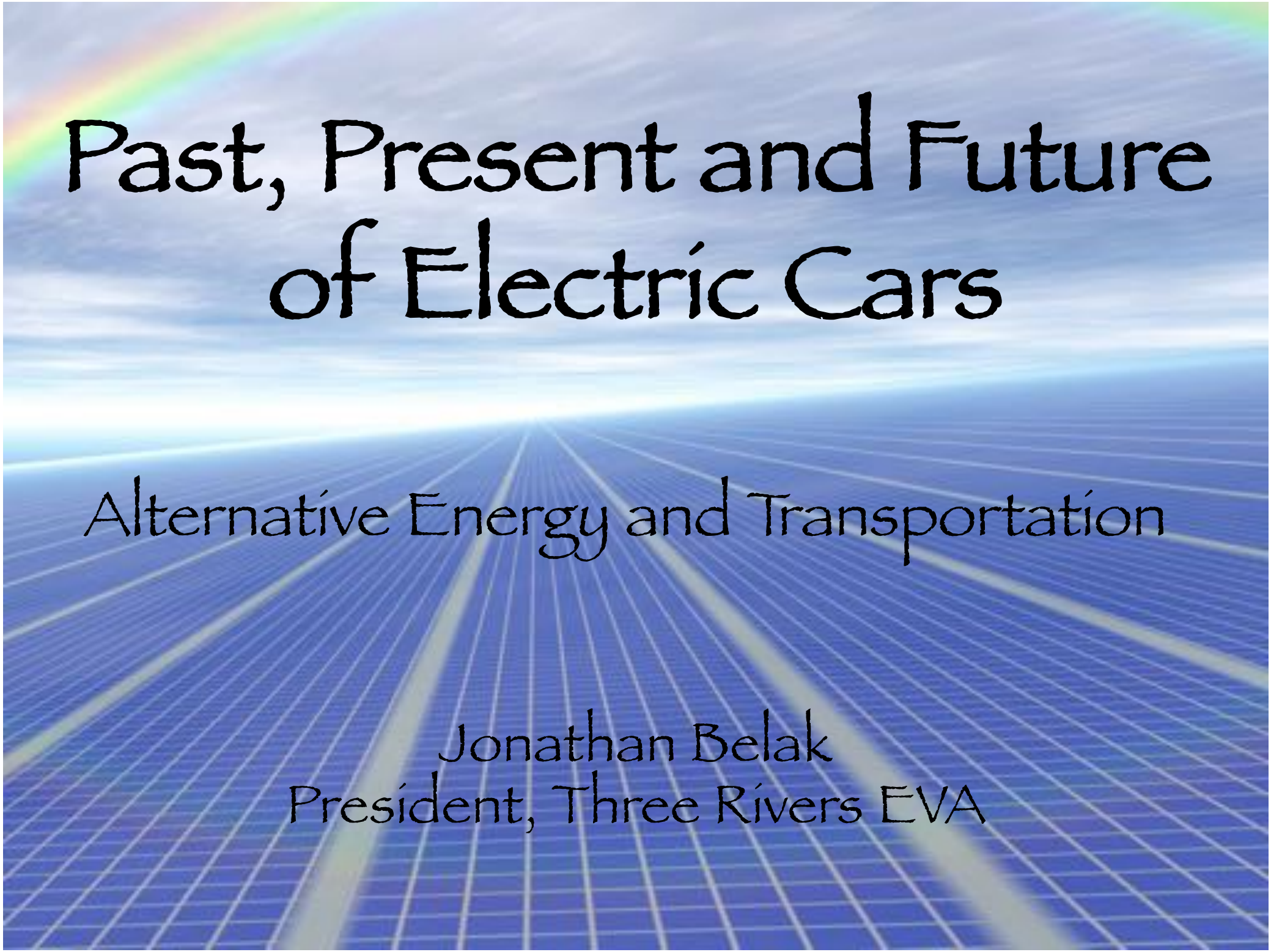

Past, Present and Future of Electric Cars
Alternative Energy and Transportation
Jonathan Belak
President, Three Rivers EVA

Background and Introduction

President of Three Rivers EVA since 2008.

Current 2 time electric drag racing world record holder.

Over ten thousand + hours of educational research on electric vehicles.

