats + center infant seat, 100+ mi range, top speed 90 mph, 0-60mph < 10 sec, Li-ion phosphate battery, 8 hr recharge on standard 120V, 3 drive modes (*max range, balanced, max performance*), ultra low drag coefficient (Cd) 0.15, 1500 lb curb weight, \$20,000-\$40,000 for 2e & 2h models, based on options.

Target Intro: California 2011 
Progress: now in demonstration, design finalization & testing

source: [Aptera](#)



**Myers
Motors
NmG
3 wheel
EV**

Three wheel enclosed vehicle, range 30 mi, top speed 76 mph, 600 lb battery pack of 13 sealed AGM lead acid batteries, 6-8 hr recharge at 120V/20A, 30-45 min fast charge on optional 240V external charger, 6 cu ft trunk, safety certified to US DOT standards for motorcycles & 3-wheel vehicles, 14 exterior color choices, \$29,995 before tax, based in Akron, Ohio


Target Intro: Available now 

source: [Myers Motors](#)



**Myers
Motors
Duo
3 wheel
EV**

Three wheel enclosed vehicle, two-seater, range 60-100 mi depending on battery package, top speed 76 mph, Li-Ion batteries, \$29,995 for base model, as low as \$22,495.50 with federal and manufacturer rebates


Target Intro: 2010 
Progress: Now accepting pre orders for 2011 shipment

source: [Myers Motors](#)



Brammo
Enertia
2 wheel
EV

Street bike, range 42 mi, 0-30 mph 3.8 sec, top speed est. 60 mph, 3.1kWh Valence Li-ion phosphate battery pack, onboard charger recharges in about 4 hr, 13kW, 4Nm electric motor, curb weight 324 lbs, \$7,995 list (+\$500 delivery outside of CA,WA,OR), based in Ashland, OR. Best Buy reportedly has a \$10M minority stake in Brammo.

Available now: 
Progress: Selling from four Best Buy stores in Portland and California for CA, WA, and OR buyers, others reserve via Brammo website

source: [Brammo](#),



Electric Motorsport
Electric GPR-S
2 wheel
EV

Street bike style, range 35-60 mi (based on power mode), top speed 60-70 mph, 3.3kWh Li-ion battery, 1.5-4hr recharge (2 modes), 19hp electric motor, \$8500, company based in Oakland, California is EV parts retailer. Electric Motorsport won the Isle of Man 2009 TTXGP electric-only motorcycle Open class event with a modified GPR-S


Available now: 

source: [Electric Motorsports](#)



Mission Motors
Mission One
2 wheel
EV

High performance street bike, 150 mi range (EPA cycle), top speed 150 mph, onboard charger, full charge 8 hrs 120V, 2 hrs 240V. wireless, data acquisition. Series of first 50 motorcycles \$69,000 each, based in San Francisco, California


Target Intro: US 2010, first edition 50 units 
Progress: demo unit

source: [Mission Motors](#)



Zero Motorcycles
Zero S
2 wheel
EV

Street bike, range 60 mi, top speed 60 mph, 4 kWh Li-ion battery pack is recyclable & rated safe for land-fill disposal in the US, Canada and Europe, recharge 4 hr from 120V or 240V, brushed permanent magnet motor, 31 peak hp, 62.5 ft-lbs torque, clutchless one speed, user selectable driving speed & acceleration modes, total weight 225 lbs, \$9,950, based in San Francisco, CA

Available now: 
US, Canada, EU & others ([see website](#))
 now selling

CVRP Eligible

source: [Zero Motorcycles](#)



Balgon Nautilus E20 / E30 EV

All-electric shipping cargo port drayage tractors, 60,000 lb payload, 30-60 mi range (full load vs empty), top speed 25mph (E20) / 40mph (E30), 336V flooded, deep cycle lead acid batteries, 140kWh (E20) / 160kWh (E30), 100 hp 230V AC motor, proprietary 240kW liquid cooled controller, recharge fast charge 60% SOC 1 hr (E30), 80% SOC 3.5 hr (E20) using Aerovironment Posicharge, funded development with AQMD & Port of LA grant, now testing with Li-ion batteries

Available now: 

Progress: 25 trucks being delivered to the Port of Los Angeles

source: Balgon



Boulder Electric Vehicles Truck & WUV EV

Cargo Van (Work Utility Vehicle) & Truck models built on common frame, range 200 mi for van, 120 mi for truck, top speed 65 mph, 80 kWh Li-ion Iron Phosphate battery, aluminum composite frame, composite body, payload: van 4500 lbs, truck 6000 lbs, GVWR: van 8490 lbs, truck 11,000 lbs, cost "around \$100,000," startup based in Boulder, CO

