ELECTRIC & HYBRID VEHICLES

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Academic Year 2015-2016


Michel Kant. La voiture électrique. Les techniques de l’ingénieur. Dossier D 5 560.
HISTORY OF EV AND HEV
In 1769, Frenchman Nicholas Cugnot built a steam-powered motor carriage capable of six miles per hour.

In 1825, British inventor Goldsworthy Gurney built a steam car that successfully completed a 85 mile round-trip journey in ten hours time.

Between 1832 and 1839 (the exact year is uncertain), Robert Anderson of Scotland built the first crude electric carriage.

A small-scale electric car was designed by Professor Stratingh of Groningen, Holland, and built by his assistant Christopher Becker in 1835.
Practical and more successful electric road vehicles were invented by both American Thomas Davenport and Scotsmen Robert Davidson around 1842. Both inventors were the first to use non-rechargeable electric cells.

1870 : Sir David Salomon developed a car with a light electric motor and very heavy storage batteries. Driving speed and range were poor.

The first practical electric car may have been built by the English inventor Thomas Parker in 1884.
History – Electric car

- Frenchmen Gaston Plante invented a better storage battery in 1865 and his fellow countrymen Camille Faure improved the storage battery in 1881. This improved-capacity storage battery paved the way for electric vehicles to flourish.
- 1890 – 1910 – Period of significant improvements in battery technology, specifically with development of the modern lead-acid battery by H. Tudor and nickel-iron battery by Edison and Junger.
- Electric vehicles would hold all vehicle land speed records until about 1900.
History

- 1900: The German Dr. Ferdinand Porsche, at age 23, built his first car, the Lohner Electric Chaise. It was the world's first front-wheel-drive.

In 1900 for Paris International exhibition, Ferdinand Porsche designed and built the Elektromobil Lohner-Porsche, a vehicle equipped with 4 motors inserted in the wheel hubs in order to save room.

Porsche's second car was a hybrid, using an internal combustion engine to spin a generator that provided power to electric motors located in the wheel hubs. On battery alone, the car could travel nearly 40 miles.
1899: The Pope Manufacturing Company merged with two smaller electric car companies to form the Electric Vehicle Company, the first large-scale operation in the American automobile industry.

1900: American car companies made 1,681 steam, 1,575 electric and 936 gasoline cars. In a poll conducted at the first National Automobile Show in New York City, patrons favored electric as their first choice, followed closely by steam.

This car, made in 1903 by the Krieger company, used a gasoline engine to supplement a battery pack.
**History**

**1899**: The first car to break the 100 km/h (105.88 km/h) is an electric car: The «Jamais contente» was driven by its Belgian inventor Camille Jenatzy. The car is made of partinium (an laminated aluminum alloy) while its aerodynamics is inspired by torpedoes.
History

- 1899: Henri Pieper, an engineer and car manufacturer from Liege introduces a 3-1/2 horsepower "voiturette" in which the small gasoline engine was mated to an electric motor under the seat.

- When the car was "cruising," its electric motor was in effect a generator, recharging the batteries. But when the car was climbing a grade, the electric motor, mounted coaxially with the gas engine, gave it a boost.

- Pieper’s idea to use electric motor to assist the internal combustion engine allows the vehicle to reach a 25 mph velocity.
As soon as 1905-1906 Henri Pieper creates the petroleo electrical cars, combining a thermal engine with an electric motor. The hybrid vehicle was born.

The Pieper patents were used by a Belgium firm, Auto-Mixte (in Nessonvaux, near Liege), to build commercial vehicles from 1906 to 1912.
History

- **1904:** Henry Ford overcame the challenges posed by gasoline-powered cars — noise, vibration, and odor — and began assembly-line production of low-priced, lightweight, gas-powered vehicles. Within a few years, the Electric Vehicle Company will be failed.

- **1910:** A car maker builds an hybrid truck that uses a 4 cylinder engine spinning a generator, which eliminates the need for a transmission and a battery pack. These trucks are sold up to 1918.