Designed and built electric vehicles.

Contacts all over the world also involved with electric transportation.

Owner of PA Electrics.

ELECTRIC VEHICLE HISTORY

1769 – Nicolas Joseph Cugnot invented and used the first self-powered/steam-powered road vehicle.

1790 – Bicycles were invented and began being used.

1834 - Thomas Davenport invents and patents an electric motor using electromagnets. Also credited with inventing the battery electric car – using non-rechargeable batteries.

1859- Gaston Plante invents rechargeable lead-acid batteries.

1867 - The first gas-powered bicycle (motorcycle) was invented.

1885 - Karl Benz invents the first internal combustion engine driven automobile for actual use.

1889- Thomas Edison builds an electric vehicle (EV) using nickel-iron batteries.

1890- William Morrison builds an EV in Des Moines that can travel for 13 hours at a speed of 14mph.

1895- The first auto race in America was won by the Electrobal II (an EV).

1896- Andrew Riker begins ...any ...V.

1897- First Vehicle with power steering introduced (EV).

1897- Early and clean electric vehicles, easy to operate, gained popularity among women, lawyers, and physicians according to *Automotive Industries*.

1899- Camille Jenatzy's 'Jamais Contente' sets the first land speed record of 66mph in a streamlined vehicle powered by two 12 volt motors.

1900- First auto show in New York City – 40 manufacturers show 300 cars; steam and electric vehicles outsell gasoline-powered vehicles.

1900- The first distance record is set by the BGS Company's EV – it was driven 180 miles on a single charge.

1900- Of the vehicles being driven 33% are steam, 33% are electric, and 33% are gas.

1900- Ferdinand Porsche develops first hybrid battery-powered e
The **Lohner-Porsche Mixed Hybrid** (sometimes wrongly referred to as *Löhner-Porsche*).

1901- Krieger Company of Electric Vehicles (in France) manufactures the first electric vehicles to use regenerative electric brakes.

1903- The first speeding ticket given to the driver of an EV.

1960- GM begins work on their Electrovair, a converted Corvair. Ford begins development of their sodium-sulfur battery.

1966- Gallup poll: 36 million really interested in EVs. At the time EVs had a top speed of 40 mph, and typical range of less than 50 miles with flooded-lead acid batteries.

1970- The oil crisis renews public interest in EVs. Ford continues developing their sodium-sulfur battery. GM continues work on their Electrovair and many independent EV companies begin to appear.

