

## Electric Vehicles



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## Summary

- Introduction
- History
- Motivations
- What's a Electric Vehicle?
- Types of Electric Vehicles
- Detailed comparison between Electric and Combustion Vehicles
- Future Vehicles



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## Introduction

- Electric Vehicle theme has known a growing propagation in our society and manufacturers, specially in this two last decades, but is not a truly new theme.
- Successive energy crisis in the end of the XX century, the environment growing concerns and the take of conscience regarding fuel availability limits, brought on evidence the electric vehicles as an alternative to combustion vehicles.



For more information....

Neutro À Terra (Revista Técnico-Científica Nª4 – Outubro 2009) – [www.neutroaterra.blogspot.com](http://www.neutroaterra.blogspot.com)

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de Engenharia  
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## Introduction

- Transport sector is responsible for large consumption of energy, and growing annually.



- In the urban areas, the replacement of combustion transports for electric ones, will benefit the levels of pollution in a large scale, as noise levels too.

For more information....

Neutro À Terra (Revista Técnico-Científica Nª4 – Outubro 2009) – [www.neutroaterra.blogspot.com](http://www.neutroaterra.blogspot.com)

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## Introduction

- In general terms, the electric power plants emissions, based on the fossil fuels, associated with the electric vehicles proliferation, will be less inferior than the sum of the emissions of all combustion engines running today.
- The reasons are the higher efficiency from the electric engines compared to combustion engines, as well as being capable of making regenerative braking.



For more information....

Neutro À Terra (Revista Técnico-Científica Nº4 – Outubro 2009) – [www.neutroaterra.blogspot.com](http://www.neutroaterra.blogspot.com)

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## Introduction

- Electric Vehicle proliferation will be dictated by the actual transport users, which in the developed countries case, it's the generality of their citizens.



- It means, that at the least, electric vehicles need to have the common characteristics from the actual ones, like safety and security systems, comfort, reliability, performance, at affordable prices.

For more information....

Neutro À Terra (Revista Técnico-Científica Nº4 – Outubro 2009) – [www.neutroaterra.blogspot.com](http://www.neutroaterra.blogspot.com)

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## Introduction

## Comparison between Electric and Combustion Vehicles:

	Electric Vehicles	Combustion Engine Vehicles
Engine type	Electric Engine	Internal Combustion Engine
Energy Source	Batteries, Fuel Cells or Super Capacitors	Gasoline or Diesel
Weight	High ( mainly because batteries weight)	Low, in comparative terms
Power Transmission	Can exist without gearbox	With gearbox (manual or automatic)
Braking	Regenerative	Dissipative
Efficiency	High	Low
Environmental Footstep	Reduced	High
Initial Cost	High	Medium
Maintenance Costs	Reduced	Very High

For more information....

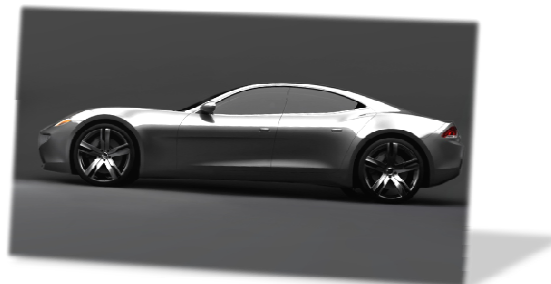
Neutro À Terra (Revista Técnico-Científica Nª4 – Outubro 2009) – [www.neutroaterra.blogspot.com](http://www.neutroaterra.blogspot.com)

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## Introduction

- For the success of electric vehicles, the technology developments in the power electronics (new convertor architectures), electrical machines (new engine conception and materials evolution), control systems ( energy flow optimized management) and storage energy systems, is a huge contribution.



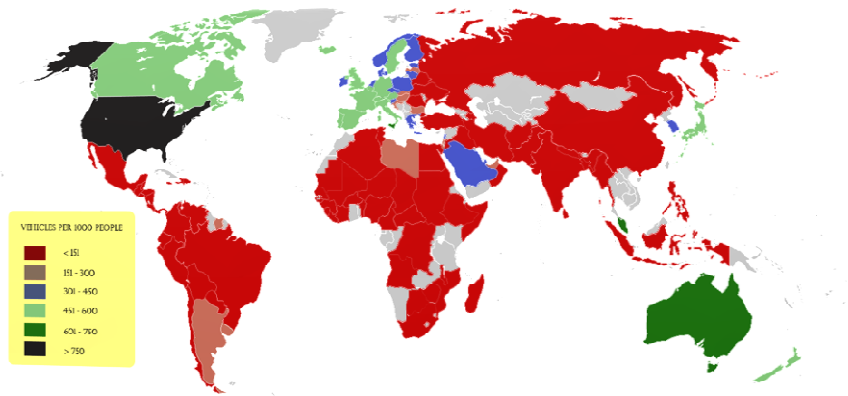
For more information....

