Overview of Electric Vehicle

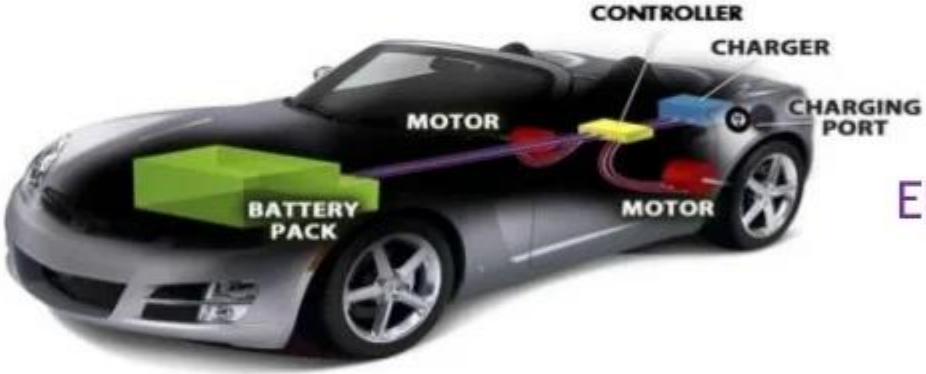
What is an Electric Car ?

Electric Car propelled by Electric Motors and uses electrical energy sored in batteries.

Unlike vehicles with combustion engines, electric vehicles do not produce exhaust gases during operation. This alone makes electric vehicles more environmentally friendly than vehicles with conventional technology. However, the electrical energy for charging the vehicle does have to be produced from renewable sources, e.g. from wind, solar, hydroelectric or biogas power plants. By combining different drive types, the overall efficiency of the vehicle can be improved and fuel consumption can be reduced.

How does it work?

Controller



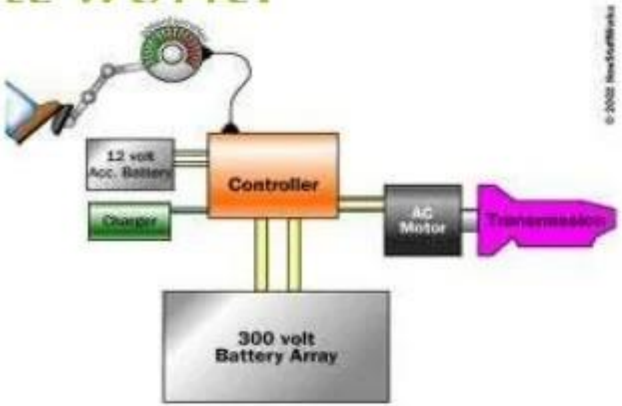
Electric Motor

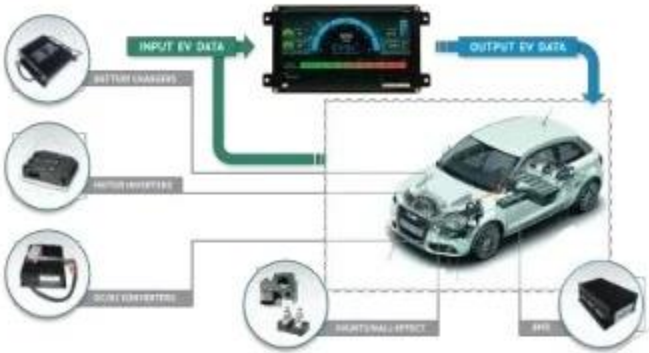
Battery

How does it work?

When the pedal is pushed;

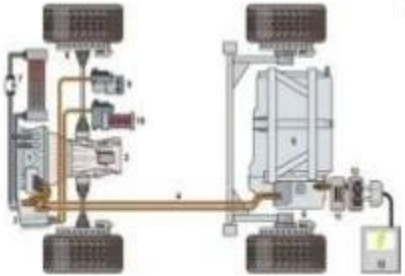
1. The controller gathers energy from the battery,
2. Controller delivers the appropriate amount of electrical energy to the motor.
3. Electric energy transforms to mechanical energy.
4. Wheels turn, vehicle moves.

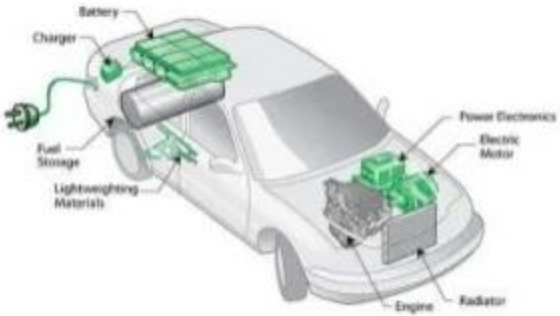




Main Components of EV

- High-voltage battery with control unit for battery regulation and charger
- Electric motor/generator with electronic control (power electronics) and cooling system
- Transmission including the differential
- Brake system
- High-voltage air conditioning for vehicle interior climate control
- Electric motor/generator
- Transmission with differential
- Power electronics
- High-voltage lines
- High-voltage battery
- Electronics box with control unit for battery regulation
- Cooling system
- Brake system
- High-voltage air conditioner compressor
- High-voltage heating
- Battery charger
- Charging contact for external charging
- External charging source





History of EV’s

History of Electric Car

- 1830's - first electric carriage was built
- 1891 - the first electric automobile was build in the United States
- 1900 - heyday
- 1908 - Henry Ford introduces Model T (top image)
- 1974 -Vanguard-Sebring's

History of Electric Car

- 1970s - governmental acts
- 1988 - GM EV1 (top image)
- 1997-2000 - a few thousand electric cars were only available for lease.
- 2003 GM discontinued the EV1 and "killed the electric car"
- 2007- Tesla Roadster, an all electric vehicle. (bottom image

Types of Electric Vehicles

Three Types of Electric Vehicles On the Road Today

1.BEV: - Battery Electric Vehicle

2.PHEV and HEVs: – (Plug-In) Hybrid Electric Vehicle

3.FCEV: – Fuel-cell Electric Vehicle

Battery Electric Vehicle (BEV)

A BEV runs entirely on a battery and electric drive train, without an internal combustion engine. It is powered by electricity from an external source, usually the public power grid. This electricity is stored in onboard batteries that turn the vehicle's wheels using one or more electric motors.