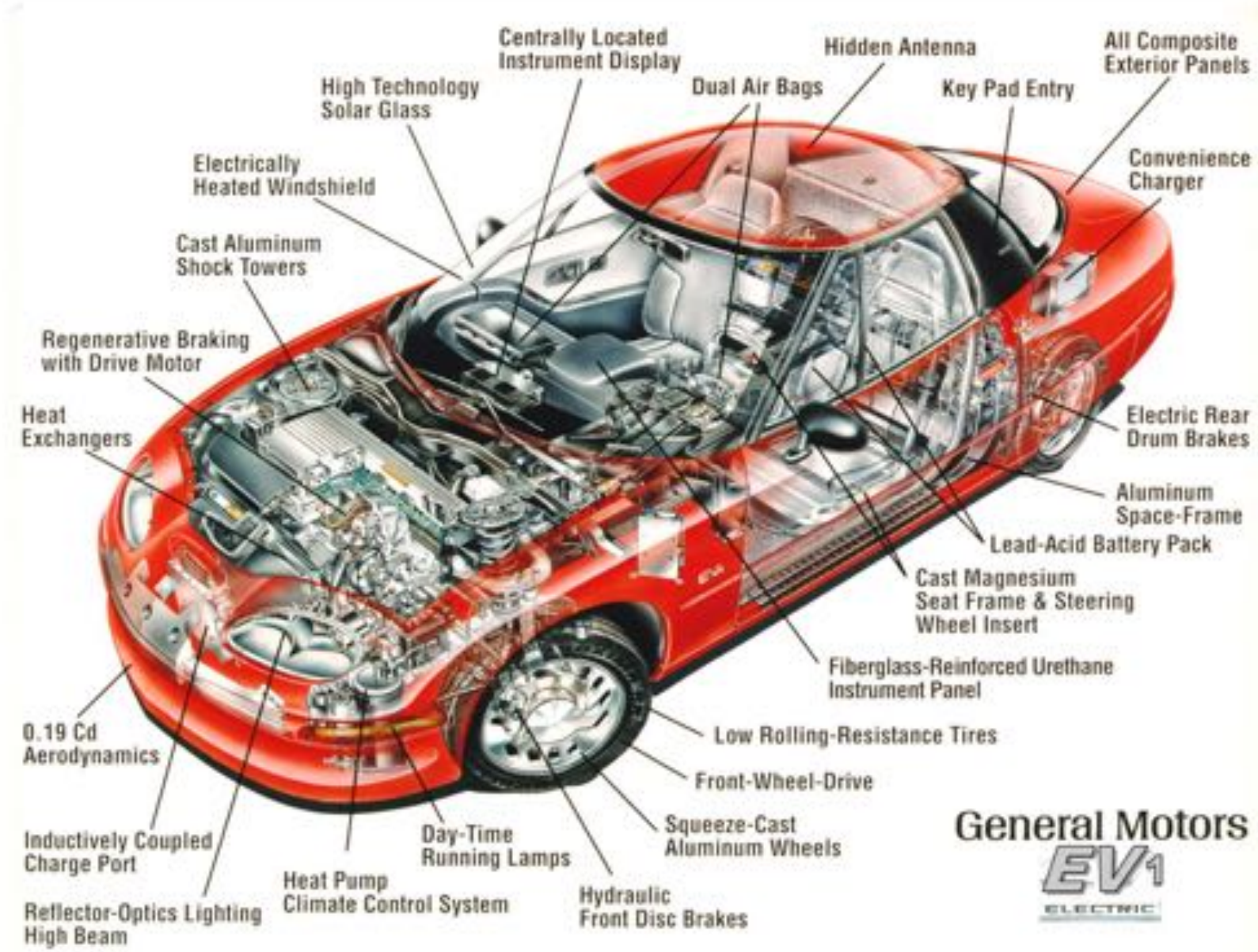
1975- Vanguard-Sebring, maker of CitiCar is the 6th largest auto maker in the US.

1976- Congress passes the Electric and Hybrid Vehicle Research & Development Act over protests from automakers and President Ford's veto.

1979- President Jimmy Carter resolves that the US will never use more foreign oil then it imports in 1977. Installs Solar Panels on the White House Roof.

1988- General Motors CEO Roger Smith (from 1981 to 1990) arranges to fund a prototype for a practical consumer electric car, engineered by the Sunraycer design team, Aero Vironment

1990- General Motors introduces an all electric concept car at the Los Angeles Auto Show named the Impact. It was renamed the EV1 before the commercial release in 1996.


Centrally Located
Instrument Display
Hidden Antenna
All Composite
Exterior Panels
High Technology
Solar Glass
Dual Air Bags
Key Pad Entry
Electrically
Heated Windshield
Convenience
Charger
Cast Aluminum
Shock Towers
Regenerative Braking
with Drive Motor
Heat
Exchangers
Electric Rear
Drum Brakes
Aluminum
Space-Frame
Lead-Acid Battery Pack
Cast Magnesium
Seat Frame & Steering
Wheel Insert
Fiberglass-Reinforced Urethane
Instrument Panel
0.19 Cd
Aerodynamics
Low Rolling-Resistance Tires
Front-Wheel-Drive
Squeeze-Cast
Aluminum Wheels
Inductively Coupled
Charge Port
Day-Time
Running Lamps
Heat Pump
Climate Control System
Hydraulic
Front Disc Brakes
Reflector-Optics Lighting
High Beam
General Motors
EV1
ELECTRIC

1990- The California Air Resources Board (CARB) adopts the Zero Emission Vehicle (ZEV) mandate, requiring the automaker's California market share to include 2% ZEVs in 1998, 5% ZEVs in 2001, and 10% ZEVs in 2003.

1993- GM estimated that it would take three months to collect the names of 5,000 people interested in the EV-1 – it took one week!

1996- The GM EV1 was made available for lease at $450/month.

1999- GM finalizes its purchase of the Hummer brand name from American General Corporation.

