A History of Electric Vehicles & Women of the EV Industry

EV Presentation to the Alameda Girl Scouts Dec 2, 2011

EV History

Electric cars enjoyed popularity between the mid-19th century and early 20th century, when electricity was among the preferred methods for automobile propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. Advances in internal combustion technology, especially the electric starter, soon rendered this advantage moot; the greater range of gasoline cars, quicker refueling times, and growing petroleum infrastructure, along with the mass production of gasoline vehicles by companies such as the Ford Motor Company, which reduced prices of gasoline cars to less than half that of equivalent electric cars, led to a decline in the use of electric propulsion, effectively removing it from important markets such as the United States by the 1930s. However, in recent years, increased concerns over the environmental impact of gasoline cars, higher gasoline prices, improvements in battery technology, and the prospect of peak oil, have brought about renewed interest in electric cars, which are perceived to be more environmentally friendly and cheaper to maintain and run, despite high initial costs. Electric cars currently enjoy relative popularity in countries around the world, though they were absent from the roads of the United States, after they briefly re-appeared in the late 90s.

Timeline:

1834: Thomas Davenport invents the battery electric car, using non-rechargable batteries. Electric vehicles would hold all vehicle land speed records until about 1900.

1895-1898: First auto race in America, won by an EV. First car dealer – sells only EVs.First vehicle with power steering – an EV. Electric self-starters 20 years before appearing in gas-powered cars. NYC blizzard, only EVs were capable of transport on the roads. First woman to buy a car – it was an EV.

1900: NYC's huge pollution problem – horses. 2.5 million pounds of manure, 60,000 gallons of urine daily on the streets; 15,000 dead horses removed from the streets each year. All US cars produced: 33% steam cars, 33% EV, and 33% gasoline cars. Poll at the National Automobile Show in NYC showed people's first choice for automobiles was electric followed closely by steam.

1908-1910: Henry Ford buys his wife, Clara Ford, an EV. Many socialites of that time gave this rousing endorsement for EVs, "It never fails me.” Motorized assembly produces gas-powered cars in volume; reducing cost per vehicle.

1912-1913: 38,842 EVs on the road. Horse drawn "tankers” deliver gasoline to gas stations. EVs perform well in snow. Ford creates experimental EVs. Self starter for gas cars (10 years later for the Model-T).

1967: Gallup poll: 36 million really interested in EVs. At the time EVs had a top speed of 40 mph, and typical range less than 50 miles. Electric Auto Association founded.

1974: CitiCar debut at Electric Vehicle Symposium in Washington , DC. Full production also ramps up. By 1975, Vanguard-Sebring, maker of the CitiCar is the 6th largest auto maker in the US. EAA member Roger Hedlund sets first world speed record for EVs at Bonneville Salt Flats.

1983-1985: A fleet of EVs drove from San Jose, CA to San Francisco, CA, 100 mile round trip, on a single charge. Saied Motai drove 230 miles on a single charge.

1990: California establishes the Zero Emission Vehicle (ZEV) Mandate; requires 2% of vehicles to be ZEVs by 1998, 10% ZEVs by 2003. GM shows their production EV initially named, Impact; later it was re-named the EV-1. (US government spent $194 million on all energy efficient research. Much less than the $1 billion for a single day of Desert Storm, or the $1 billion per week of 2003 Iraq conflict.)

1993: GM estimated that it would take 3 months to collect names of 5,000 people interested in the EV-1 – it only took one week! Twelve additional states adopt the California ZEV mandates. The GM Impact EV (later to be named the EV-1) sets a 187 mph speed record.

1996: EAA helps to hatch CALSTART incubator (for EV research) in Alameda , CA. Solectria Sunrise breaks the 300 mile range at the NESEA Tour de Sol. GM begins production of the EV-1 (formerly called the Impact).

2000: Ford offers the Th!nk City EV, it's version of the Pivco, in California. Toyota Prius and Honda Insight Hybrids start to be sold in California and the USA.

2001: CARB upholds the ZEV Mandate of between 4,000 and 15,000 EVs starting in 2003. Dr. Andy Frank and his UC Davis Team Fate produce demonstration plug-in hybrid vehicles.