Target Intro: Q2 2010 

Progress: one prototype being road tested, 2nd vehicle being built for X-Prize

source: Boulder EV



Bright Automotive Idea PHEV

Light-duty commercial & gov't fleet van, AER 30 mi before switching to est. 40 mpg hybrid mode (100 mpg @ 50 mi/day), 10kWh pack, all-wheel drive, 180 cf cargo space, weight 3200 lbs, 2000 lb payload, 70/30 split rear door, utilizes aluminum & composite materials, deso with fleet customer input included throughout development, target production of 50,000/year,

Target Intro: US fleets 

Progress: concept vehicle & mule testing

source: Bright Automotive



EVI MD EVI EV

Class 4, 5, 6 (GVWR 15,000-25,950 lbs) trucks built on Freightliner chassis, top speed 60 mph, range 60, 80, 115 mi options, Valence Li-ion battery pack, electric motor 100 kW (max. 146 hp), torque 450 lb-ft, prices \$120,000 to \$180,000, to be built at new headquarters in Stockton, California

Target Intro: early 2010 

Progress: Truck unveiled at Nov 2009 press conference in Stockton

CVRP Eligible

source: EVI



Electrorides ZeroTruck EV

Class 4 truck, range up to 100 mi, top speed 60mph, Li-ion polymer battery, UQM 100 kW (124 hp) motor, peak torque 650 Nm (400 lb-ft), peak power 150 kW, continuous torque 400 Nm (295 lb-ft), continuous power 100 kW (134 horsepower), developed using an Isuzu chassis & 2 speed EDIS automatic transmission, range of body choices from utility to dry freight, \$130,000 including battery pack, body optional.

Available now:



Progress: first sale June 10, 2009 to City of Santa Monica

source: [Electrorides](#) & [Autoblog Green](#)



Ford Transit Connect EV

Also known as the Smith Electric Vehicles Ampere, designed on popular Ford van from Europe, introduced to EU in 2002, selling in gasoline version in USA in mid 2009. EV version range 100 mi, top speed 70 mph. Ford has officially broken their partnership with Smith EVs and is now partnering with Azure Dynamics to build the Transit Connect.

Target Intro: 2010



Progress: announced at 2009 Chicago Auto Show

source: [Ford](#) & [All Cars Electric](#)



Smith Electric Vehicles Newton EV

Large delivery truck already marketed in UK, range up to 100 mi, top speed 50 mph, Li-ion Iron Phosphate battery, onboard charger allows 6-8 hr recharge, Enova P120 120kW induction motor, payload up to 16,280 lbs, GVW: 16,535 lbs, 23,148 lbs or 26,455, lbs, to be assembled near Kansas City Intl Airport, CEO quotes 80% per mile cost savings, but purchase cost of about 3x cost in comparison to similar gas/diesel trucks

Available now: US & UK




CVRP Eligible

source: [SEV USA](#) & [Fox News](#)



Electrorides ZeroTruck EV

Class 4 truck, range up to 100 mi, top speed 60mph, Li-ion polymer battery, UQM 100 kW (124 hp) motor, peak torque 650 Nm (400 lb-ft), peak power 150 kW, continuous torque 400 Nm (295 lb-ft), continuous power 100 kW (134 horsepower), developed using an Isuzu chassis & 2 speed EDIS automatic transmission, range of body choices from utility to dry freight, \$130,000 including battery pack, body optional.


Available now: 
Progress:
first sale June 10, 2009 to
City of Santa Monica

source: [Electrorides & Autoblog Green](#)



IC Bus CE 10AHJ School Bus PHEV


IC offers PHEV "Charge Depleting" & hybrid "Charge Sustaining" versions of CE series bus, charge depleting range 40 mi, Li-ion, liquid cooled battery pack, 80kW Enova Systems motor, post-transmission parallel hybrid (motor between transmission & rear differential), from max to 25% battery SOC gets up to 70% fuel economy improvement, during recharge mode gets 20-50% boost, adds about 2000 lbs and \$100k to bus price

Available now: 
source: IC Bus



Proterra EcoRide BE35 EV

Golden, Colorado based, full size city bus, UQM 150 electric drivetrain, AltairNano batteries, claimed to capture 90% of kinetic energy on braking