What you should know about BEVs:

•The initial purchase price is significantly higher than similar gas-powered vehicles, even with government incentives, if offered in your province.

•Demand for BEVs should result in lower purchase prices in future.

•You can save a lot of money on fuel and maintenance costs.

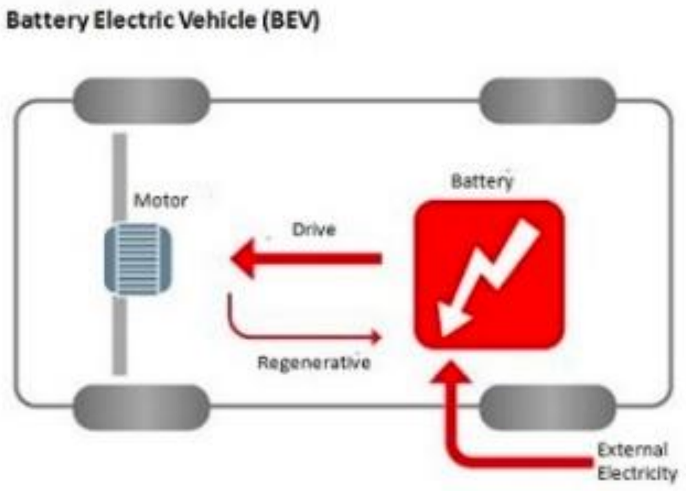
•They have a range between 100 and 160 km, compared with 500 km for most conventional cars, but for most consumers, that range is well within their current commute range.

•Batteries can recharge overnight plugged into a regular household outlet of 120 volts, or even faster using a 240 volt outlet, similar to the type of outlet used for domestic clothes dryers.

•Installing a 240V outlet for your BEV costs approximately $200-$400.

•Many BEV owners purchase a charging station for their home, which ranges in price from $600-$1200.

•400V rapid charging stations are now available in many locations, where BEVs equipped with a CHAdeMO or COMBO connector can be 80% charged in under 30 minutes.



Components of BEV

- Electric motor
- Inverter
- Battery
- Control Module
- Drive train

Examples of BEV

Volkswagen e-Golf, Tesla Model 3, BMW i3, Chevy Bolt, Chevy Spark, Nissan LEAF, Ford Focus Electric, Hyundai Ioniq, Karma Revera, Kia Soul, Mitsubishi i-MiEV, Tesla X, Toyota Rav4.

Plug-in Hybrid Electric Vehicle (PHEV)

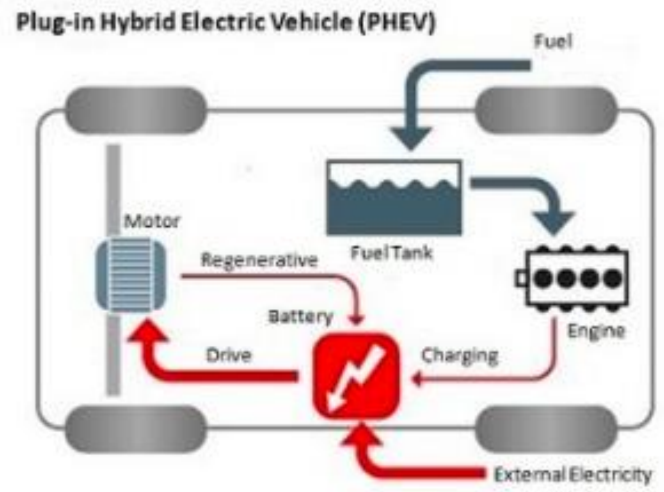
A PHEV runs mostly on a battery that is recharged by plugging into the power grid. It is also equipped with an internal combustion engine, running on gasoline or diesel fuel, that can recharge the battery and/or to replace the electric drive train when the battery is low and more power is required.

What you should know about PHEVs:

- The original purchase price is comparable to similar vehicles operating on internal combustion alone.
- PHEVs have an advantage over BEVs because consumers are already comfortable with gas- or diesel-fuelled vehicles.
- PHEVs offer readily-available fuel for long distance driving and have a significantly increased range compared to BEVs.
- Because PHEVs can be recharged on the public network, as opposed to HEVs (covered next), they are often cheaper to run than HEVs, though the amount of savings depends on the distance driven on the electric motor alone.
- If the distance traveled before recharging is always less than the vehicle's range in electric-only mode, the car never has to be refueled with conventional fuel.
- Autonomy of a PHEV can vary between 10 and 35 km in electric mode.
- Since PHEV batteries are smaller than BEV batteries, charging time is less.

ECO FRIENDLY

Architecture and Main Components of PHEV



Components of PHEV

- Electric motor
- Engine
- Inverter
- Battery
- Fuel tank
- Control module
- Battery Charger (if onboard model)

Examples of PHEV

Porsche Cayenne S E-Hybrid , Chevy Volt, Chrysler Pacifica, Ford C-Max Energi, Ford Fusion Energi, Mercedes C350e, Mercedes S550e, Mercedes GLE550e, Mini Cooper SE Countryman, Audi A3 E-Tron, BMW 330e, BMW i8, BMW X5 xdrive40e, Fiat 500e, Hyundai Sonata, Kia Optima, Porsche Panamera S E-hybrid, Volvo XC90 T8.

Hybrid Electric Vehicle (HEV)

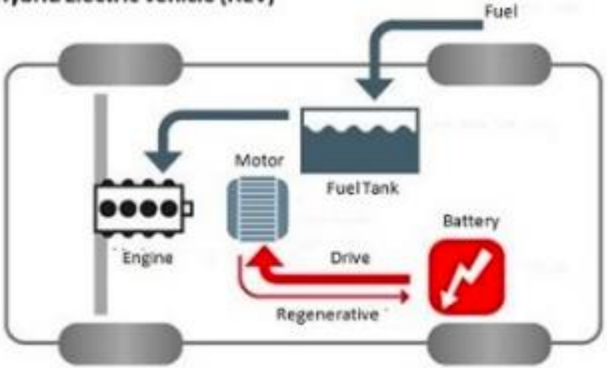
An HEV has two complementary drive systems - a gasoline engine and fuel tank, and an electric motor, battery and controls. The engine and the motor can simultaneously turn the transmission, which powers the wheels. Where the HEV differs from the above two types of electric vehicles (BEV and PHEV) is that HEVs cannot be recharged from the power grid. Their energy comes entirely from gasoline and regenerative braking.