2002: Toyota RAV4-EV retail sales begins; their estimated 2-year supply sold out in 8 months. Ford gets rid of the Th!nk City Group.

2003: ZEV Mandate weakened to allow ZEV credits for non-ZEVs. Only requires 250 fuel-cell vehicles by 2009. Toyota stops production of the RAV4-EV; Honda stops lease renewals of the EV-Plus; GM does the same for the EV-1.

2003: AC Propulsion's tZero earns highest grade at the Michelin Challenge Bibendum; tZero specs: 300 miles per charge, 0-60mph in 3.6 seconds, 100 mph top speed.

2004: The Ford Ranger EV and Th!nk are saved from the crushers. Unfortunately, the GM EV1 could not be saved from the crusher. CalCars demonstrates modifications to a Toyota Prius to enable plug-in capabilities. Myers Motors introduces the MM NmG (formerly the Corbin Sparrow). DontCrush.com saves EVs from the crusher — including the Th!nk City, Ranger EV, RAV4-EV. The EAA launches a Plug-In Hybrid Special Interest Group. Hybrid sales are through the roof. Launch of PlugInAmerica, a coalition of EV drivers, clean air and energy independence advocates working to promote the use of plug-in vehicles.

2008: Tesla gets its first Roadsters on the road. After 3 years over 2,000 EV sportscars have been built and sold around the world. Standard performance is 0-60 mph in 3.7 seconds, up to 250 miles per charge. Each car sells for over $100,000.

2011: Chevy Volt & Nissan Leaf starts public sales of EVs, exceed company expectations.

Maintenance
Q: Are plug-in vehicles dependable?

A: Battery Electric Vehicles are the most dependable vehicles made. Well made production EVs have the potential to last as long or longer than gasoline automobiles, with less regular maintenance. There are many fewer moving parts in an EV, and therefore less ongoing preventative maintenance. Brake life is significantly extended since the motor is used to slow the car, recapturing the kinetic energy and storing it back in the battery. While replacement batteries may be required during the life of an EV, newer battery chemistries are demonstrating very long lives.

Q: How often do you have to replace the batteries?

A: Nickel Metal Hydride batteries (NiMH) are proving to be very long lived. Several cars with over 130,000 miles have been reported with virtually no range degradation. Estimates of 150,000 – 200,000 miles are predicted. Lithium Ion (LiIon) is thought by most experts to be the chemistry that will supplant NiMH. The testing of battery life is continuing, but it's too early to tell how long LiIon will last.

Pollution
Q: What if electric cars get their energy from dirty sources like coal – how clean are they then?

A: The Argonne National Labs have looked into this issue and report that the mix of power in the electrical grid, not all of which is coal, results in a 32% decrease in greenhouse gases with EVs. The other pollutants similarly meet the stringest standards for the cleanest gas cars today, even charging completely from an ordinary coal plant. Many states such as California are much cleaner, with a grid mix at 29% coal. EVs also allow you to use 100% clean renewable electricity from sources such as the sun or wind. In addition, **EVs get cleaner as the electrical grid gets cleaner**. Gas cars only get dirtier as they age. We support replacing all "fossil-fuel" electricity generation with clean and renewable generating methods.

Q: Aren't all those batteries full of toxic chemicals and precious metals that will just end up in a landfill?

A: Not at all. Every car in the world has a lead-acid battery, the most toxic metal used for batteries. Even with its low value as scrap, the recycling rate for lead-acid batteries is about 98% in the U.S. EVs will use newer chemistries such as NiMH and LiIon. Both of these metals are inherently more valuable than lead, and since the batteries are quite large, the value of the spent battery packs will be such that the recycling rate will approach 100%. It is illegal to dispose of these batteries in a landfill and their value will ensure that is not their fate. Nickel, while mildly toxic, will be reclaimed during the recycling process. Lithium is even less toxic and more valuable than nickel.

Range
Q: Aren't fully electric cars impractical?

A: Not at all. EVs with a 150-mile range could be built and sold in quantity at a profit today for $25,000. Ranges exceeding 300 miles on a charge exist today, but with the cost of batteries as high as they are, it is impractical for most cars at this point. Most people, when educated as to the benefits of driving with electricity, will be well served by a car with a range of 100-180 miles. Well over 90% of daily driving is well under 100 miles. Any long distance driving can be done with a second car that is a plug-in hybrid (PHEV), or by renting or borrowing a PHEV.