Available now: 
source: Proterra



Appendix 2: Key EV Market Suppliers and Manufacturers

Suppliers to the EV and HEV Markets

Supplier	Location	Website	Tel #	Customers	Products
AC Propulsion	San Dimas, CA	www.acpropulsion.com	1 909 592 5399	BMW, Autoport	tZero trademark- proprietary EV technology- drive systems, integrated battery charger, power electronic unit & motor
Advanced Motors & Drives	East Syracuse, NY	www.adcmotors.com	1 315 434 9303	Club Car and E-Z Go	Special purpose low-voltage wound field DC and AC traction and pump motors
ALTe LLC	Auburn Hills, MI	http://altelc.com	1 248 409 1000	Fleets, taxis	Developing range extended electric powertrains focusing initially on fleet vehicles,i.e taxis, limos, delivery trucks, vans and shuttle buses
Alternative Fuels Equipment	Macedonia, OH	www.alternativefuelsequipment.com	1 330 468 4900	Tier 1 OEM's	Exclusive distributor of Analytic Systems, Curtis Instruments, NAVITAS, and Sevcon electronic controls and instrumentation
Arens	Arlington Heights, IL	www.arens.com	1 847.844.4700	Caterpillar, Freightliner,Int'l Ford, FedEx, USPS	Power Distribution Contols, Propulsion controls, Electronic throttle Controls, Electro-Hydraulic Controls
Azure Dynamics	Oak Hill, MI	www.azuredynamics.co	1 248.298.2403	US Amry	Develops proprietary electric and hybrid electric drive technology for the light to heavy duty commercial vehicle categories.
California Motors	Camarillo CA	www.calmotors.com	1 805 388 5535	Tier 1 OEM's, Tier 1 suppliers	Integrated Traction Drive Systems
Curtis Instruments	Mount Kisco, NY	www.curtisinst.com	1 914 666 2971	Tier 1 OEM's	Motor controllers, Power conversion, instrumentation
Dakkota Integrated Systems	Holt, MI	www.dakkotasystems.com	1 517 694 6500	Tier 1 OEM's	Complete assembly and sequencing of integrated automotive interiors.
Delphi	Troy, MI	www.delphi.com	1 248 813 2000	Tier 1 OEM's, Tier 1 OEM's, Aftermarket	Offering hybrid & electric vehicle manufacturers and consumers affordable power electronics.
Denso NA	Southfield, MI	www.densocorp.com	1 248 350-7500	Tier 1 & 2 OEM's, Tier 1 & 2suppliers	Battery ECU, DC-DC Converter, Electric Compressor
Eaton	Cleveland, OH	www.eaton.com	1 216 523 5000	Tier 1 OEM's	Leader in the development and production of hybrid electric and hybrid hydraulic power systems for commercial vehicle fleets.
Efficient Drivetrains Inc (EDI)	Palo Ato, CA	www.efficientdrivetrains.com	1 408 624 1231	Tier 1 OEM's	EV and parallel or series PHEV and HEV drivetrain solutions that run in charge-depleting and charge-sustaining modes.
Electric Motors Corporation	Wakarusa, IN	www.electricmotorscorp.com	1 574 862 1010	Tier 1 suppliers	Manufacturers family of Electronically Controlled Flex-fuel ULE (ultra low emissions) ICE engines and EV HEV Drive Systems
Emerson Motor Technologies	St. Louis, MO	www.emersonmotors.com	1 888 637 7333	Manufacturers, and commercial end users	Electric motors

Energy CS	Monrovia, CA	www.energycs.com	1 626 622 7376	EV /hybrid OEM's	Advanced controls for energy storage for advanced batteries in electric and hybrid transportation and stationary application
Enhanced Vehicle Acoustics, Inc.	Santa Clara, CA	http://evacoust.startlogic.com	1 800 708-9256	EV and hybrid OEM's	Vehicular Operations Sound Emitting Systems for EV's & hybrids
Enova	Torrence, CA	www.enovasystems.com	1 310 527 2800	Ford, Smith, Think, Isuzu, Mack Truck, & others	EV, HEV and Fuel cell drive systems & components
Electric Vehicles of America, Inc	Wolfeboro, NH	www.evamerica.com	1 603 569 2100	Tier 2 OEM's, utilities, industrial, airports	EV battery systems and technology
Federal-Mogul Corporation	Southfield, MI	www.federalmogul.com	1 248-354-7700	Tier 1 OEM's, Tier1 suppliers	Premier supplier of products, services and solutions to original equipment manufacturers and to aftermarket customers who sell our world renown brand-name replacement parts
FEV Engine Technology, Inc.	Auburn Hills, MI	www.fev.com	1 248 373 6000	Tier 1 OEM's, heavy-duty and industrial engine manufacturers	Optimization of Hybrid Concepts through Simulation.FEV's simulation models of various hybrid powertrain configurations
GE Energy	Niskayuna, NY	www.ge-energy.com	1 877 435 7375	Utilities, industry	Smart meters, smart charging stations
IBM Global Automotive	Armonk, NY	www.935.ibm.com/services/us/gbs/bus/html/bcs_automotive.html	1 914 499 1900	Tier 1 OEM's, Tier1 suppliers	In-vehicle electronics
Imperial Electric (Kinetik)	Akron, OH	www.imperialelectric.com	1 330 734 3600	Tier 1 suppliers	Custom manufacturer of special application AC and DC motor systems
Infineon	Milpitas, CA	www.infineon.com	1 866 951 9519	Tier 1 OEM's	EV, HEV DC-DC Converter, battery charger
Johnson Controls	Milwaukee, WI	www.johnsoncontrols.com	1 414 524 1200	Tier 1 OEM's	Hybrid batteries, car electronics, interiors
Kemet	Simpsonville, SC	www.kemet.com	1 864 963 6300	Tier 1 automotive suppliers, including Bosch, Continental, Delphi, TRW and Visteon.	DC bus capacitors for EV's &HEVs
La Marche Manufacturing	Des Plaines, IL	www.lamarchemfg.com	1 847 299 1188	Utility, Engine Start,, Marine & others	Battery chargers and power conversion equipment
Lear Corp.	Southfield, MI	www.lear.com	1 248 447 1500	Tier 1 OEM's Leading Ev OEMs, military	Advanced high-voltage technologies to power a new generation of alternative-powered vehicles.
Light Engineering	Indianapolis, IN	www.lt-eng.com	1 317 471 1800		SmartTorq brushless motors
Magmotor Technologies Inc (US Hybrid)	West Boylston, MA	www.magmotor.com	1 508 835 4305	OEM and system suppliers	System design and integration for OEM and system suppliers of electric, hybrid electric and fuel cell powered vehicles.