2000- Despite GM's claim that it was still committed to its electric vehicle program, Vice Chairman Harry Pearce says that 'there is no particular need' to continue building electric vehicles.

2002-Toyota RAV4-EV sales begin. Their 2-year supply 8 months.

2002- General Motors, DaimlerChysler and seven other San Joaquin Valley auto dealerships sue the California Air Resources Board in the United States District Court in Fresno, California to try to repeal the Zero Emission Vehicle mandate.

2002- The US Department of Justice files a 'friend of the court brief' in support of GM and DaimlerChrysler's lawsuit against CARB, arguing the ZEV mandate is an attempt to regulate fuel economy standards which only the federal Government can do.

2003- President George W. Bush calls for research/development of hydrogen fuel cell vehicle technology in State of the Union address. Hydrogen fuel cell vehicles said to be only ten years away.

2003- Toyota stops production of the RAV4-EV. It was the only electric vehicle that could be purchased at the end of the lease. (Only 377 were able to be purchased, the rest were crushed.)

2003- AC Propulsion was founded by Alan Cocconi (He was instrumental in designing the electric drive for GM's EV1). Their tZero goes 300 miles on a charge, 0-60 in 3.6 seconds and had a 100 mph top speed.

2003- AC Propulsion tries to sell their drive system to the auto industry. Only a new startup called Tesla Motors is interested.

2006- Tesla signs agreement with Lotus to purchase Elise gliders. They install the AC Propulsion drive system combined with 6,831 Panasonic 18650 Lithium-ion cylindrical battery cells into these gliders.

2008- Tesla Motors begins production of their all electric Roadster in California.

2009- Chrysler Motor Corporation files for bankruptcy. They are bailed out by the US Government and merges with Fiat to form Fiat Chrysler Association.

2009- General Motors files for bankruptcy. They are also bailed out by the US Government. They stop production of Pontiac and Oldsmobile and try to sell the Saturn, Hummer and Saab lines. However, they are unable and just cease production of those lines.

2010- Chevy Volt Plug-In Hybrid and the fully electric Nissan Leaf are introduced.

2011- Fiskar Karma and Th!nk City developed.

2012- Tesla Model S, Coda Sedan, Ford Focus EV, Mitsubishi i-MiEV and second generation Toyota RAV4-EV are all available for sale.

2013- Chevy Spark now available in US. The BMW i3 is unveiled in July.

2014- Kia began marketing the Soul EV.

2015- Tesla Model X, Volkswagen e-Golf and Mercedes-Benz B-Class Electric Drive available for sale.

2015- Tesla starts building their first Gigifactory in Sparks, Nevada. It is a lithium-ion battery and electric vehicle subassembly factory. (Over 6 million square feet, 25% completed.)

2016- Tesla purchases Solar City.

2016- Tesla opens ordering for the new Tesla Model 3 – receives over 276,000 orders in the first 24 hours.

2016- Chevy announces their all electric Bolt at the Consumer Electronics Show in Las Vegas .

2017- Hyundai Ioniq offered as a Hybrid, Plug-in Hybrid and all Electric Vehicle.

2017- Tesla began production of solar cells and solar module at Gigafactory 2 – a 1.2 million square-foot facility in Buffalo, New York.

2017- Tesla introduces their Electric Semi.

2017- Tesla introduces their second generation Roadster with 620+ mile range and a 0-60 speed of 1.9 seconds.

2017- First deliveries of the Tesla Model 3.

2018- Hyundai Kona available for sale.

2019- In January, Tesla officially begins building the Gigafactory 3 in Shanghai, China.

2019- The 6 million square foot Gigafactory 3 opens in December. Production of the Tesla Model 3 begins at the rate of 3,000 vehicles a week.

2019- Audi e-tron, Kia Niro EV and Jaguar I-Pace offered for sale.

2019- Tesla unveils their Cybertruck at the end of November. Received over 200,000 reservations in just 3 days. Current demand outpaces four years of its projected production.

2019- Porsche begins deliveries at year's end of their brand new electric Taycan and Taycan Turbo S.

2020- Tesla begins process to build Gigafactory 4 in Berlin, Germany.

2020- Tesla overtakes Volkswagen as world's second most valuable carmaker.