Neutro À Terra (Revista Técnico-Científica Nª4 – Outubro 2009) – [www.neutroaterra.blogspot.com](http://www.neutroaterra.blogspot.com)

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## Introduction



For more information...  
[www.wikimedia.org](http://www.wikimedia.org)

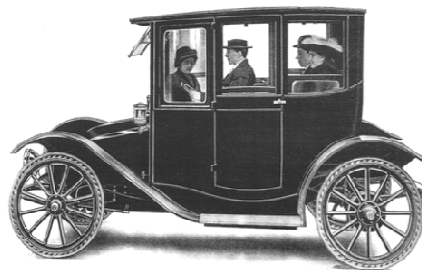
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## History



This rare picture shows what the underside of an electric car really looked like. There is a huge bank of storage batteries connected by heavy cables to a powerful driving motor mounted just in front of the rear axle. Since the car went slowly and usually travelled on paved city streets, the tires could be solid so the female driver never had to contend with a flat or blowout. The car is illustrated below



The Argo Fore-Drive Electric  
 Our Latest Town Car Ideal

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## History

- In the beginning of the XIX century, there were more electric vehicles than combustion ones, mainly because they're silent and didn't scare the horses.
- The principal manufacturers were Baker Electric, Columbia Electric and Detroit Electric.



For more information...  
Veículos Eléctricos – Hélder Filipe Matos Fernandes – 2007

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## History

- Around 1910, with the appearance of Ford Model T and with its price, it was the first signs that electric vehicles were going to disappear, mainly because Model T was sold for half of the price compared to the electrical ones.



- Around 1915, less than 2% of 2,5 million cars on the roads were electric.

For more information...  
Veículos Eléctricos – Hélder Filipe Matos Fernandes – 2007

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## History

- After 1920, the combustion vehicles won the market, because of their innovations, like the electric starter, rubber tires, ignition system, carburetor, making combustion vehicles easier to drive.
- With the development of roads and highways and the need for more autonomy for longer travels, allowed the proliferation and domination for combustion vehicles.

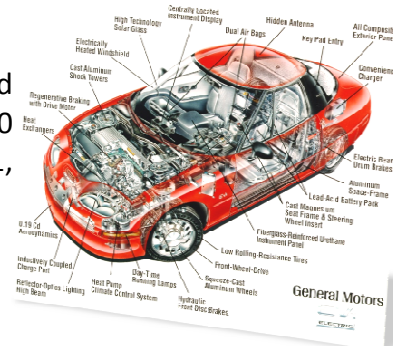


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## History

- In 1990, the interest in the electric vehicles comeback, with the start of the energy crisis and fluctuations of fuel market. General Motors introduces the EV1.
- GM estimated that it would take 3 months to collect 5000 people interested in the EV1, but it only took one week



For more information...  
Electric Auto Association – Electric Vehicles ([www.eaaev.org](http://www.eaaev.org))  
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## History

- In 1991, Reva Electric Car Company started producing their REVA, a city car that measures 2,6 meters. It's the world best electric car sold of all time.
- In 2008, they launched a evolution from their REVA, the REVAi, with a new chassis, brake discs and with a improved top speed to 80 Km/h.

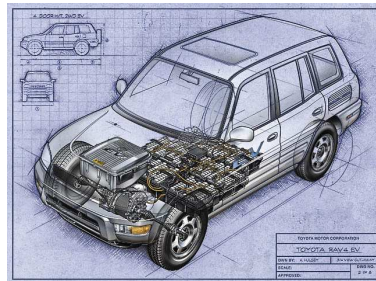


For more information...  
 Revaglobal.com and Wikipedia.org  
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## History

- In 1997, Toyota introduced is RAV4-EV, the same model was available with combustion engine, but the RAV4-EV could only be leased to customers.
- Toyota production vehicles estimation for 2 years, was leased after 8 months and there were enormous waiting lists.
- The production stopped in 2003.



For more information...  
 Electric Auto Association – Electric Vehicles (www.eaaev.org)  
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## History

- In 2006, Tesla Motors introduced Tesla Roadster, it's a sport car with a capacity for 393Km and top speed of 200Km/h (limited).
- It's a highway capable electric vehicle.
- It was the first electric vehicle to use Lithium-Ion batteries.
- More than 800 Roadster sold till today.



For more information...  
Tesla Motors – [www.teslamotors.com](http://www.teslamotors.com)  
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## Motivations

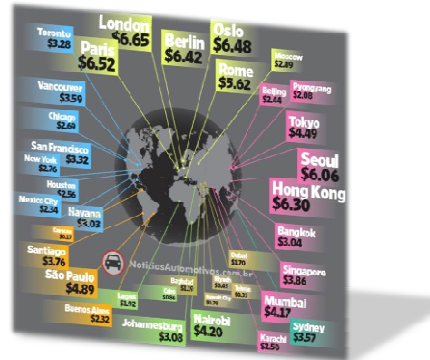


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## Motivations

- The environmental impacts and economical from the fossil fuels have a strong source from the transport sector.
- This fact has motivated, in this last two decades, a research increase on electric vehicles, specially hybrid solutions.