Magna Int'l America	Troy, MI	www.magna.com	1 248 729 2400	OEM of cars and light trucks	Engineering, integration & production of solutions for future mobility with regards to hybrids and EVs.
Manzanita Micro	Kingston, WA	www.manzanitamicro.com	1 360 297 1660	Tier 2 OEM's	Battery chargers, and battery regulators
Method Electronics, Inc	Chicago, IL	www.methode.com	1 877-885-6006	Tier 1 OEM's, Tier1 suppliers	Interior and exterior user interface solutions
MGA Research Corp.	Akron, NY	www.mgaresearch.com	1 716 542 5672	OEM and system suppliers	Independent provider of engineering consulting, testing services, and facilities/equipment.
Motiv Power	Boise, ID	www.motivpower-wabtec.com	1 208-947-4800	Locomotives &buses for transit Authorities	Leader in the design, manufacture and re-manufacture of diesel-electric locomotives.
Net Gain Motors, Inc	Lockport, IL	www.go-ev.com	1 630 243 9100	Sell to Tier 2 OEM dealers	Distributor of WarP™, ImPulse™, and TransWarP™ electric motors for EV's and EV conversions.
Odyne	Waukesha, WI	www.odyne.com	1 262 544 8405	Fleets, Utilities, Tier1 suppliers	Plug-in hybrid electric vehicle systems for medium and heavy duty trucks
Quantum Technologies	Irvine, CA	www.qtw.com	1 949 399 4520	OEMs, (Fiskar) gov'ts and commercial organizations	Powertrain Engineering and Integration. Proprietary "Q-Drive" system
Remy International, Inc	Pendleton, IN	www.remyinc.com	1 765 778 6499	Tier 1 OEM's	Components used to produce HEV's & EV's
Rinehart Motion Systems	Wilsonville, OR	www.rinehartmotion.com	1 503 344 5085	Commercial, military and automotive OEM's	Power electronics products for EV, HEV and PHEV
RUSSCO Electro-Mechanical Eng	Merlin, OR	www.russcoev.com	1 541 479 0903	Commercial, dealers	EV battery chargers
SABIC Innovative Plastics	Pittsfield, MA	www.sabic-ip.com	1 413 448 7110	Automotive industry: designers, suppliers, OEMs	High-performance thermoplastics
Saminco	Fort Myers, FL	www.samincoinc.com	1 239 561 1561	Mining Industry,heavy Equipment OEM's	High Power AC and DC Motor Control for EV's
Solar Electrical Vehicles	Westlake Village, CA	www.solarelectricalvehicles.com	1 805 497 9808	Fleets, consumers	Mono-crystalline photovoltaic custom-fabricated compound convex solar roofs for EV's & PHEV's
Tyco Electronics		www.tycoelectronics.com	1 800 522 6752	Vehicle OEMs and Tier 1 suppliers.	Terminals and connectors, cable assemblies, sensors, relays and switching modules, inductive systems, high power components for hybrids
UQM Technologies	Frederick, CO	www.uqm.com	1 303 682 4900	Tier 1 OEM's, US DOD, State Gov't	Electric propulsion systems, power electronics, auxilliary systems for EV's HEV's and fFC vehicles
US Hybrid Corp.	Torrence, CA	www.ushybrid.com	1 310 212 1200	Tier 1& 2 OEM's	Design/manufacture power conversion systems for medium/heavy-duty electric, hybrid, and fuel cell commercial buses and trucks