The Future
NEXT EXIT

In the next few years…

Tesla Cybertruck

Tesla Roadster

Tesla Model Y

Byton M-Byte

Tesla Semi

Fayaday Future FF91

Bollinger B2

Fisker Ocean

Rivian R1T

… we should see these vehicles.

Ford Mustang Mach-E

Tesla Model 2

Mini Cooper SE

Mazda MX-30

Sono Motors Sion

Lucid Motors Air

Polestar 2

Volkswagen Microbus ID Buzz

Mercedes Benz EQC

And further in the future…

Where can I find Electric Vehicles to purchase?

Locations to look for vehicles.

- Cars.com
- Autotrader.com
- Carfax.com
- Evfinder.com
- Edmunds.com
- Currentautomotive.com
- Onlyusedtesla.com
- Carmax.com
- Craigslist
- e-Bay
- Facebook Marketplace
- Carvana
- Car Dealers
- Used Car Lots
- Classified Ads

ALTERNATIVE ENERGY and Transportation

Solar, Powerwalls and Charging

Solar Carports

DIY Powerwall

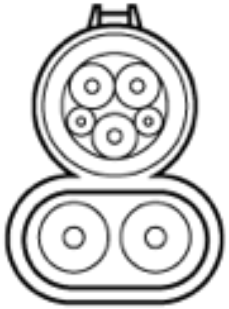
Level 1 Charging

Level 2 Charging

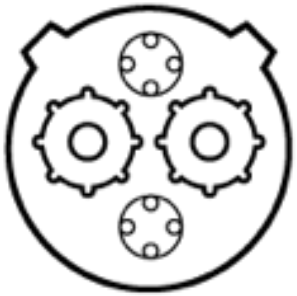
Level 3 Charging

Level 1-3 Connector Types

Connector:
J1772
Level: 2 and 1
Compatibility:
100% of electric cars
Tesla: With adapter



Connector:
SAE Combo CCS
Level: 3
Compatibility:
Check specs of your EV
Tesla: No



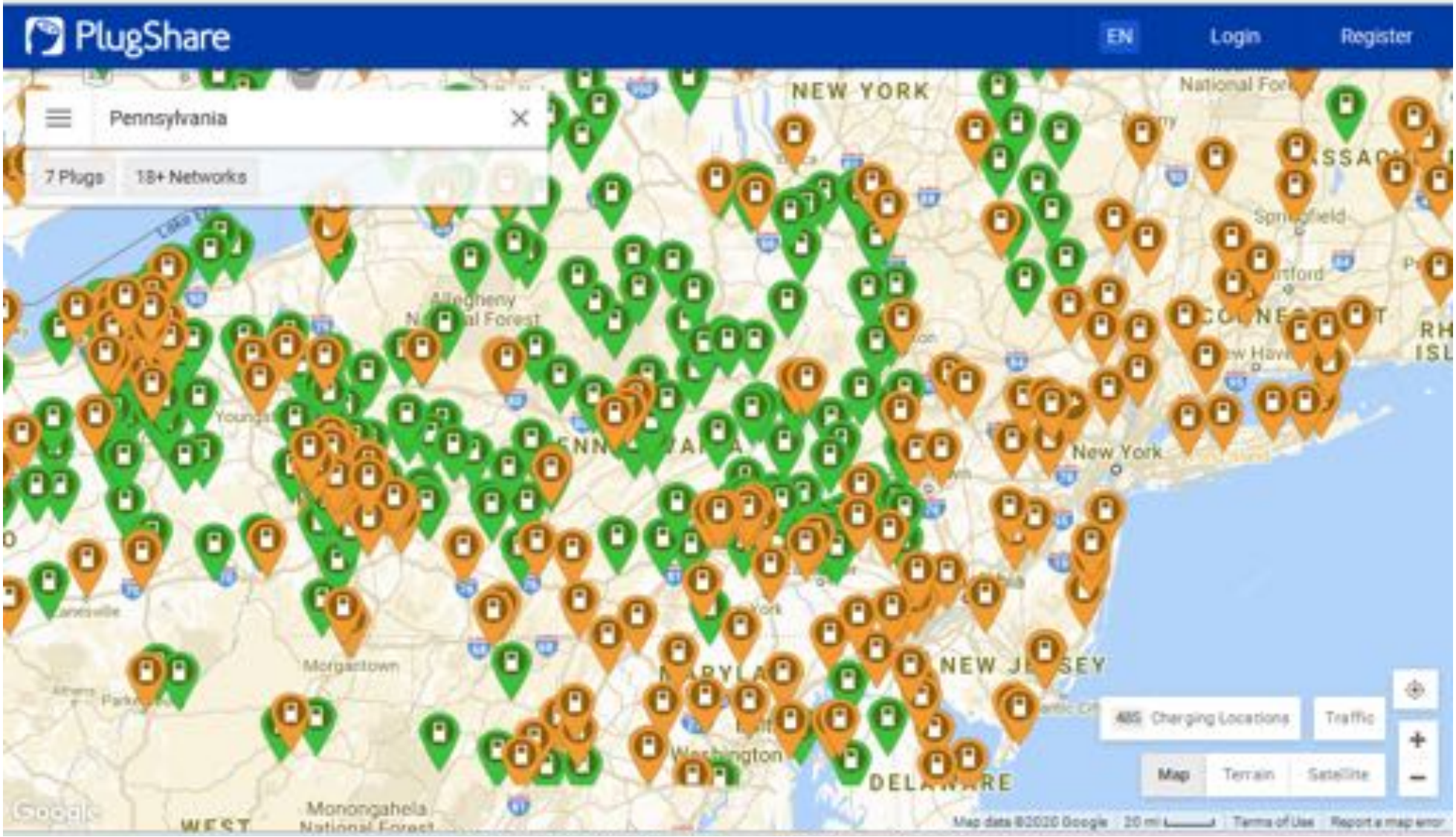
Connector: CHAdeMO
Level: 3
Compatibility:
Check specs of your EV
Tesla: With adapter