For more information...  
Neutro À Terra (Revista Técnico-Científica Nº4 – Outubro 2009) – [www.neutroaterra.blogspot.com](http://www.neutroaterra.blogspot.com)

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## Motivations - Environmental

- Air pollution consists of substances present in the atmosphere in high enough levels to harm humans, other animals, plants, or materials.
- Air pollution can result from human activities such as driving cars. It can also come from natural sources, such as smoke from forest fires caused by lightning or from volcano eruptions..



For more information...  
WWF – Pakistan ([wwfpak.org](http://wwfpak.org)) – December 2009

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## Motivations - Environmental

- Pollution caused by humans is now disturbing the delicate balance of nature on earth. Far from being a new problem, pollution has been around for centuries. However, as the population increases, pollution problems also increase.
- Major Air Pollutants:
  - Suspended Particulate Matter
  - Volatile Organic Compounds
  - Carbon Monoxide
  - Nitrogen Oxides
  - Sulphur Oxides
  - Lead & other heavy metals
  - Ground Level Ozone
  - Fuel Wood

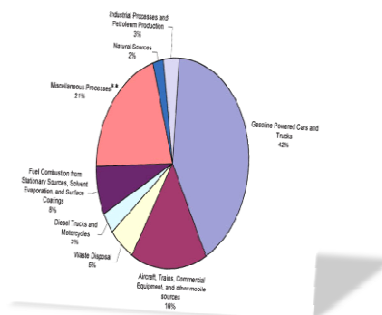


For more information...  
WWF – Pakistan (wwfpak.org) – December 2009  
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## Motivations - Environmental

- The two main sources of air pollution are motor vehicles & industries. When they burn petrol, cars and trucks release significant quantities of sulphur dioxide, oxides of nitrogen, carbon monoxide, lead, and suspended particulate matter.
- Lead used in petrol to protect engines is also dangerous. Diesel powered cars produce large quantities of particulates in the form of black soot. Reduced use of private cars, proper legislation and enforcement of laws can curb this menace.



For more information...  
WWF – Pakistan (wwfpak.org) – December 2009  
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### Motivations - Economical

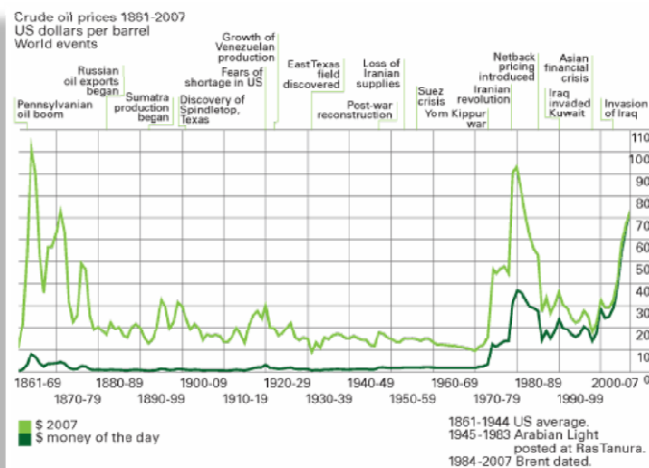
- With the fuel prices and the fluctuation of oil and petrol prices, society is looking forward to more fuel saving solutions or solutions without fuel necessity, that's were Electric Vehicles come to the subject, the interest is growing every day.
- In these times were fuel availability is coming to a limit and the prices increasing, new opportunities appear, with the society interest in more efficient solutions, manufacturers research is now focused in electric and hybrid vehicles.



For more information...  
 Google.com  
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### Motivations - Economical



For more information...  
 BP (www.bp.com)  
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## What's a Electric Vehicle?



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## What's a Electric Vehicle?

- A Electric Vehicle is a type of vehicle that uses electric engines to move or to drive persons, objects or a specific load. It can use one or more engines to move and in many types of vehicles (cars, motorcycles, bus, airplane, etc.).



- 1 Charging Plug
- 2 Switch/Reconnect
- 3 Battery
- 4 Contacts Box
- 5 High Voltage Wires
- 6 Control Module
- 7 Power Electronic Unit
- 8 Electric Motor
- 9 Electric Wheel/Pump
- 10 Gearbox



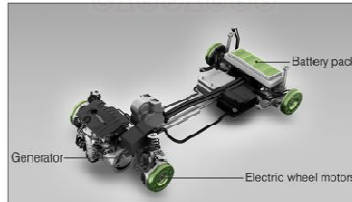
For more information...  
Veículos Eléctricos – Hélder Filipe Matos Fernandes – 2007  
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## What's a Electric Vehicle?