Recharging

Q: How long does it take to charge?

A: 3 seconds. At least that is how much time we invest in the process. Our current commute car, the EV1, needs about 1.5 hours of being on the charger for the 40-mile round-trip commute. More range requires more charge, of course. Normally we don't care how much time the charging process takes since we are typically sleeping when it happens. To go from completely empty to completely full (which we rarely do unless we need the full range) can take five hours. But again, we are normally sleeping during this process. The better question is: "how long does it take ICE drivers to drive out of their way to a gas station, stand around (in the wind, rain, heat, on greasy asphalt, breathing benzene) while the car fills, pay, and get back onto the road?" Our fueling is done at home, in our garage, while we are doing other things. Our time involvement in the charging process is about 1.2 seconds for plugging, and 1.2 seconds again for unplugging. It is more difficult and time-consuming to plug a vacuum into the wall outlet, than it is to charge an EV each day.

Q: Isn’t plugging in an inconvenient chore?

A: Not at all. Plugging in literally takes less than 5 seconds of your time. There is no going out of your way to a gas station and jockeying for a pump. You can charge anywhere there is an electric outlet.

Q: What happens when the batteries run out of power?

A: You charge them back up. When EVs and PHEVs are commonplace, charging stations will be everywhere. Restaurants, grocery stores and other retail establishments will offer free or low cost charging as enticements to get customers. Parking meters will be charging stations where you will plug in, swipe a card, and when you unplug, your account will be debited with the energy used and the time at the meter. Of course, anyone with access to a plug at home will charge there over night when cheap surplus power is readily available. Studies indicate 80% of Americans have ready access to plugs where they park at night.

PHEVs, of course, will not need to be charged since their internal combustion engine will allow virtually unlimited range for long trips. However, to minimize pollution, cost and other ills associated with the use of oil, one would do well to plug in whenever possible to maximize the use of the electric grid, hopefully sourced with renewable electricity.

Q: How long does it take to fully charge a plug-in hybrid or electric car?

A: It would depend on the amperage of the charging system. From an ordinary 120V socket, you would need overnight to charge a battery EV fully. With a fast charger, you could fully charge in 5-10 minutes. A plug-in hybrid could fully charge in 6-9 hours from an ordinary outlet.

Hybrid

Q: Aren't hybrids just EVs that are more convenient?

A: Hybrids are a double-edge sword for me. On the one hand they are a small step forward from pure ICE vehicles; and they allow for some efficient and relatively clean ICE vehicles with good (to extreme!) performance and unlimited range. On the other hand, hybrids are a large step backwards from pure BEVs in both efficiency and cleanliness. Today we have everybody (even the American auto makers, finally!) jumping on the "hybrid" bandwagon. And since there is no firm definition of "hybrid vehicle" we are seeing pickup trucks that do nothing more than shut the ICE off when slowing or stopped. For my money, we don't have ANY real production hybrids on the road today. In my book, a hybrid would be able to run on at least two different fuels. Today's "hybrids" require gasoline to run. We often hear in the press (repeated by proud owners) that hybrids are "cleaner" then BEVs. Well, it should be obvious that this is an impossibility, unless you purposefully ignore most of the upstream pollution caused by *creating* the gasoline. The supporters of the "BEVs are dirty" position want to include the emissions from the dirtiest coal-fired power plant on the BEV side of the equation - while at the same time ignoring all the pollution (including electricity generation!) involved in gasoline production. We hear the same argument from the FCV folks. The power to create Hydrogen is all going to come from clean sources only, apparently. And BEVs will all need to be charged from coal power.