What you should know about HEVs:

- The original purchase price is comparable to similar vehicles operating on internal combustion alone.
- HEVs have an advantage over BEVs because consumers are already comfortable with gas- or diesel-fuelled vehicles.
- HEVs offer readily-available fuel for long distance driving and have a significantly increased range compared to BEVs.
- As soon as the driver accelerates moderately, running entirely on the electric motor lasts rarely more than 5-10 km.
- Typically, the electric motor can also function as a generator, driven by the engine, to help recharge the batteries when electric power is not needed for driving the vehicle.
- They are more expensive to run than PHEVs, because they cannot be recharged on the public network.

Architecture and Main Components of HEV

Hybrid Electric Vehicle (HEV)



Components of HEV

- Engine
- Electric motor
- Battery pack with controller & inverter
- Fuel tank
- Control module

Examples of HEV

Honda Civic Hybrid, Toyota Prius Hybrid, Honda Civic Hybrid, Toyota Camry Hybrid.

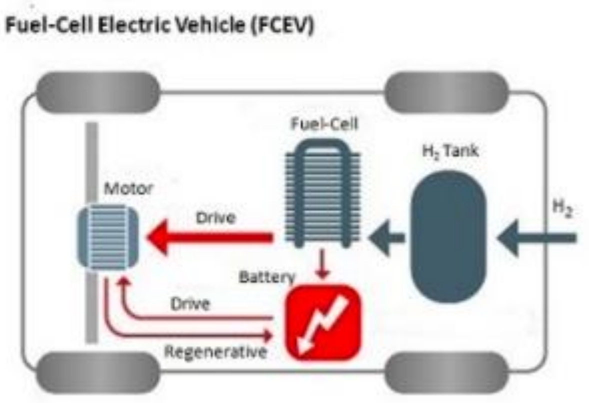
Fuel-cell Electric Vehicle (FCEV)

A FCEV creates electricity from hydrogen and oxygen, instead of storing and releasing energy like a battery. Because of these vehicles' efficiency and water-only emissions, some experts consider these cars to be the best electric vehicles, even though they are still in development phases and provide many challenges.

What you should know about FCEVs:

- Purchase price is high because the cost of a fuel cell is several times more expensive than the cost of an internal combustion engine.
- Extracting hydrogen from a water molecule is an energy-intensive process that generates greenhouse gas emissions if renewable energies are not used.
- FCEVs are expected to be widespread on the market in the next few years.
- Since February 12, 2015, the fuel-cell Tucson has been for sale in the Vancouver area, making Hyundai the first original equipment manufacturer to market a fuel-cell vehicle.
- The Toyota Mirai was slated to follow suit, but was stalled due to lack of infrastructure.
- The transportation and infrastructure required to bring this fuel to stations is a challenge.

Architecture and Main Components of FCEV



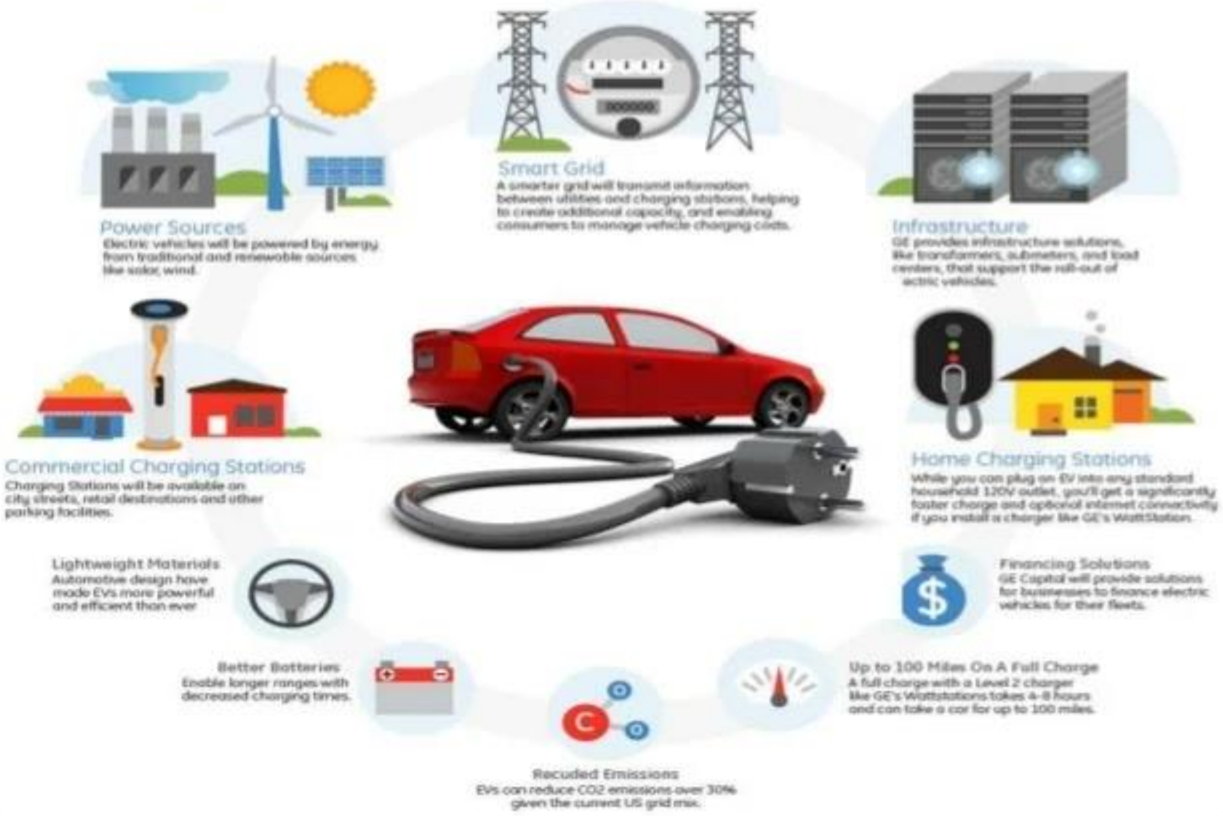
Components of FCEV

- Electric motor
- Fuel-cell stack
- Hydrogen storage tank
- Battery with converter and controller