- Electric Vehicles are composed by the following elements:

- Energy Management System
- Energy Storage System
- Electric Propulsion System



For more information...

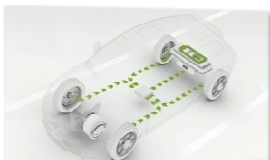
Neutro À Terra (Revista Técnico-Científica Nº4 – Outubro 2009) – [www.neutroaterra.blogspot.com](http://www.neutroaterra.blogspot.com)

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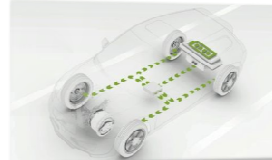


## What's a Electric Vehicle?

- Energy System Management has a fundamental importance, since the energy flow, as in the “engine mode” (batteries to engine), as in “regenerative mode” (engine to batteries), has to have elevated efficiency.



- In the “regenerative mode” (vehicle slowdown periods), the kinetic energy reduction doesn't translate to dissipation, but in energy storage.



For more information...

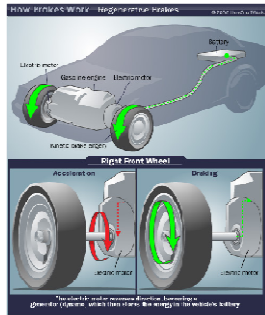
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## What's a Electric Vehicle?

- What's "regenerative mode" ?
  - "Regenerative mode" is when the user is braking or slowdown, uses the fact that a electric engine, can work as generator too. The electric engine is used as a generator during braking periods, the energy created by the kinetic energy, is then used to charge the batteries



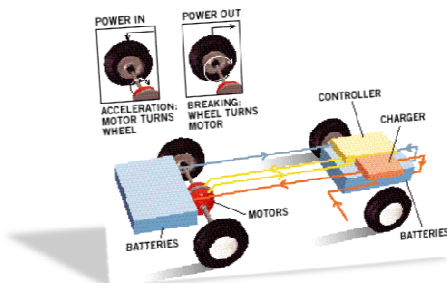
- During the braking, the flow of energy from the electric engine changes, in a way, that the electric engine becomes a generator, the rotor becomes the inductor and the stator the induced.
- The charge system receives the energy from the stator and then converts into energy, for charging the batteries.

For more information...  
HowStuffWorks – howstuffworks.com  
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## What's a Electric Vehicle?

- Storage energy systems nowadays, are the "weak" point, not the system itself, but the autonomy of the electric vehicles. This fact only shows why, manufacturers only offer hybrid solutions nowadays.



- In this late few years, there were important evolutions on this area, but still needs to have great improvements.

For more information...  
Neutro A Terra (Revista Técnico-Científica Nª4 – Outubro 2009) – www.neutroaterra.blogspot.com

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## What's a Electric Vehicle?

- In terms of storage energy systems, the main characteristics are:

- Specific Energy (Wh/Kg);
- Specific Power (W/Kg);
- Energy Density (Wh/Volume);
- Power Density (W/Volume);
- Useful Life (Number of Cycles);
- Functioning Temperature;
- Cost

ENGINE	
Type	Electric motor
Motor type	Asynchronous motor
Output	150/204
Thrust (from roller)	kWhip
	Nm
Max. RPM (cut-off)	min <sup>-1</sup>
	>2000
ELECTRICAL SYSTEM	
Battery capacity	kWh
Battery weight	kg
Battery charge time (h)	at 1.10 V/12 A
	(1.3 kW)
	at 2.40 V/32 A
	(7.2 kW)
	at 2.40 V/48 A
	(11.6 kW)
Battery design	14 cells connected in parallel constitute a unit, 2 units reconnected in series constitute a module. 48 modules connected in series constitute the battery. 5,000 individual cells in total.
Battery cooling	Air cooling via temperature. Ice-cold liquid coolant circulates from extends rearward from the heel plate, rolls to the rear seat bench.
Battery location	
Peak current	A
	Short bursts of up to 300A

For more information...

Neutro A Terra (Revista Técnico-Científica Nº4 – Outubro 2009) – [www.neutroaterra.blogspot.com](http://www.neutroaterra.blogspot.com)

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## What's a Electric Vehicle?

- There's various types of storing the energy :

- Batteries;
  - They've got specific energy values higher than the super capacitors and inferiors to the Fuel Cell's, in terms of specific power values, they're lower than the capacitors and higher than Fuel Cell's.
- Super Capacitors;
  - They've got higher values of specific power, yet they have lower values of specific energy, the reasons they're used as complement of Batteries or Fuel Cell's. They've got short periods of charging and functioning cycles higher than batteries.
- Fuel Cell;
  - These systems produces electric energy, by chemical reactions between the hydrogen and oxygen, being the result the water vapor. The environmental impact is null, and the efficiency is very high. They're still object for research, with the goals to improve their costs and characteristics.