Electric Vehicle Charging Station Providers (EVSE's)

AeroVironment	Monrovia, CA	www.avinc.com	1 626 357 9983	Think, EnerDel, US DOD	Fast charge systems for industrial electric vehicles (EVs)- PosiCharge™. Partnered with Nissan to supply home charging packages to be sold with the EV's.
Betterplace	Palo Ato, CA	www.betterplace.com	1 650 845 2800	Renault-Nissan Alliance, utilities	EV driver services, systems and infrastructure; a network of charge spots, switch stations and systems
BTCPower	Santa Ana, CA	www.btcpower.com	1 714 259 4888	Commercial & consumer	Material handling chargers and development of a standard Level 3 EV Fast charger
Carbon Day Automotive	Chicago, IL	www.carbondayautomotive.com	1 312 275 5747	Municipalities, utilities, corporations, fleets and property owners	ChargePoint Networked Charging Stations
Car Charging Group	Miami Beach, FL	www.carcharging.com	1 305 521 0200	Municipalities, corporations and organizations	Electric car charging stations
Clipper Creek, Inc.	Auburn, CA	www.clippercreek.net	1 530 8871674	Telsa Motors	High-rate charge stations that is compatible with all major automakers' Plug-In Hybrid and Electric Vehicles
Coulomb Technologies	Cambell, CA	www.coulombtech.com	1 408 370 3802	Municipalities, corporations and organizations	Vehicle-charging infrastructure, with an open system driver network. Stations ranging in capability from 120 Volt to 240 Volt AC charging and up to 500 Volt DC charging
ECOtality	San Francisco CA	www.ecotality.com	1 480 219 5005	Nissan	ECOtality North America Minit-Charger line of battery fast-charging systems
Eetrex	Boulder, CO	www.eetrex.com	1 303 444 0569		Energy efficient power electronics for traction battery chargers and Invergers™ (inverter-chargers).
Evatran	Wytheville, VA	www.pluglesspower.com	1 276 228 911	Consumers, corporate	Plugless Power™, world's first "hands-free" proximity charging system for electric vehicles. Utilizing a unique dual-component system based on inductive technology
EV-Charge America	Las Vegas, NV	www.ev-chargeamerica.com	1 702 696 1600	Parking lots, apartment buildings, malls, schools, government and fleets	Fast -EV charging stations and Smart Vehicle-to-Grid Infrastructure
EVOASIS	Solana Beach, CA	www.evoasis.com	1 858 509 2973	Public and private	EVSTAT™ electric vehicle charging stations

Electric Vehicle Charging Station Providers (EVSE's) cont'd

Greenlight AC	Washington, DC	www.greenlightac.com	1 202. 204. 2184	Residential apartments,fleets	The ChargeBar™, accommodates both 120v and 240v charging
GridPoint	Arlington, VA	www.gridpoint.com	1 703 667 7000	Enterprise,consumers, utilities, Govt	Smart energy solutions combine software, hardware and services that integrate, aggregate and manage distributed sources of energy consumption, generation and storage.
Juice Technologies	Columbus, OH	www.plugsmart.net	1 614 247 1610	Utilities,partnering with GE	Plug-in vehicle charging and energy management technologies developed under the Plug Smart brand.
Leviton	Melville, NY	www.leviton.com	1 800 323 8920	Partner in with Coulomb	Complete solution for home and public EV charging, providing charging stations and installation by certified contractors. Partnering with Coulomb Technologies on the ChargePoint network.
Liberty PlugIns	Los Angeles, CA	www.libertyplugs.com	1 310 439 9119	Municipal and corporate garages	"Synchronous Codes" Level I (110V) or Level II (220V) charging
NovaCharge	Tampa, FL	www.novacharge.net	1 813 333 1119	Partnering with Coulomb& CarCharging Group	A smart charging infrastructure for EV's
Optimization Technologies	Beaverton, OR	www.opconnect.com	1 503 690 4475	Rockwell Collins, Honeywell, Sandia Aerospace, Aerosonic	OpConnect System offers pedestal-mounted or wall-mounted charging stations suitable for commercial, fleet, and public applications.
PEP Station LLC	Livonia, MI	www.pepstations.com	1 734 793 2000	Businesses, movie theaters, apartments, hospitals	PEP Stations (Plug-in Electric Power), the smart, stylish, and simple charging station for the electric vehicle
SemaConnect	Annapolis, MD	www.semacconnect.com	1 410 384 4223	Parking operators, fleets	Networked charging stations for EV's and PHEV's
Shorepower Technologies	Utica, NY	www.shorepower.com	1 315 404 5613	Fleets, Truck stops, Gov't	Electrified Parking Spaces (EPS) at truck stops, rest areas, travel plazas, warehouses, truck depots, shopping malls, businesses & other parking areas
Siemens Energy	NewYork NY	www.usa.siemens.com	1-800 743 6367	OEM's municipalities, corporations, fleets, utilities and residential customers	includes wall-mountable, community multi-level and community multi-level II models Partnering with Coulomb in offering Coulomb Technologies' ChargePoint® Network