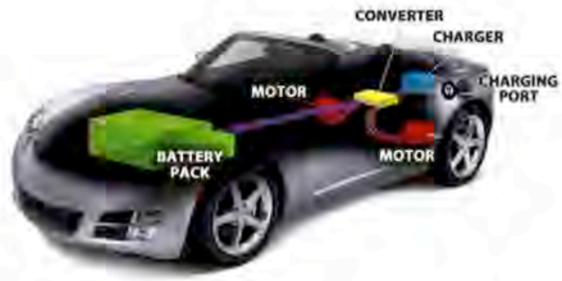
So back to hybrids - Electricity can be made renewably; gasoline cannot be. Electricity can be made cleanly; gasoline cannot be. Electricity can all be domestically produced; we have been net importers of oil since the 1930's. Hybrids are a small step in the right direction. Yet they still rely on foreign oil, still require trips to the gas station, they need tune ups and oil changes, and they still pollute. For me, a real hybrid is one that allows me to charge the batteries without using a fossil fuel (in other words, I *want* to plug it in!), and drive exclusively on battery power for a significant range before the ICE kicks in. That would make an excellent second vehicle for our family.

Q: I never see EVs on the road - nobody really wanted these cars, did they?

A: Turns out that every "production" EV ever made available for lease or sale was leased or sold. A waiting list was left dangling for each car-makers' electric vehicle when the respective program was terminated. And ironically, each program termination was blamed at least partially on "no demand for EVs." Usually factual numbers are repeated in the press, but with only part of the fact behind it. For example, I have heard GM say, "We cannot make a business model out of this - we could only lease 1,100 EV1s over four years!" Sure enough, 1,100 just happens to be the number of EV1s that were ever built during those four years. Not too surprising that non-existent cars could not be leased. Obviously it would have been more honest to say, "We leased every EV1 that we built," but that doesn't have the same ring to it, does it? Here are the approximate numbers for each modern "production" EV made and put in service in the US.

Toyota RAV4 EV prior to retail program 1039
GM EV1 about 1100
Ford Ranger EV about 1500
Honda EV Plus about 320
Chrysler TEVan about 30
Toyota Ecoms about 30
Th!nk Cities about 550
RAV4 EV retail program about 330
Chevrolet S10E about 500
Ranger EV in USPS body 500
Nissan Altra about 120
Dodge Epic minivans about 120
Nissan HyperMinis about 50 (maybe more)

As of April, 2007 - According to the California Department of Motor Vehicles, there are a total of 82,654 electric vehicles registered. The department's system does not differentiate between the different types of electric vehicles so this counts all NEVs, conversions and freeway-capable production cars. Approximately 1,000 - 1,200 of the 5-7,000 freeway-capable EV's are left-over's from California's Zero-Emission Vehicle Mandate (ZEV).



Electrification provides several key advantages:

Reduces oil use – Transportation demand accounts for over 70% of total U.S. oil use, 61% of which is used to power the light duty vehicle fleet. Nationally, less than 3% of electricity is produced with oil. Shifting from oil to electricity directly cuts oil use. If by 2025 35% of Washington's light duty vehicle fleet were PHEVs able to go 20 miles on a charge, 580 million of gallons of oil could be saved per year. The full build out of a Truck Stop Electrification network on the West Coast and the retrofit of 15,000 trucks with on-board idle reduction kits would save close to 100 million gallons of oil per year.

Reduces energy imports - Electrification firms up national and state economies by replacing imports with domestic energy production. The U.S. imported oil bill for 2006 is estimated at $329 billion, more than one-third the total trade deficit. Washington State in 2006 paid an estimated $9.29 billion for oil from beyond state boundaries. That compares to $9 billion spent on public K-12 education, and $5.8 billion in farm cash receipts.

Increases national energy security – By diversifying transportation fuels, electrification reduces vulnerability to oil shocks and price rises due to natural disruptions such as hurricanes and political disruptions from unstable and unfriendly countries. A Stanford University Energy Modeling Forum study for the U.S. Department of Energy analyzed the probability of severe oil shocks over the next decade. In the EMF study, the participants found that the odds of a foreign oil disruption happening over the next 10 years are slightly higher at 80 percent. In addition, oil price shocks preceded nine of the last 10 recessions in the United States.

Reduces air pollution – Use of electricity reduces transportation air pollutants that have serious impacts on human health including particulates and volatile organic compounds. For example, replacing diesel with electricity has important health benefits. Clean Air Task Force notes, "Fine particle pollution from diesels shortens the lives of nearly 21,000 people each year. This includes almost 3,000 early deaths from lung cancer."