For more information...

Neutro A Terra (Revista Técnico-Científica Nº4 – Outubro 2009) – [www.neutroaterra.blogspot.com](http://www.neutroaterra.blogspot.com)

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## What's a Electric Vehicle?

- There are some requisites for batteries that need to be fulfilled, like:
  - Ability for working in the cold or extreme hot temperatures;
  - Low Maintenance;
  - Low Cost;
  - Universal;
  - Security;
  - Adequate for the application.
- There are very types of batteries, like:
  - Nicd;
  - Nickel Metal Hybrid;
  - Lithium Ion;
  - Li-Ion;
  - Zinc-Air;
  - Molten Salt.

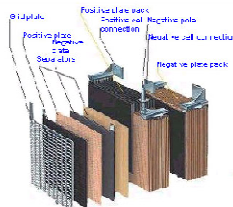


For more information...  
 Wikipedia.org and Veículos Eléctricos – Hélder Filipe Matos Fernandes – 2007  
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## What's a Electric Vehicle?

- Main Characteristics about Batteries:
  - Specific Energy (Wh/Kg), if it's a high value, it means more autonomy;
  - Energy Density (Wh/l), if it's a high value, it means less space needed;
  - Specific Power (W/Kg), if it's a high value, it means more performance;
  - Life Cycles (# recharges), if it's a high value, it means more useful life;
  - Recharge Time, if it's a low value, more practical.



For more information...  
 Wikipedia.org and Veículos Eléctricos – Hélder Filipe Matos Fernandes – 2007  
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## What's a Electric Vehicle?

	Pb/ac	Ni/Cd	NiHM	Li-Ion	Li/p	Na/NiCl <sub>2</sub>	Object USAB C
<b>Specific energy(Wh/kg)</b>	35-40	55	70-90	125	155	80	200
<b>Specific Power(W/kg)</b>	80	120	200	260	315	145	400
<b>Energy Density(Wh/m<sup>3</sup>)</b>	0	90	90	200	165	130	300
<b>Life Cycle ( Number of recharge Cycles)</b>	300	1000	600	+600	+600	600	1000
<b>Recharge Time(h)</b>	6-8	6-8	6	4-6	4-6	4-6	3-6
<b>Autonomy (km)</b>	75	100	200	200	250	200	250
<b>Cost (€ / kWh)</b>	100	400	550	-	-	-	<90

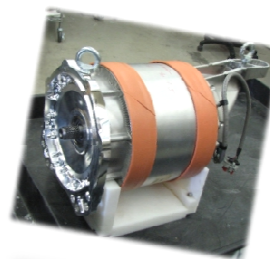
For more information...  
 Wikipedia.org and Veículos Eléctricos – Hélder Filipe Matos Fernandes – 2007  
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## What's a Electric Vehicle?

- **Electrical Propulsion System**

- It's composed by:
  - Electric Engine;
  - Power Converter;
  - Controller;
  - Mechanical transmission system.



- The demands for electric vehicles regarding engines are high, they need engines with particular characteristics, like elevated power densities and torque, high efficiency in different load regimes and moderated costs.
- Electrical Propulsion Systems may allow the user to have high instantaneous power, with great efficiency in every function modes.

For more information...  
 Neutro A Terra (Revista Técnico-Científica Nª4 – Outubro 2009) – www.neutroaterra.blogspot.com

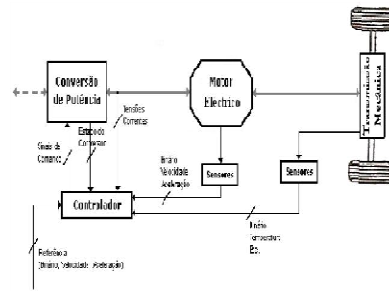
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## What's a Electric Vehicle?

- We can see in the image bellow, mechanical and power characteristics typical for electrical propulsion systems.
- In the same image, we can see the typical mechanical characteristics for a combustion engine (dashed).

- The grey arrows represents the energy flow.



For more information...

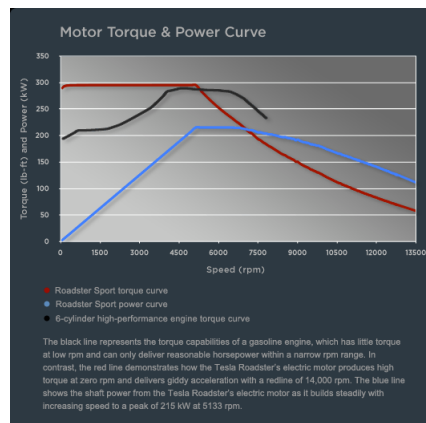
Neutro À Terra (Revista Técnico-Científica Nº4 – Outubro 2009) – [www.neutroaterra.blogspot.com](http://www.neutroaterra.blogspot.com)

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## What's a Electric Vehicle?