- **1913:** With the advent of the self-starter (making easier for all drivers to start gas engines), steamers and electrics were almost completely wiped out.
History

- 1913. In this year, sales of electric cars dropped to 6,000 vehicles, while the Ford Model T sold 182,809 gasoline cars.
- 1920-1965: Dormant period for mass-produced electric and hybrid cars. So-called alternative cars became the province of backyard tinkerers and small-time entrepreneurs.
- 1966: U.S. Congress introduced first bills recommending use of electric vehicles as a means of reducing air pollution.
- 1973: The Arab oil embargo brings increased gasoline prices and a new interest in electric and hybrid vehicles.

This 1921 Owen Magnetic Model 60 Touring uses a gasoline engine to run a generator that supplies electric power to motors mounted in each of the rear wheels.
History

- **1970-1980:** “VW Taxi” produced by Volkswagen in Wolfsburg, West Germany. The Taxi, which used a parallel hybrid configuration allowing flexible switching between the gasoline engine and electric motor, logged over 8,000 miles on the road, and was shown at auto shows throughout Europe and the United States.

- **1975:** AM General, a division of American Motors, began delivery of 352 electric vans to the U.S. Postal Service for testing.

- **1975:** Government program to advanced electric and hybrid technology is implemented by the U.S. Energy Research and Development Administration.
History

- **1976**: U.S. Congress enacted Public Law 94-413, the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976. Among the law’s objectives were to work with industry to improve batteries, motors, controllers, and other hybrid-electric components.

- **1976**: General Electric was chosen to construct a parallel-hybrid sedan, and Toyota built its first hybrid — a small sports car with a gas-turbine generator supplying current to an electric motor.

- **1977-1979**: General Motors spent over $20 million in electric car development and research, reporting that electric vehicles could be in production by the mid-1980s.
History

- 1982: « All about Electric & Hybrid Cars » by Robert J. Taister. The author emphasizes the battery problem which should be circumvented by using a generator onboard and charge the batteries while driving downhill for instance.

- 1991: United States Advanced Battery Consortium (USABC) launches a program to make a “super” battery in hopes of getting electric cars on the road as soon as possible. The USABC invests over $90 million in the nickel hydride battery which can “accept three times as many charge cycles as lead-acid” and also works well in the cold weather.

- 1992: Toyota Motor Company releases a document that outlines goals to develop and market vehicles with the lowest emissions possible. It is called the “Earth Charter.”
History

- 1997: The Toyota Prius was introduced to the Japanese market, two years before its original launch date, and prior to the Kyoto global warming conference held in December. First-year sales were nearly 18,000.

- 1997-1999: A small selection of all-electric cars from the big automakers — including Honda’s EV Plus, GM’s EV1 and S-10 electric pickup, a Ford Ranger pickup, and Toyota’s RAV4 EV — were introduced in California. Despite the enthusiasm of early adopters, the electrics failed to reach beyond a few hundred drivers for each model. Within a few years, the all-electric programs were dropped.
1999: **Honda** released the two-door **Insight**, the first hybrid car to hit the mass market in the United States. The Insight won numerous awards and received EPA mileage ratings of 61 mpg city and 70 mpg highway.

2000: Toyota released the **Toyota Prius I**, the first hybrid four-door sedan available in the United States.

2002: Honda introduced the Honda Civic Hybrid, its second commercially available hybrid gasoline-electric car. The appearance and drivability of the Civic Hybrid was (and still is) identical to the conventional Civic.
History

- **2004**: The **Toyota Prius II** won 2004 Car of the Year Awards from Motor Trend Magazine and the North American Auto Show. Toyota was surprised by the demand and pumped up its production from 36,000 to 47,000 for the U.S. market. Interested buyers waited up to six months to purchase the 2004 Prius. Toyota Motor Sales U.S.A. President Jim Press called it "the hottest car we've ever had."

- **2005**: **Ford** released the Escape Hybrid, the first American hybrid and the first SUV hybrid. Toyota also released several models equipped with hybrid propulsion system **Lexus RX400h**, **Lexus GS300h** etc.