Connector:
Tesla supercharger
Level: 3
Compatibility:
Only Tesla
Tesla: Yes

Tesla Supercharger Map

Electrify America Charger Map

PlugShare Map



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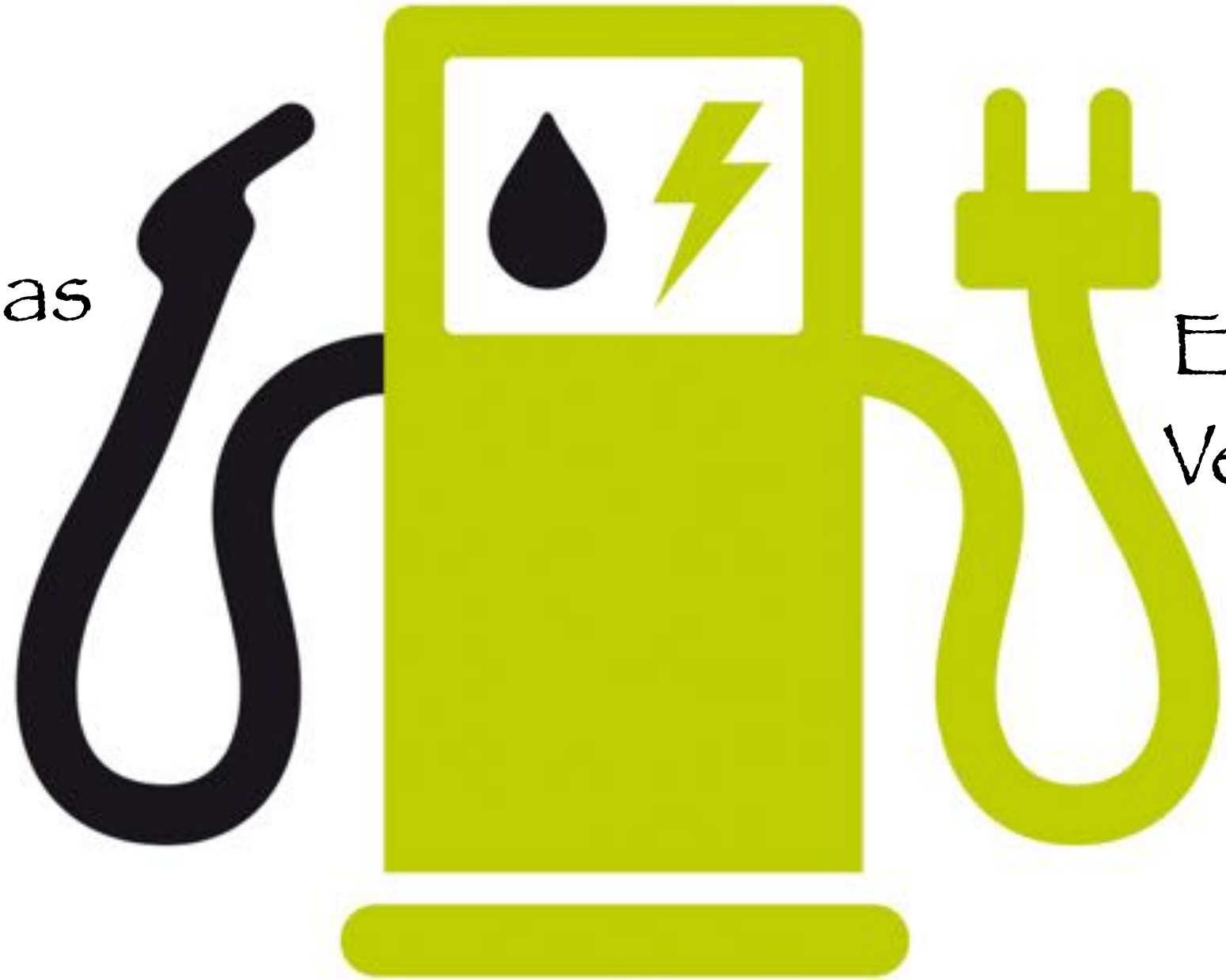