- In the electric engines, high torque values are achieved in the low rpm, compared to the combustion engines, we can see a enormous difference in the low rpm.
- The power constant zone function is accomplished by combustion engines with a multiple transmission system, which in the electrical aren't needed.



For more information...

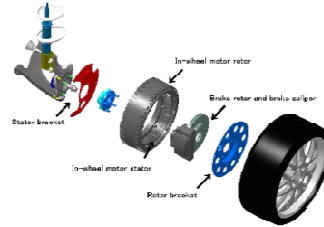
Neutro À Terra (Revista Técnico-Científica Nº4 – Outubro 2009) – [www.neutroaterra.blogspot.com](http://www.neutroaterra.blogspot.com) & [Teslamotors.com](http://Teslamotors.com)

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## What's a Electric Vehicle?

- The electrical propulsion systems are known by their associated engine, nowadays the more important and used are:
  - Continuous Current Engine (DC);
  - Three Phase Induction Engine;
  - Synchronous Motor Permanent Magnets;
  - Brushless DC Motors;
  - Switched Reluctance Motor.
- The engines can be mounted in different ways, they can be mounted on the front of the vehicle (FWD), in the back (RWD), four wheel drive (4WD) and can be mounted directly on the wheels (in-wheel mounted).



### For more information...

Neutro À Terra (Revista Técnico-Científica N°4 – Outubro 2009) – www.neutrotterra.blogspot.com && Veículos Eléctricos – Hélder Filipe Matos Fernandes – 2007

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## What's a Electric Vehicle?

- System Control is responsible for monitoring the engine or engines function, battery and traction for the vehicle. Nowadays, electric controllers are electric, mainly for being very flexible and with high efficiency.
- The controllers are known by “choppers” in DC engines and Inverters in AC engines
- System Control is also responsible for the engine, when regenerative braking is applied, assuring that the engine inverts his logic, for functioning like a generator.



### For more information...

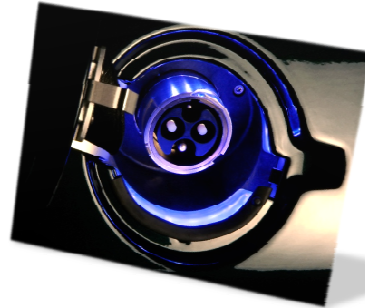
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## What's a Electric Vehicle?

- Charging System has to transform the alternate current from the grid or from the alternator, in continues current and with the right tension to recharge the batteries.
- The volume and weight are important aspects for the charging systems that are built "on-board".
- Normally is needed to recharge the batteries everyday, being the weak point for electrical vehicles.
- Charging time can be from 2 to 16 hours.



For more information...  
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## Types of Electric Vehicles



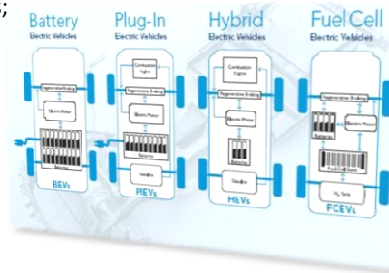
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## Types of Electric Vehicles

- Nowadays, there are many types of electric vehicles, that uses electric engines for locomotive effect. They're all considered electrical vehicles, but it's necessary to make some distinction:

- On and Off Road Electric Vehicles;
- Hybrid Electric Vehicle;
- Rail borne Electric Vehicles;
- Airborne Electric Vehicles;
- Seaborne Electric Vehicles;
- Space borne Electric Vehicles.



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## Types of Electric Vehicles

- On and Off road Electric Vehicles are those that only depend on the electric engine for locomotion, electric energy is the only source for traction.
- We can have inside On and Off category, various types of vehicles:
  - Battery Electric Vehicles;
  - Fuel Cell Electric Vehicles;
  - Solar Electric Vehicles;
  - Electric Wired Vehicles (Public Transportation).



For more information...  
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## Types of Electric Vehicles

- Hybrid Electrical Vehicles are those that use combustion engines (gasoline, diesel, ethanol, etc.) and also electric engines, that in certain regimes they're considered electric hybrid engines.



- The Hybrids still pollute, but in less quantity, because in certain regimes only the electrical engine is working, in other cases, both are running, decreasing fuel consumption.