- **2007**: Toyota sold one million of Prius II around the world.
# Electric Vehicles on Sale

Top selling highway-capable electric cars and light utility vehicles produced since 2008 through June 2013

<table>
<thead>
<tr>
<th>Model</th>
<th>Market launch</th>
<th>Global sales</th>
<th>Sales through</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nissan Leaf</td>
<td>Dec 2010</td>
<td>~ 69,000</td>
<td>June 2013</td>
</tr>
<tr>
<td>Mitsubishi i-MiEV family</td>
<td>Jul 2009</td>
<td>~ 25,600</td>
<td>June 2013</td>
</tr>
<tr>
<td>Tesla Model S</td>
<td>Jun 2012</td>
<td>12,700</td>
<td>June 2013</td>
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<tr>
<td>Chery QQ3 EV</td>
<td>Mar 2010</td>
<td>7,105</td>
<td>June 2013</td>
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<tr>
<td>JAC J3 EV</td>
<td>2010</td>
<td>4,918</td>
<td>June 2013</td>
</tr>
<tr>
<td>Renault Zoe</td>
<td>Dec 2012</td>
<td>4,818</td>
<td>June 2013</td>
</tr>
<tr>
<td>Mitsubishi Minicab MiEV</td>
<td>Dec 2011</td>
<td>4,627</td>
<td>June 2013</td>
</tr>
<tr>
<td>Renault Fluence Z.E.</td>
<td>2011</td>
<td>3,518</td>
<td>June 2013</td>
</tr>
<tr>
<td>Smart electric drive</td>
<td>2009</td>
<td>&gt; 3,100</td>
<td>June 2013</td>
</tr>
<tr>
<td>BYD e6</td>
<td>May 2010</td>
<td>2,854</td>
<td>June 2013</td>
</tr>
<tr>
<td>Tesla Roadster</td>
<td>Mar 2008</td>
<td>~ 2,500</td>
<td>Dec 2012</td>
</tr>
<tr>
<td>Bolloré Bluecar</td>
<td>Dec 2011</td>
<td>2,200</td>
<td>June 2013</td>
</tr>
</tbody>
</table>
History

Renault Twizzy, Zéro, Fluence, Kangoo

Mitsubishi MiEV, Citroën C-zéro, Peugeot ion

Smart EV

Nissan Leaf

Tesla
History

- Evolution of electric vehicle towards smaller urban car (L7)
Bikes and four wheeled bikes

- Reva electric
- Renault Twizzy
- Zen car
- Electric bikes
- Segway
- E-Scooters
Plug-in hybrids

Opel Ampera

Toyota Prius Plug-in hybrid

Imperia GP
History and perspectives

Global HEV/PHEV/EV Market Projections

Global xEV Volume by Type (Million Units), Percentage Global Vehicle Sales

Sales of EV and HEV (VE + PHEV): Up-to 26% of the vehicle sales in Belgium by 2020 (???)
History and perspectives

- Forecast by ERTRAC strategic agenda
The electric car exist from the eve of automobile in the end of 19th century

After a rather erratic period that ends up in the 30ies, the piston engine has definitively won the contest and has been, since that time, the dominating solution for road vehicles

Electric machines has intrinsically superior characteristics superior to piston engines:
- Constant power in a large range of operation
- No idle regime
- Easy maintenance
- Reliability
History – Electric car

- However the energy storage system based on batteries appears to be less efficient than petrol that was abundant and cheap:
  - Higher specific energy so longer range and autonomy
  - Easiness of maintenance
  - Not expensive
  - Abundant

- Nowadays, while one might have believed that electric drivetrain was forgotten for ever, piston engine is the victim of its success story:
  - Reduction of petrol resources
  - CO₂ emissions
  - Emissions of pollutants from combustion
In the beginning of the 21st century, the electric motor could be the final winner.

Indeed, in order to preserve individual mobility, one needs vehicles with:
- Less pollutants
- Less noise
- Less fuel consumption
Electric powertain for road vehicles

- Advantages:
  - Zero emissions on site → urban application
  - Zero (low) noise emissions
  - Simple mechanical transmission (no gear box)
  - Torque and speed regulation possible
  - Energy recovery while braking
  - High torque at low and zero speed
  - Smooth operation
  - No range limitation if external power supply (catenaries for trains)

- Disadvantages:
  - Weight penalty and cost of batteries
  - Limited autonomy is batteries (Max 200 km)