Gas vs. Electric

Electric vehicles require significantly less maintenance than traditional gas-powered vehicles. For example gas cars have/need:

- Engine Oil
- Coolant/Radiator
- Exhaust pipe
- Clutch
- Fuel Injectors
- Engine Belts
- Oil Pump
- Transmission
- Exhaust manifold
- Spark Plugs
- Fuel/Oil/Air Filters
- Timing Chains

Gas vs. Electric

There are some things they have in common in for maintenance. For example both gas cars and electric cars have/need:

- Windshield Washer Fluid and Wiper Blades
- Brake Fluid, Brake Pads (after100,000 miles if the electric car has regenerative braking/more frequently for most gas cars.)
- Tires and Tire Rotation
- Various Light bulbs

The drivetrain in an ICE vehicle contains 2,000+ moving parts typically, whereas the drivetrain in an EV contains around 20.

Gas

- A gallon of gas burned by a gas vehicle adds roughly 19 lbs of Carbon Dioxide to the atmosphere.
- A gasoline vehicle can only use fuel from one source; petroleum.

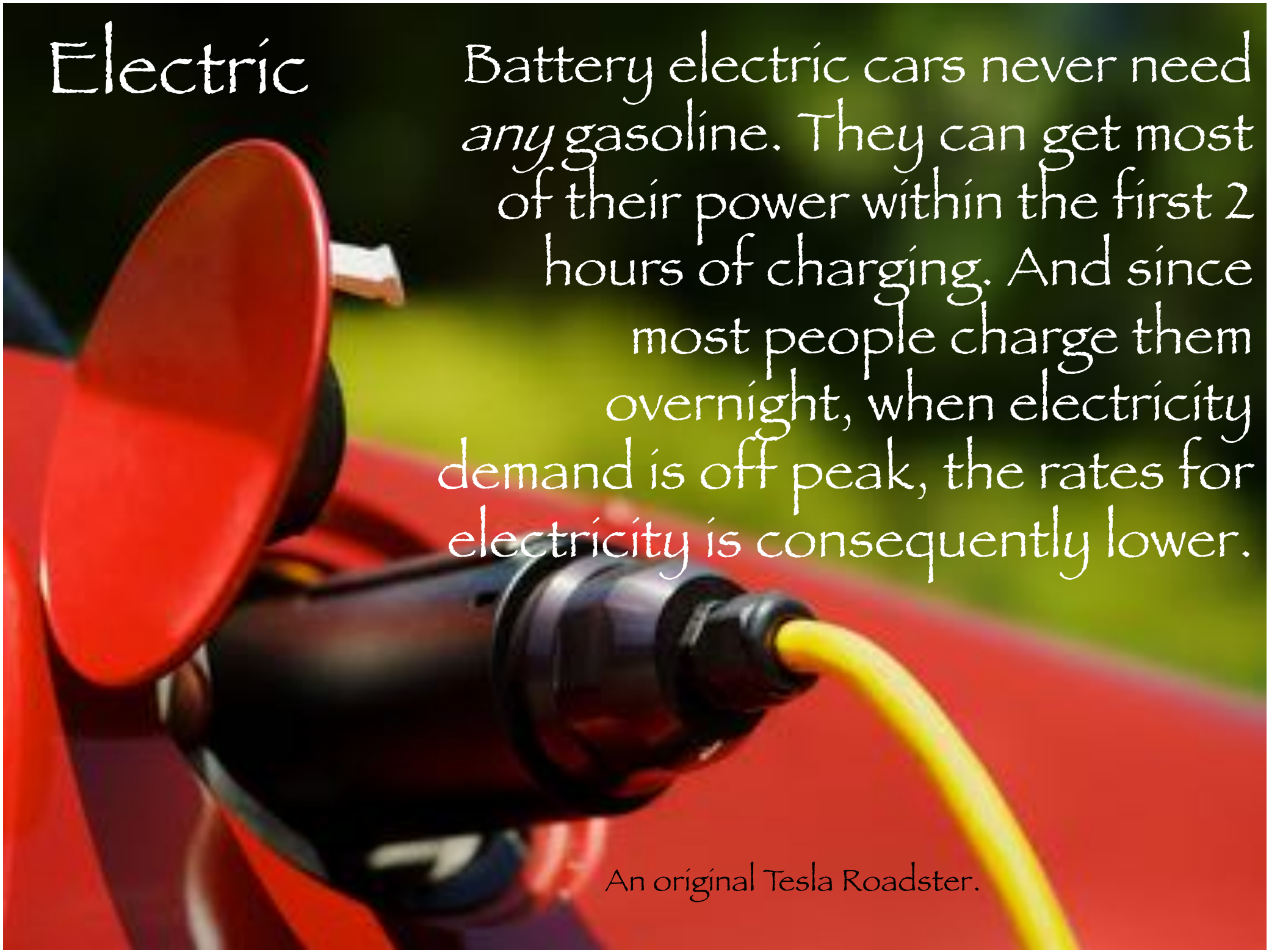
Electric Vehicles

- An electric vehicle fuel source (electricity) can be obtained from multiple forms of generation. Which include, but not limited to: Solar, Wind, Water (Hydro), Geothermal, and also …

  Hamster power.

Electric

Battery electric cars never need *any* gasoline. They can get most of their power within the first 2 hours of charging. And since most people charge them overnight, when electricity demand is off peak, the rates for electricity is consequently lower.