For more information...  
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## Types of Electric Vehicles

- Rail borne Electric Vehicles Examples



- Air borne Electric Vehicles Examples



For more information...  
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## Types of Electric Vehicles

- Sea borne Electric Vehicles Examples



- Space borne Electric Vehicles Examples

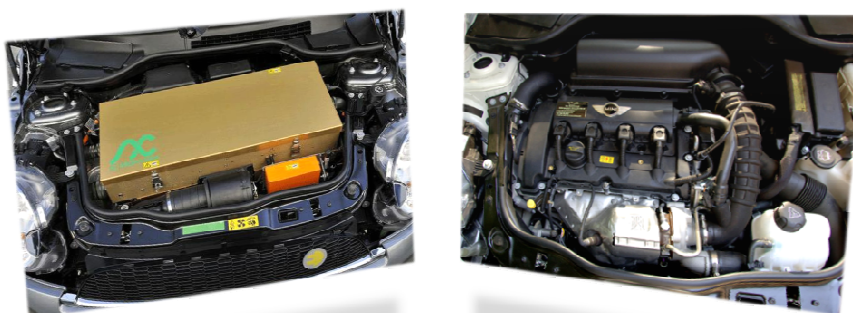


For more information...  
Wikipedia.org

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## Detailed Comparison between Electric and Combustion Vehicles



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## Detailed Comparison between Electric and Combustion Vehicles

- User Cost:
  - While vehicles with combustion engines can at the minimum get fuel consumption of 3L/100 KM, the electric vehicle makes a consumption of 1,5L/100KM, with a approximated cost of 2 to 3 cents per kilometer;
  - Combustion Engine Vehicles cost 8 to 10 times more per kilometer;
  - The total cost for a electrical vehicle depends on the type of batteries, their capacity, which determines their autonomy, recharge time and lifetime as well as final cost for the user.

For more information...  
Veículos Eléctricos – Hélder Filipe Matos Fernandes – 2007  
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## Detailed Comparison between Electric and Combustion Vehicles

- Acquisition Cost:
  - The initial cost for a electric vehicle (only power source is electrical energy) can be higher than the traditional combustion vehicle. Yet, this price difference can be recovered pretty easily with the economy in energy terms;
  - In some countries, the legislation favors those that have a electric vehicle, with tax reduction when the vehicle is bought while during the lifetime of the vehicle;
  - Nowadays, there is lot of skepticism around electric vehicles, mainly because the autonomy, recharging time and lifetime of the batteries.

For more information...  
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## Detailed Comparison between Electric and Combustion Vehicles

- Energy Efficiency and Carbon Dioxide Emissions:
  - Electrical Vehicles consumption is around 0,1 to 0,23 KW/h per Km. About half of this consumption is because inefficiency of battery charge. The average fuel consumption for a petrol vehicle In the USA is 10,2 L/Km, which is equivalent to 0,98 KW/h per Km, a Hybrid consumes in average 0,32KW/h per KM (considering 8,0KW/h per liter of fuel).
  - This shows that Hybrid Vehicles are more efficient than traditional combustion engines, but Electric Power Source Vehicles are even more efficient.
  - Electricity generation and fuel production are different energy categories, with different inefficient and environmental impacts,
  - Electric Vehicles, depending on the source of electric energy used to recharge of the batteries, produce between 55 to 99,9% less emissions of Co2.

**For more information...**

Veículos Eléctricos – Hélder Filipe Matos Fernandes – 2007

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## Detailed Comparison between Electric and Combustion Vehicles

- Maintenance Costs:
  - Electrical Vehicles that uses AC engines or DC Brushless engines have less parts that needs maintenance. In opposition, a combustion engine vehicle has lots of mechanic and electric parts that need regular maintenance;
  - Both types (AC or DC engines) can use regenerative braking, which significantly reduces the wear and substitution of the friction brakes;
  - Electricity generation and fuel production are different energy categories, with different inefficient and environmental impacts.

**For more information...**

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## Detailed Comparison between Electric and Combustion Vehicles

- Performance:
  - Even some electric vehicles with small engines, with 20HP or less, with moderated acceleration capacities, the relatively constant torque from the electric engines, tends to get closer to the capacity of traditional combustion engines;
  - Easier to drive with maximum torque at low speeds;
  - Don't need gearbox, more comfortable and less vibration.

For more information...  
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## Detailed Comparison between Electric and Combustion Vehicles

- Summary:

### Advantages

- Noise reduction;
- Less Consumption;
- Recharge Cost;
- Efficiency at any speed;
- High Torque at low speeds;
- Smooth StartM
- Doesn't need gearbox;
- Regenerative Braking;
- Relaxed and Comfort driving.

### Disadvantages

- Limited Autonomy;
- Limited Speed in some cases;
- Battery Problems;
- Recharging Spots .

For more information...  
Veículos Eléctricos – Hélder Filipe Matos Fernandes – 2007  
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## Future Electric Vehicles



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## Future Electric Vehicles

- Opel Ampera
  - Ampera is going to be launched (in 2011) in Europe by Opel, but in the US is going to be by Chevrolet, whose name is going to be Volt.
  - It's a new concept, different from a normal Hybrid Vehicle, it's a E-REV (extended range electric vehicle) with a 1.4L combustion engine and a electric motor combined.
  - It's autonomy is for 60Km using a electric engine and more than 500Km using the combustion engine has an electric generator.
  - A E-REV is more efficient than a Hybrid, because it only uses the combustion engine has a electric generator, charging the batteries and providing power to them, when the 60Km mark has passed.
  - Even when using the combustion engine, it emits less than 40 g/KM of CO<sub>2</sub>.