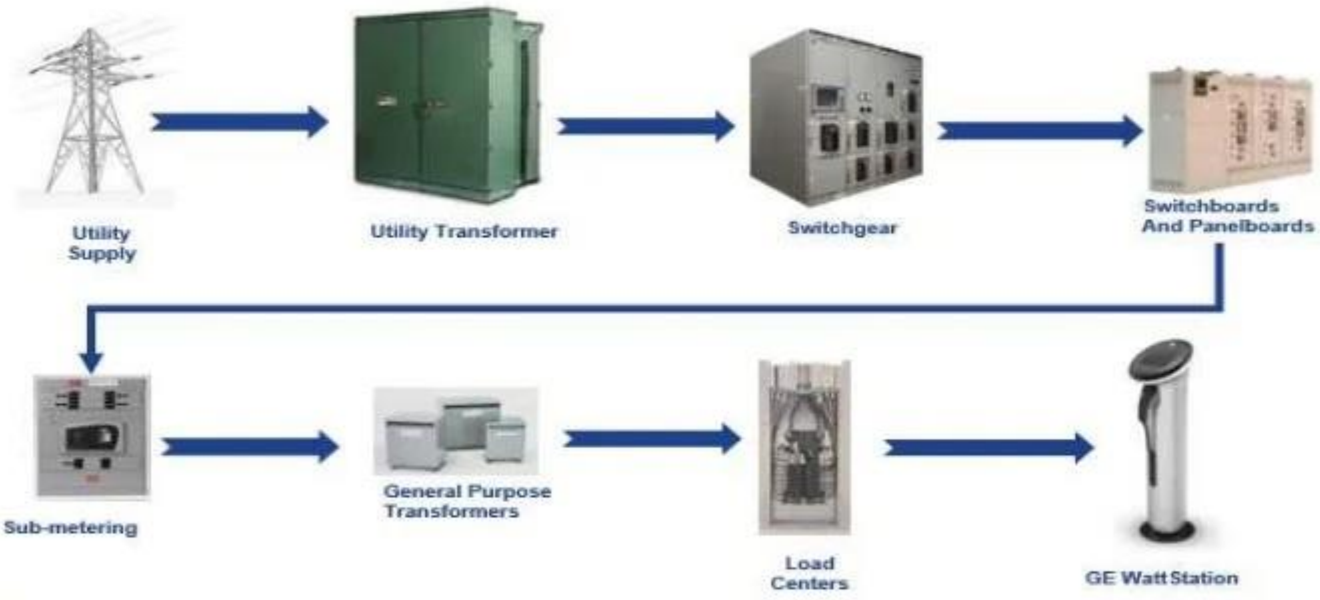
Examples of FCEV
Toyota Mirai, Hyundai Tucson FCEV, Riversimple Rasa, Honda Clarity Fuel Cell, Hyundai Nexo.

Infrastructure of EV's

Infrastructure of EV



Charging Station Infrastructure



Confusion Regarding Speed!!!

Speed's

Race cars with a top speed near 200 km/h (120 mph)

Model	Top speed	Acceleration
Aptima eCobra	est higher than 240 PS (176.5 kW; 236.7 hp)	0-97 km/h (60 mph) in 3.9 seconds
Detroit Electric SP:01[57]	249 km/h (155 mph)	0–100 km/h (62 mph) in 3.7 seconds.
Exagon Furtive-eGT	155 mph (249 km/h)	0-100 km/h (62 mph) in 3.5 seconds
Li-ion Inizio **R - Rally**	209 km/h (130 mph)	0–97 km/h (60 mph) in 5.9 seconds
Li-ion Inizio **RT - Rally Touring**	212 km/h (132 mph)	0–97 km/h (60 mph) in 7.1 seconds
Li-ion Inizio **RTX - Rally Touring Extreme**	273 km/h (170 mph)[58]	0–97 km/h (60 mph) in 3.4 seconds
Lola-Drayson B12/69EV[59]	320 km/h (199 mph)	0–100 km/h (62 mph) in 3 seconds.
Rimac Concept One	355 km/h (221 mph)	0–100 km/h (62 mph) in 2.6 seconds.
Spark-Renault SRT 01E	250 km/h (155 mph)	0–100 km/h (62 mph) in 3 seconds.
NIO EP9	294 km/h (183 mph)	0–100 km/h (62 mph) in 7.1 seconds.
Tango	240 km/h (149 mph)	0–96 km/h (60 mph) in 4 sec
Volar-e[63]	300 km/h (190 mph)	0–100 km/h (62 mph) in 3.4 seconds.
VW Beetle dragster[citation needed]	300 km/h (186 mph)	0–100 km/h (62 mph) in 1.6 seconds.

Speed's

All Buckeye Bullet vehicles have been electrically powered, with power coming from either batteries or hydrogen fuel cells.

Vehicle	U.S. Record	World Record (km)	World Record (mile)	Power Source
Buckeye Bullet 1	314.958 mph (508.485 km/h)		271.737 mph (437.318 km/h) (Non-FIA)	Battery (NiMH)
Buckeye Bullet 2		303.025 mph (487.672 km/h)	302.877 mph (487.433 km/h)	Hydrogen Fuel Cell
Buckeye Bullet 2.5		307.905 mph (495.526 km/h)	307.666 mph (495.140 km/h)[2]	Battery (Li-ion)
Buckeye Bullet 3		341.4 mph (549.43 km/h)		Battery (Li-ion)

Speed's

CAR	RANGE (MILES)	HORSEPOWER	TOP SPEED MPH)	ACCELERATION (0–60 MPH)	COST
Ford Focus Electric	76	143	84	10.1 sec.	$29,170
BMW i3	81	170	93	7 sec.	$42,400
Volkswagen e-Golf	83	115	87	10.1 sec.	$28,995
Fiat 500e	93	111	85	8.7 sec.	$31,800
Kia Soul EV	93	109	90	9.2 sec.	$31,950
Mercedes B-class B250e	101	177	101	7.9 sec.	$41,450
Nissan Leaf SL	107	107	100	10.2 sec.	$36,790
Chevy Bolt	200	200	91	> 7 sec.	$37,500
Tesla Model 3	215	TBA	TBA	< 6 sec.	$35,000
Tesla Model X	289*	TBA	140	2.9 sec.	$135,500
Tesla Model S	315*	TBA	140	2.5 sec.	$134,500