Protects our climate – Electrically powered vehicles operate with significantly lower emissions of heat-trapping gases, especially carbon dioxide. Electrical drive is more efficient than mechanical drive, so even when fossil-fuel generated electricity is used to power vehicles, heat-trapping emissions are still reduced when using the Northwest power grid mix.

Power in Alameda:

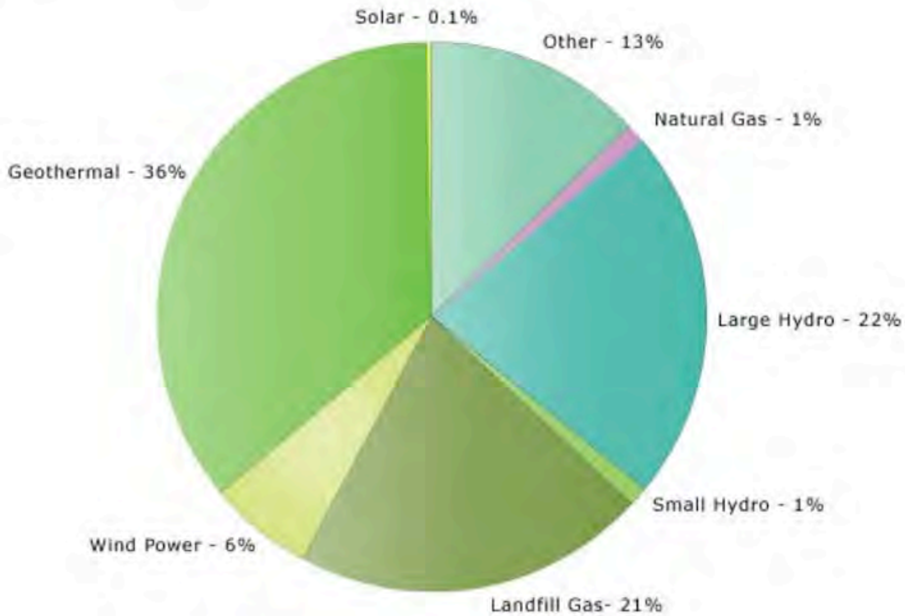
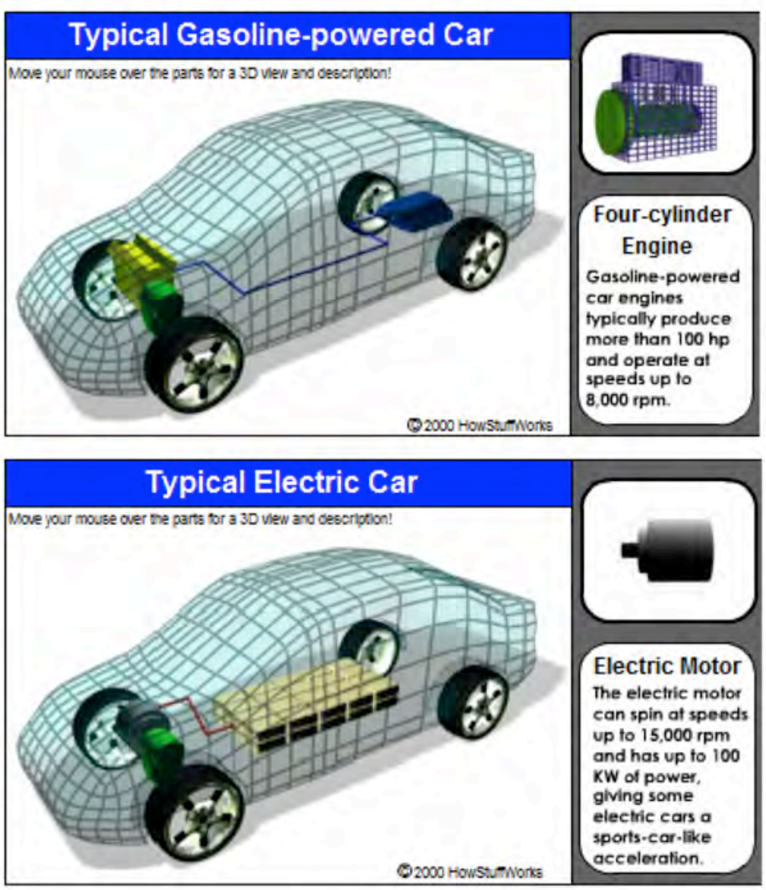


Diagram – make a list of moving parts:



Sarah Cooley, student & engineer

Commuted in High School in Pleasanton in a white Corbin Sparrow for 3 years. Then went to college at Oregon State University to study computers and worked on the Solar Car challenge and raced Electrathons.