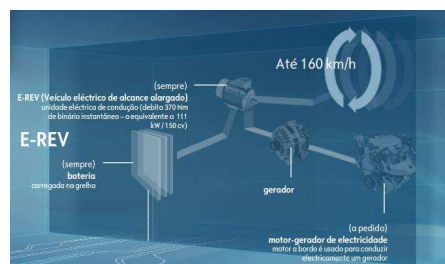


For more information...  
[www.opel-ampera.com/portugues/](http://www.opel-ampera.com/portugues/)  
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## Future Electric Vehicles

- Ampera can be plugged to any 230V household for charging its 16 kWh lithium ion battery pack.
- It's autonomy is for 60Km using a electric engine and more than 500Km using the combustion engine has a electric generator.
- With the electric engine the costs are 0,02€/Km and for the combustion engine the costs are 0,09€/Km.
- Has 370Nm of torque, 0-100Km/h in 9s and with a top speed of 160 KM/h.



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## Future Electric Vehicles

- Nissan Leaf
  - Is going to be launched in late 2010, in the US, Europe and Japan.
  - It's a completely electric vehicle that seats 5 adults.
  - The key characteristics are Zero-Emission power train and platform, affordable pricing, distinctive design, real world autonomy and connected mobility
  - It can charge to up to 80% of the batteries full capacity in under 30 minutes with a quick charger.
  - It's autonomy is for 160Km, so it's capable for the real world.
  - Connected Mobility IT System is connected to a global data center, the system provides support, information and entertainment for drivers 24 Hours a day. It can use mobile phones to turn on the air conditioner or set charging functions



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 For more information...  
[www.nissan-global.com](http://www.nissan-global.com)



## Future Electric Vehicles

- **Tesla Model S**

- Is going to be launched in 2011, in the US.
- It's a completely electric vehicle that seats 7 adults.
- It has a autonomy for 480 Km and 45 minutes Quick Charge.
- 3 battery autonomy pack's for chosen by the customer, 250 Km, 350Km and 480Km.
- Charges from 120V, 240V or 480V.
- 5 minute battery swap.
- 0 to 100 Km/h in 5.6s.
- 17 inch infotainment touchscreen in the dashboard.
- 2 trunks, in the rear and front.
- For sale for 49,900 USD, already 500 are sold.



For more information...  
[www.teslamotors.com](http://www.teslamotors.com)  
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## Future Electric Vehicles

- **Audi E-Tron**

- Is going to be launched in 2012, in the US and Europe.
- It's a sports electric vehicle from Audi.
- It has 4 in-wheel engines that develops 313cv and a maximum torque of 4000 Nm.
- 0-100 Km/h in 4.8s and top speed of 200 Km/h.
- 248 Km Maximum autonomy .
- 5 minute battery swap.
- 0 to 100 Km/h in 5.6s.
- It takes 6 to 8H to charge the batteries in a 230V plug or 2,5H in a 400V plug.
- 1000 Limited Edition E-Tron's.
- MultiMedia Interface with Windows from Microsoft.



For more information...  
[www.autohoje.com](http://www.autohoje.com)  
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## Future Electric Vehicles

- Citroen C4 WRC Hybrid

- It's a prototype for the World Rally Championship, it was the first Hybrid WRC car.
- Has a electric kinetic energy recovery system.
- A 125Kw electric motor generator is geared to the rear axle of the all wheel drive rally car.
- A lithium ion battery pack sits on the top of the fuel tank.
- The driver can enable a electric only drive mode for use on road sections , in urban or residential areas where noise is a concern.
- 30% Fuel Consumption reduction.
- 0 to 100 Km/h in 5.6s.



For more information...  
[www.autohoje.com](http://www.autohoje.com)  
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## Future Electric Vehicles

- Peugeot 908 Le Mans Hybrid

- It's a evolution from the 908 Diesel Fap Le Mans.
- Has a electric kinetic energy recovery system.
- A 60Kw electric motor, replacing the car's standard starter motor
- Powered by 600 lithium ion batteries located in the cockpit and on the left bottom of the car.
- Uses regenerative braking, requiring approximately 20 to 30s to recharge.
- Electric motor can be used to provide extra power to the car for approximately 20 seconds, either automatically or through the driver activation.
- Electric motor can be used when entering the pitlane.



For more information...  
[www.autohoje.com](http://www.autohoje.com)  
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## Interesting Websites

- <http://ocarroelectrico.com/>
- <http://gas2.org/>
- <http://green.autoblog.com/>
- <http://www.evworld.com/index.cfm>
- <http://www.evdriven.com/>
- <http://www.greenvehicles.com/>

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