NIO EP9 Name of a High Speed EV

On November 21,2016 Nextel launches new brand 'NIO' and its first electric car: 1 MW supercar with 265 miles range & top speed of 194 mph

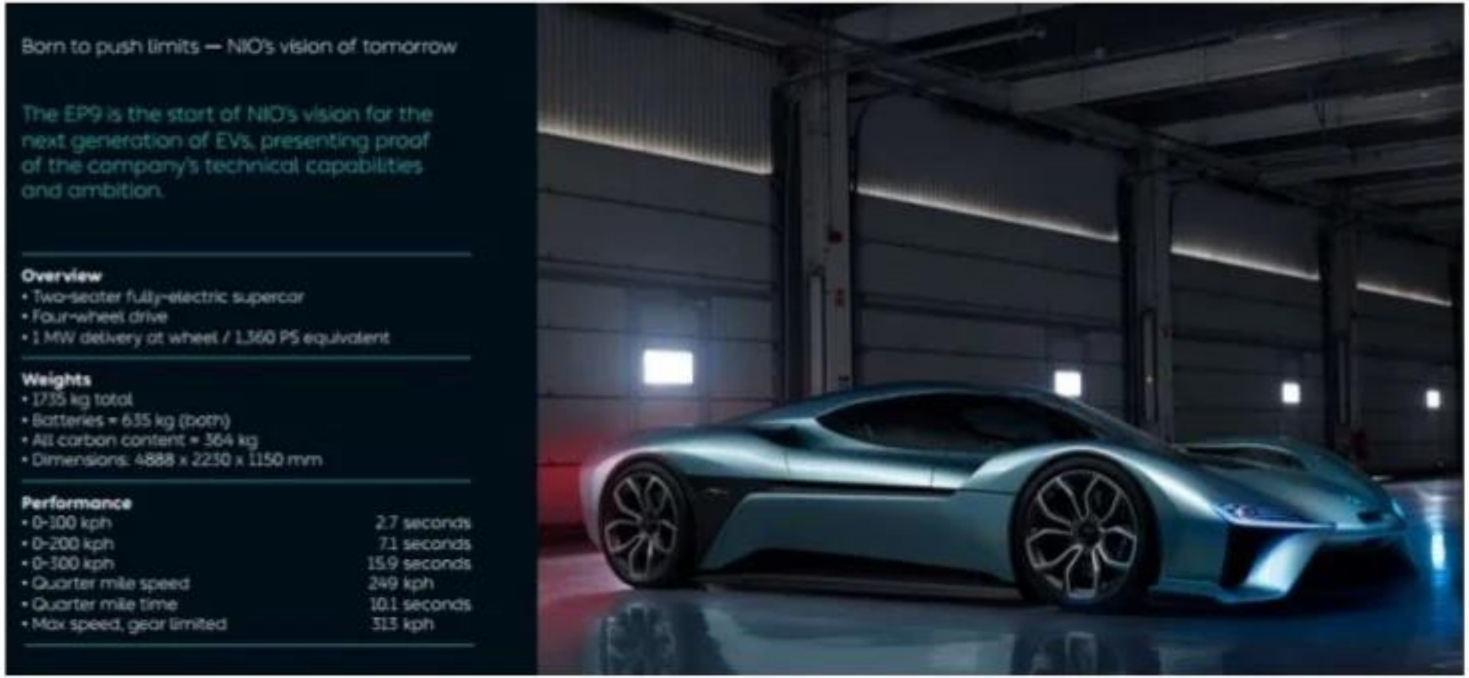
The 'NIO EP9' is equipped with "four high-performance inboard motors and four individual gearboxes" capable of torque vectoring. The powertrain can deliver up to 1 megawatt of power and 24,000 Newton's of down force at 240 km/h (150 mph).

The vehicle can achieve a top speed of 313 km/h (194 mph) – narrowly beating the Rimac Concept One, which until now was the electric supercar to beat in all performance specs.

But there's no doubt that the NIO EP9's performance specs are seriously shaking Rimac's position at the top and in some cases, they are setting a new benchmark for electric supercars. As for range, NextEV claims the 'NIO EP9' can travel up to 427 km (265 miles) on a single charge and then it will only take 45 minutes to recharge the battery pack.

The design of the battery pack, or should I say packs, is particularly interesting. The EP9 is equipped with two battery packs installed on the sides of the platform :

NIO EP9 Name of a High Speed EV



Prospect & Reality of EV's

Motivation to embrace EV

Domestic Policy Goals

- Reduce dependence on foreign oil
- Job creation
- Economic Growth (energy sources local)

Global Impact

- Europe to mitigate climate change
- China to balance growth with pollution
- Governments around the world have allocated funding for clean technology

Energy Independence

- Local energy sources reduce price volatility
- Reduce export of dollars, particularly to unstable regions of the world
- Reduce dependence on few key regions – roughly half of the EU's gas consumption comes from only three countries (Russia, Norway, Algeria)

Developing Nations

- Lower-cost conventional vehicles support economic development goals.
- Urban air pollution and rising oil imports to be the main driver of electrification
- China has stated its goal of reducing the carbon intensity of its economy.
- Lack of Infrastructure (grids) is a huge factor.

Climate Change

- Global support for climate change has gained momentum with Europe leading the way.
- Transportation accounts for roughly 15% of energy related CO_2 emissions globally.
- In 1992, the United States ratified the United Nations' Framework Convention on Climate Change (UNFCCC), which called on industrialized countries to make voluntary efforts to reduce greenhouse gases.
- EU energy policy provides affordable energy while contributing to the EU's wider social and climate goals

Economic Reality of EV

Economics Will Favor Electrification

- Electric vehicles emit zero tailpipe emissions at the point of use. The carbon footprint of electric vehicles is approximately 30% better than that of conventional vehicles, even when the electricity used is produced by a coal-fired power station.
- Total Cost of Ownership (TCO) will become increasingly favorable as the price of fuel rises in the future. Current global economic conditions will drive how quickly fuel prices begin to appreciably rise and influence the TCO of various models (ICE, Hybrid, PHEV, EV)..