Clare Bell, engineer & EV racer

Leaving IBM in 1990 to begin a full-time writing career, Bell also became interested in electric vehicles. After converting a VW beetle to electric with a conversion kit, she began building, racing, repairing, designing and racing electric cars. From 1992 to 1999 also became the editor of the Electric Auto Association's (a nationwide US electric car club) monthly newsletter, Current Events. As part of the Women's Electric Racing Team, she competed in the Arizona Public Service utility company's APS Solar and Electric 500 and APS Electrics electric vehicle races, held in Phoenix, Arizona from 1993 to 1997.

She also turned her electric vehicle experience into a profession, working as an electric vehicle engineer for CALSTART and private companies until 2003.

Lightning Bug, the dune buggy-style result, was soon joined by a Porsche 914 conversion, and hobby became job as word of her engineering talents spread. Since then she has worked for a Who's Who of electric car manufacturers, including Green Motorworks; the Pivco City Bee station car program in Alameda, California; Ford's Th!nk Nordic division (the successor to the City Bee); and most recently, Corbin Motors, creators of the Sparrow.

Dressed in dirty jeans and sneakers, her wispy hair shoved under a baseball cap, Bell seems like she'd have no problem fitting into the auto industry. Yet despite her appearance, and despite her list of advanced degrees (including mechanical engineering from Stanford), it hasn't been easy. At Ford's Th!nk Nordic factory in Norway, Bell found herself one of very few women-and when she disagreed with the head of the Th!nk electrical department, she had very little support. In the resulting power struggle, Bell lost.

At Corbin Motors, makers of the Sparrow, electrical safety caused repeated concerns. "The biggest shock I got when I came to Corbin was finding that the battery pack wasn't [electrically] isolated-and it was literally a shock! Hobbyists always isolate the battery pack for safety [to prevent high-voltage shocks when touching the metal vehicle frame]. Somebody at Corbin said to me, "Well, Clare, you're being really stupid about this, this has a fiberglass body, not metal.' But I discovered later it has a virtual metal body in the form of the brake lines. They go all over the car, they're connected to the frame..."

"At the time, Corbin had only mechanical engineers, no electrical engineers. But you need both to build an electric car." As Corbin faced tough times and Bell continued to raise safety issues, management decided it no longer required her services (or, apparently, those of fellow engineer Jim Robbins, who quit in protest).

Chelsea Sexton, EV advocate

Chelsea is a marketing expert and advocate of alternative fuel vehicles. Sexton entered the automotive industry at the age of 17 after buying her first Saturn. She wanted to put herself through college by working at Saturn, but she ended up finding that she loved the cars more than what she was studying, so when General Motors announced the EV1 electric vehicle program three years later, she jumped on it. Focusing on building a market for alternate-fuel vehicles through partnerships with corporate and non-profit stakeholders, shaping public policy and incentives, developing marketing strategies, and working directly with the drivers themselves, Sexton became well known as an advocate for clean, efficient, transportation.

Sexton was laid off at the end of 2001 when General Motors closed their EV1 assembly line. She became a consultant to auto manufacturers and clean energy providers helping bring alternate fuel vehicles to market, as well as incr easingly clean ways to power them. In 2005, Sexton joined the X PRIZE Foundation and led the creation of a prize effort, which to deal with both energy and automobiles. In 2006, she managed an alternative fuel division for the Santa Monica, California based start-up Zag.com and also serves as the Executive Director of Plug In America, a coalition of individuals and organizations that advocates for the preservation and manufacture of plug-in hybrids (PHEVs) and electric vehicles.

Since then, she has gone on to become the founder of the Lightning Rod Foundation.

Chelsea is one of the key individuals interviewed in the 2006 documentary film “Who Killed the Electric Car?” and 2011 film “The Revenge of the Electric Car”.