Battery Manufacturers

A123 Systems	Watertown, MA	www.a123systems.com	1 617-778-5700	Fiskar, Chrysler, Think, Chevy	One of the world's leading suppliers of high-power lithium ion batteries
Celgard	Charlotte, NC	www.celgard.com	1 704 588 5310	OEM's	Battery separators used in disposable and rechargeable lithium-ion batteries for electric drive vehicles
Ciobasys	Orion, MI	www.cobasys.com	1 248-620-5700	OEM's	Nickel Metal Hydride batteries for HEV's
Compact Power, Inc.	Troy, MI	www.compactpower.com	1 248 307 1800	OEM's	Subsidiary of LG Chem Ltd., one of the largest producers of lithium-ion batteries for automotive (HEVs) and non-automotive applications.
Dow Kokam	Midland, MI	www.kokamamerica.com	1 989698 3300	OEM's, Smith EV's	Equally owned by Dow Chemical and TK Advanced Battery (Korea)
EnerDel	Indianapolis, IN	www.ener1.com		Think, Volvo, OEM's Tier 1 suppliers	Technology related to PHEV and EV batteries
Johnson Controls-Saft	Milwaukee, WI	www.johnsoncontrols.com	1 414 524 1200	OEM's	Hybrid and electric battery systems
K2 Energy	Henderson, NV	www.peakbattery.com	1 702 478 3590	OEM's, Tier 1 suppliers	Manufacturer and seller of rechargeable Lithium-Ion battery systems
Lio Energy Systems	Columbus, OH			OEM's	JV between Coda Auto and Chinese co, Lishen Power Battery. Contingent on getting federal funding.
Lithium Technology Corp.	Plymouth Meeting, PA	www.gaia-akku.com	1 610.256. 1567	DuraCar, US Hybrid	Battery systems based on lithium-ion technology
Sakti3	Ann Arbor, MI	http://sakti3.com	1 734 827 2583	GM	Advanced solid state rechargeable lithium-ion battery Technology
Seeo	Berkeley, CA	www.seeo.com		OEM's	Solid state battery utilizing a novel solid polymer electrolyte material
Trojan Battery Company	Santa Fe Springs, CA	www.trojanbattery.com	1 562-236-3000	OEMs in the golf, energy, floor machine, aerial work Platform/access, marine and RV markets	World's leading manufacturer of deep cycle batteries
Valence Technology	Austin, TX	www.valence.com	1 512-527-2900	OEM's	Lithium iron magnesium phosphate energy storage Systems and solutions
Voltronix USA	Long Beach, CA	www.voltronixusa.com	1 562.233.3203	OEM's	Lithium-ion battery technology