ECO FRIENDLY

Manufacturer's of EV's

Existing Manufacturer's of EV's

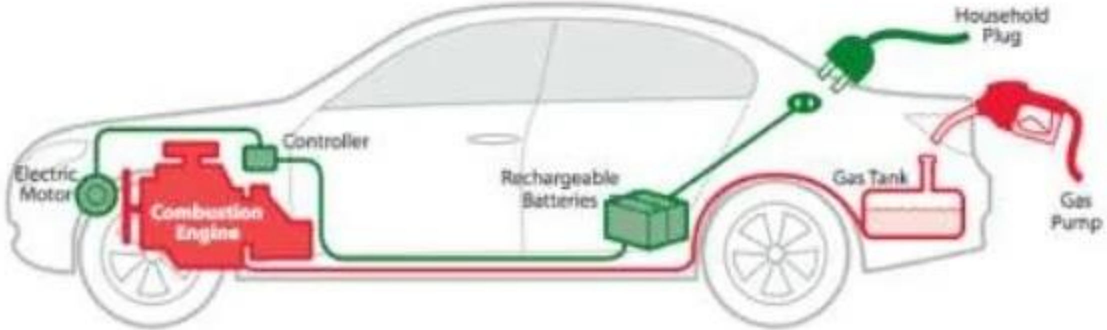
- Saturn Vue
- Ford Escape
- Tesla Road star
- GM's Chevy Volt

Manufacturer's

Comparative with FUEL

Electric vs. Gasoline

Electric	Gasoline
No Tailpipe Emissions	Greenhouse Gases/Pollution
Utility Company	OPEC
100+/- Mile Range	300+ Mile Range
Hours to Recharge	Minutes to Refuel
2 cents per mile	12 cents+ per mile



Mileage

Example Car:	Technology	Mileage:
Honda Civic	Gasoline Engine	36 miles per gallon
Toyota Prius	Hybrid Engine	46 miles per gallon
Chevy Volt	Electric/ Plug-in hybrid	40 miles on electric power 50 miles per gallon past 40 miles
Tesla Roadster	Electric	227 miles per charge

Benefits

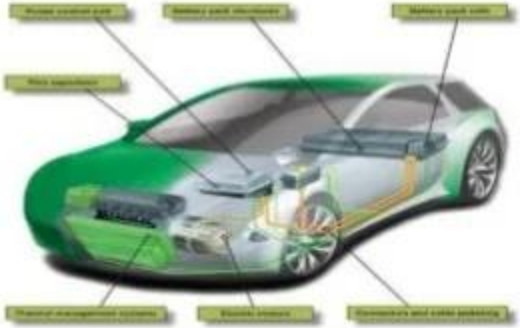
- Drive motors run quieter than internal-combustion engines. The noise emissions from electric vehicles is very low. At high speeds, the rolling noise from the tires is the loudest sound.
- Electric vehicles produce no harmful emissions or greenhouse gases while driving. If the high-voltage battery is charged from renewable energy sources, an electric vehicle can be run CO2-free.
- In the near future, if particularly badly congested town centers are turned into zero-emissions zones, we will only be able to drive through them with high-voltage vehicles.
- The electric drive motor is very robust and requires little maintenance. It is only subject to minor mechanical wear.
- Electric drive motors have a high degree of efficiency of up to 96% compared with internal-combustion engines that have an efficiency of 35–40%.
- Electric drive motors have excellent torque and output characteristics. They develop maximum torque from standstill. This allows an electric vehicle to accelerate considerably faster than a vehicle with an internal combustion engine producing the same output.

Benefits

• The drive train design is simpler because vehicle components like the transmission, clutch, mufflers,
particulate filters, fuel tank, starter, alternator and spark plugs are not required.
• When the vehicle is braked, the motor can also be used as an alternator that produces electricity and charges
the battery (regenerative braking).
• The high-voltage battery can be charged at home, in a car park and by using any accessible sockets. The blue
charging connector on the vehicle and on public charging stations has been standardized across Germany and
is used by all manufacturers.
• The energy is only supplied when the user needs it. Compared with conventional vehicles, the electric drive
motor never runs when the vehicle stops at a red light. The electric drive motor is highly efficient particularly in
lines and bumper-to-bumper traffic.
• Apart from the reduction gearbox on the electric drive motor, the electric vehicle does not require any
lubricating oil.