An original Tesla Roadster.

Gas vs. Electric
Simple Economics Time

- Internal combustion engine (ICE) = 20% efficiency
- Electric motors = 90% efficiency

Fuel cost * efficiency = $ to propel and $ to waste/heat

ICE - $3.50 * 20% = $0.70 to propel and $2.80 in heat

EV - $3.50 *90 % = $3.15 to propel and $0.35 in heat

Actual Fuel cost * efficiency = $ to propel and $ to waste/heat

ICE - $42 * 20% = $8.40 to propel and $33.60 wasted

- Gasoline costs $3.50/gallon * 12 gallons = $42/tank

THE END

(Maybe?)

Electric

- In the late 1990s GM had at least a two year jump on the world carmakers with its electric car technology. But instead of capitalizing on its lead with hybrids and more electrics it abandoned its program.
- Although a better battery was available at the time theEV1 debuted with a weaker battery that gave the car nearly half the range of the advanced battery.

Keeping the Status Quo

- Jack Doyle's Taken for a Ride - page 8
  - *Time and time again in the 1950s, 1960s,1970s, 1980s and through the 1990s , the automakers said, "we don't have the technology," "it's impossible," "we don't have the money," "we don't have the engineers," "we're at a competitive disadvantage," "jobs will be lost," "it will take ten years," "we can't change our models that quickly," "it will be too disruptive," "it will make cars unsafe," etc.*