Electric Vehicle Manufacturers

Aptera	Vista, CA	www.aptera.com		Consumer	3-wheel aerodynamic vehicles. Aptera 2 has a price range of \$25-40K depending on options with a lithium ion battery
Bannon Automotive	Syracuse, NY	www.bannonautomotive.com		Consumer	All-electric high speed "NXR" model(not yet in production)
Chevrolet (GM)	Detroit, MI	www.gm.com	1-800 950 CHEV	Consumer, fleets	"Volt" PHEV to be available late 2010; additional models from GM
Chrysler	Auburn Hills, MI	www.chryslergroupplc.com	1-800-CHRYSLER	Consumer	GEM (see below) and several PHEV's and EV models to be introduced
Coda Automotive	Santa Monia, CA	www.codaautomotive.com	1 310 390-4890	Consumer	Formed to develop & market a re-engineered electric sedan to be built in China in JV with Lishen Battery. Launched in CA. in Sept of 2010
Commuter Cars	Spokane, WA	www.commutercars.com	1 509 624-0762	Consumer	World's fastest EV (Tango), with a range of 40-200 miles
Electric City Motors	Parker, CO	www.electriccitymotors.com	1 303 646 8010	Consumer	The Current, the first US EV ready for distribution, selling for @ \$26K
Fiskar Automotive	Irvine, CA	www.fiskerautomotive.com	1 714-888-4255	Consumer	Luxury plug-in hybrid electric vehicles
Ford Motors	Dearborn, MI	www.ford.com	1 313 322 3000	Consumer	Fusion and Escape hybrid models beginning at @ \$20K
Goss132	Jacksonville, FL	www.goss132.com		Consumer	Fully electric vehicle; only US EV maker that allows consumer complete control over battery system
GreenGo TekLLC	Milford, MI	www.ggtelectric.com	1 248 529 3648	Consumer , fleets	Developing and marketing of lithium and AGM-powered cars and trucks
Myers Motors	Tallmadge, OH	http://myersmotors.com	1 330 630 3768	Consumer	"Duo" EV
Nissan Motors NA	Smyrna, TN	www.nissanusa.com	1 800 647 7261	Consumer	Leaf, all electric vehicle, to be released in the US in late 2010 for @ \$33K before federal tax credit (\$25K)
Phoenix Motor Cars	Ontario, CA	www.phoenixmotorcars.com	1 909 987 0815	Consumer, fleets	All-electric highway speed trucks and sport utility vehicles (SUVs) with a Lithium Titanate Battery (35 KWh)
Saba Motors	San Jose, CA	www.sabamotors.com	1 408 219 8675	Consumer	Carbon-Zero Roadster- 100% high performance plug-in electric vehicle. X-Prize finalist
Smart USA (Penske Auto Group)	Bloomfield Hills, MI	www.smartusa.com	1.800 762 7887	Consumer	Smart fortwo electric drive with a 30 kW magneto-electric motor
Tesla Motors	Palo Alto, CA	www.teslamotors.com	1 650 681 5000	Consumer	Hi-end, highway capable all-electric Roadsters
Think North America	Dearborn, MI	www.thinkev.com		Consumer	All-electric Think City featuring the Zebra sodium battery. Will also come with an Enerdel lithium-battery option. US manufacturing to begin in Elkhart, Ind. beginning early 2011
Toyota Motors USA	Torrance, CA	www.toyota.com		Consumer	Prius, Camry & Highlander SUV hybrid models
Zap	Santa Rosa, CA	www.zapworld.com	1707 525 8658	Consumer, fleets	Focused on two businesses, ZapElectric vehicles and Zap Recharge-it-All

Electric Truck and Bus Manufacturers

American Electric Vehicles	Palmer Lake, CO	www.aevehicles.com	1 719 488 1600	Army, public transportation	Custom solutions for clients from battery packs and charging stations to electric motors.
Balqon	Harbor City, CA	www.balqon.com	1 310 326 3055	Ports and Airports	Nautilus E20 and E30 terminal tractors and Mule M150 electric truck.
Boulder Electric Vehicles	Boulder, CO	http://boulderev.com	1 303 443 1859	Fleets	All electric delivery trucks available in 2010
Bright Automotive	Anderson, IN	http://brightautomotive.com	1 765 298 6600	Fleets	To begin mass production of the "IDEA", 100-mpg plug-in hybrid electric (PHEV) in 2013.
Columbia ParCar	Reedsburg, WI	www.parcars.com	1 800-222 4653	Airports, governments, municipalities	Various NEVs
Daimler Trucks NA LLC	Portland, OR	www.daimler-trucksnorthamerica.com	1 503 745 8000	Fleets, Government	Manufactures, sells and services commercial vehicle brands ,Freightliner, Western Star, Detroit Deisel,& Damler Trucks
Designline	Charlotte, NC	www.designlinecorporation.com	1 704 716 1020	Public transit systems	Buses
Ebus	Downey, CA	www.ebus.com	1 562 904 3474	Urban Transit systems, Universities	Busses (fuel-cell, hybrid, electric)
Electrorides	Carson, CA	www.zerotruck.com	1 714 675 7117	To be announced.	"Zero Truck" Electric medium-duty truck
Electric Vehicles Int'l (EVI)	Stockton, CA	www.evi-usa.com	1 209 9390405	Consumer, Commercial, Universities	Electric vehicles covering a diverse range of transportation options
EnVision Motor Company	Ames, IA	www.envisionmotorcompany.com	1 515-598-2258	Commercial	100% electric, by Electric Mobile Cars, includes a wagon, cargo van and an electric truck.
Foton America Bus Co.	Brookfield, CT	www.foton-america.com	1 203-740-7000	Municipalities	Buses and trucks
ICCorporation	Warrenville, IL	www.icbus.com	1 800 982 7761	School systems, municipalities	Hybrid school buses
ISE Corp	Poway, CA	www.isecorp.com	1 858 413 1720	Transit operators, truck fleets	Hybrid trucks and transit busses.
Miles Electric Vehicles	Santa Monica, CA	www.milesev.com	1 310 390 4890	Universities, Airports, Army, Municipalities	Low speed truck and low speed cars.
Proterra	Golden, CO	http://proterraonline.com	1 303 562 0500	Public transit systems, schools	"Zbus" , battery electric bus – Building all electric, fast charge bus for Foothill Transit with Veolia
Roush	Livonia, MI	http://www.roush.com/	1 734 779 7006	Universities, Parks etc.	Electric pick-up truck "Roush Electric Vehicle".
Sinautec	Arlington, VA	www.sinautecus.com	1 202 361 0549	Public transportation systems	Electric buses and minibuses
Smith Electric Vehicles	Kansas City, MO	www.sev-us.com	1 816 4640508	Pacific Gas and Electric, many others expected.	The Smith-Newton, world's largest plug-in battery-electric powered truck.
Taylor-Dunn Manufacturing Co	Anaheim, CA	www.taylor-dunn.com	1 714 956-4040	Industrial, commercial, and ground-support markets	Since 1949, electric carts, tow tractors & more