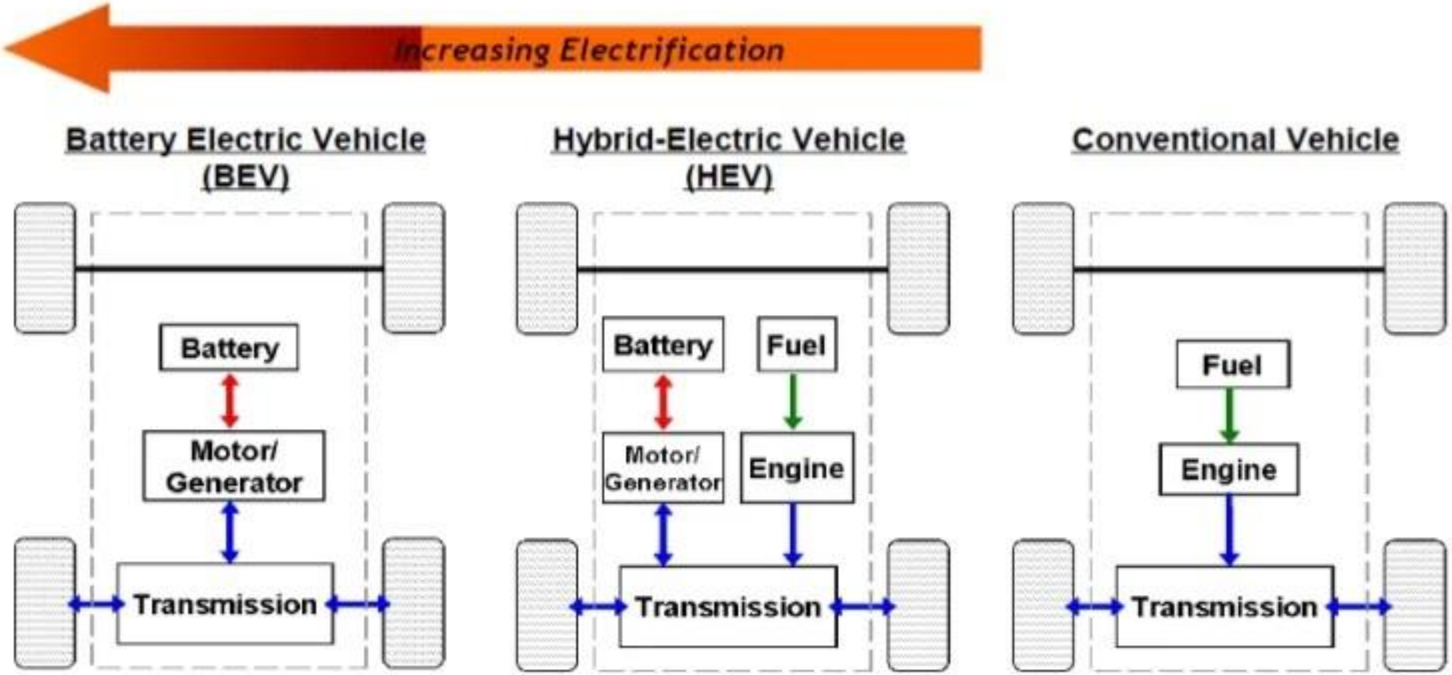
Drawbacks

- Electric vehicles have a limited range due to battery size and construction.
- Charging a high voltage battery can take a long time, depending on the battery charge and power source.
- The network of electric charging stations is sparse.
- If the destination is beyond the range of the electric vehicle, the driver will need to plan the journey. "Where
- can I charge my electric vehicle on the road?"