Motorcycles

Brammo	Ashland, OR	www.brammo.com	1 541 482 9555	For private use	Electric bike
Mission Motors	San Francisco, CA	www.ridemission.com	1 510 582 2600	For private use	Mission One superbike
Pi Mobility	Sausalito, CA	www.pimobility.com	1 415.887.7643	For private use	Advanced light electric bikes and electric motorcycles
Vectrix	New Bedford, MA	www.vectrix.com	1 949 838 7287	For private use	VX-1, highway capable scooter
Zero Motorcycles	Scotts Valley, CA	www.zeromotorcycles.com	1 831 438 3500	For private use	Dirt, Street and Dual Sports bikes

ATV's (All Terrain Vehicles)

Bad Boy Buggies	Natchez, MS	www.badboybuggies.com	1 866 678 6701	For private use	XT, LT, Classic and Stretch
Barefoot Motors	Ashland, OR	www.barefootmotors.com	1 541 482 0181	For private use	M-1
Electric Vehicle Systems	Ellicottville, NY	www.ecoeatv.com	1 716 699 6611	For private use	E-Force, electric ATV
Stealth Electric Utility Vehicles	West Monroe, LA	www.stealth4x4.com	1 318 397 2588	For private use	Patriot LSV, Predator XR, Apache XR
ZAP Electric Vehicles	Santa Rosa, CA	www.zapworld.com	1 707 525 8658	For private use	ATV: Zap Dude; also makes electric scooters and cars

Electric Boats

American Beauty Boats	Oxnard, CA	www.americanbeautyboats.com	1 805 488 3821	For private use	Front and rear driven 18' electric boats
Ashton Boat works	West Bloomfield, MI	www.ashtonboatworks.com	1 248 419 0085	For private use	14' and 16' electric "boat"
Budsin wood craft	Marshallberg, NC	www.budsin.com	1 252 729 1540	For private use	15' and 22' electric picnic boats
Cobalt marine	Cobalt, CT	www.cobaltmarine.com		For private use	5' to 21' open top electric boats
Duffy Electric Boat Co.	Adelanto, CA	www.duffyboats.com	1 949 645 6811	Disney, Marriot t, California Fi&G	Several boat models from 14' to 22'
Elco	Athens, NY	www.elcoelectriclaunch.com	1 518 945 2200	For private use	19' to 36' electric picnic boats
ElectraCraft	Westlake Village, CA	www.electracraft.com	1 800 221 2083	For private use	16' to 21' electric power boats
Endeavour Green	Clearwater, FL	www.endeavourgreen.com	1 727 573 5377	For private use	24' electric hybrid yacht
Independence Green Yachts	Cockeysville, MD	www.independencegreenyachts.com	1 717 571 8315	For private use	60' self sustaining vessel which derives its power from the sun
Lear Electric Boats	Newport Beach, CA	www.learbaylor.com	1 949 722 7757	For private use	Lear204 electric boat

BEV	-	Battery Electric Vehicle
EV	-	Electric Vehicle
EVSE	-	Electric Vehicle Supply Equipment
FCV	-	Fuel Cell Vehicle
GEV	-	Grid Enabled Vehicle
HEV	-	Hybrid Electric Vehicle
ICE	-	Internal Combustion Engine vehicle
OEM	-	Original Equipment Manufacturer
PEV	-	Plug-In Electric Vehicle
PHEV	-	Plug-In Hybrid Electric Vehicle
SAE	-	Society of Automotive Engineers
US DOE	-	United States Department of Energy
ZEV	-	Zero Emission Vehicle

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