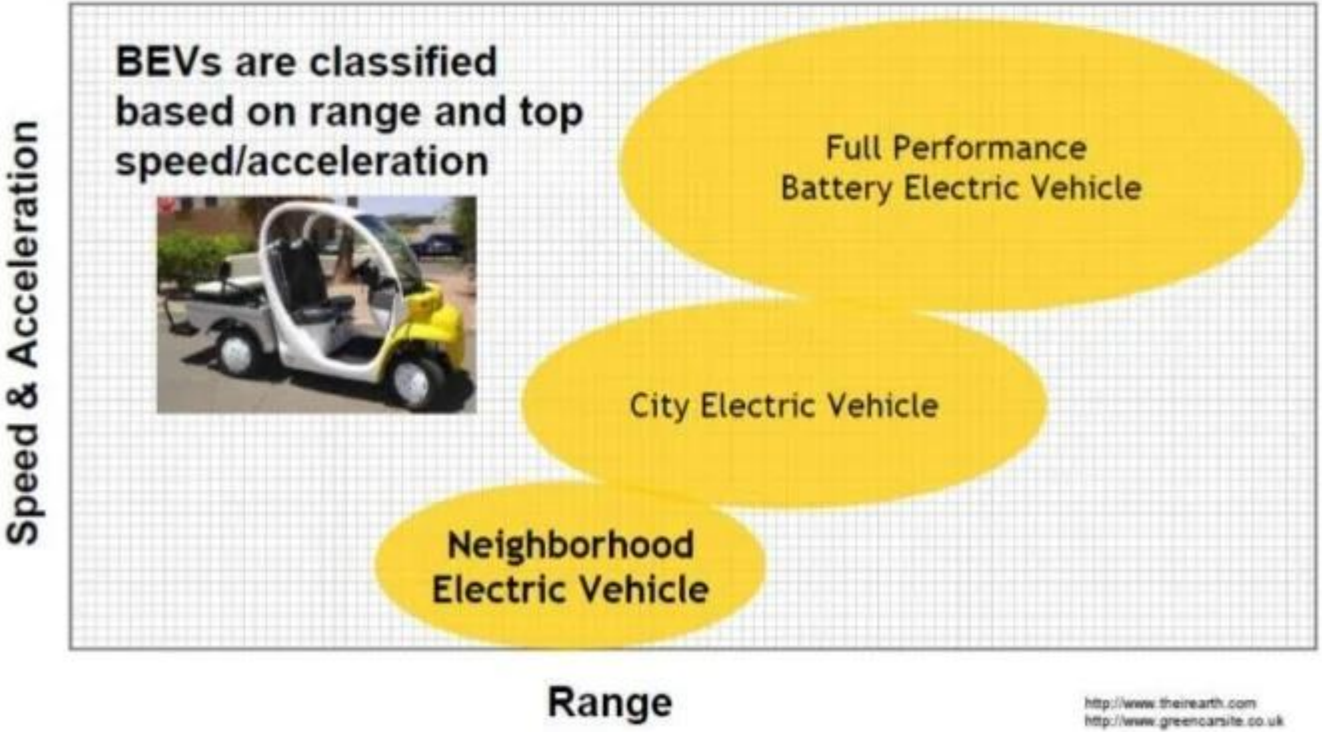
Comparison OF EV's

Electric vehicles" include hybrids as well as pure battery electric vehicles



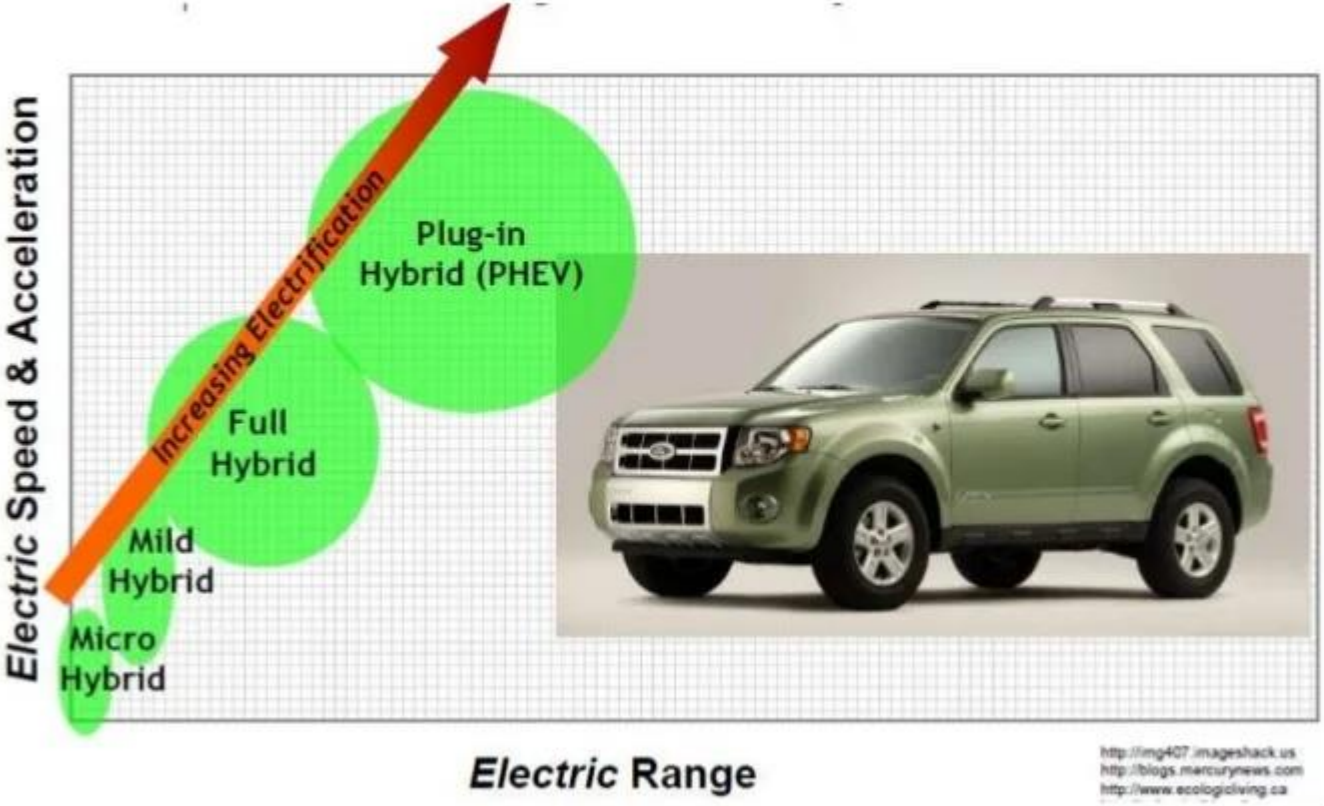
EVs also include Fuel Cell Vehicles and EVs with alternative energy storage (e.g. ultracapacitors)

There are many varieties of Battery Electric Vehicles

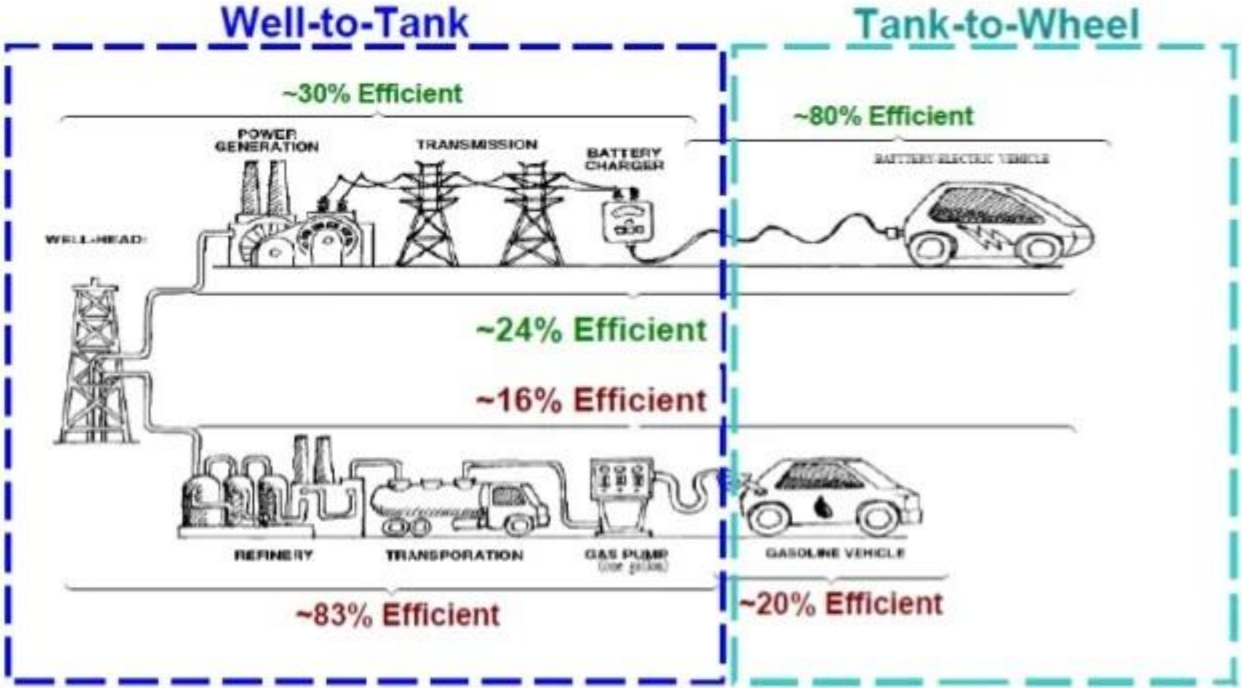


http://www.theirearth.com
http://www.greencarsite.co.uk

Hybrids (HEVs) vary in electrification while maintaining vehicle performance



Vehicles should be compared on a well to-wheels basis



Electric Car Battery

Battery

One of the key elements of any electric vehicle is its battery. Energy density is a measure of how much energy a battery can hold. The higher the energy density, the longer it will last before needing to be recharged.

Power is the rate at which energy is used. Power density is a measure of how much power a battery can deliver on demand; that is, how quickly it can release its energy (and conversely, how quickly it can be recharged).

Types Of battery :

1. Lead Acid
2. Nickel-Metal-Hydride
3. Lithium-ion (Li-ion)
4. Lithium Polymer (Li-poly)
5. Lithium Iron Phosphate (LFP)

Some Important Battery Terms

- State of charge (SOC)

– Battery capacity, expressed as a percentage of maximum capacity

- Depth of Discharge (DOD)

– The percentage of battery capacity that has been discharged

- Capacity

– The total Amp-hours (Amp-hr) available when the battery is discharged at a specific current (specified as a C-rate) from 100% SOC

- Energy

– The total Watt-hours (Wh) available when the battery is discharged at a specific current (specified as a C-rate) from 100% SOC

- Specific Energy (Wh/kg)

– The total Watt-hours (Wh) per unit mass

- Specific Power (W/kg)

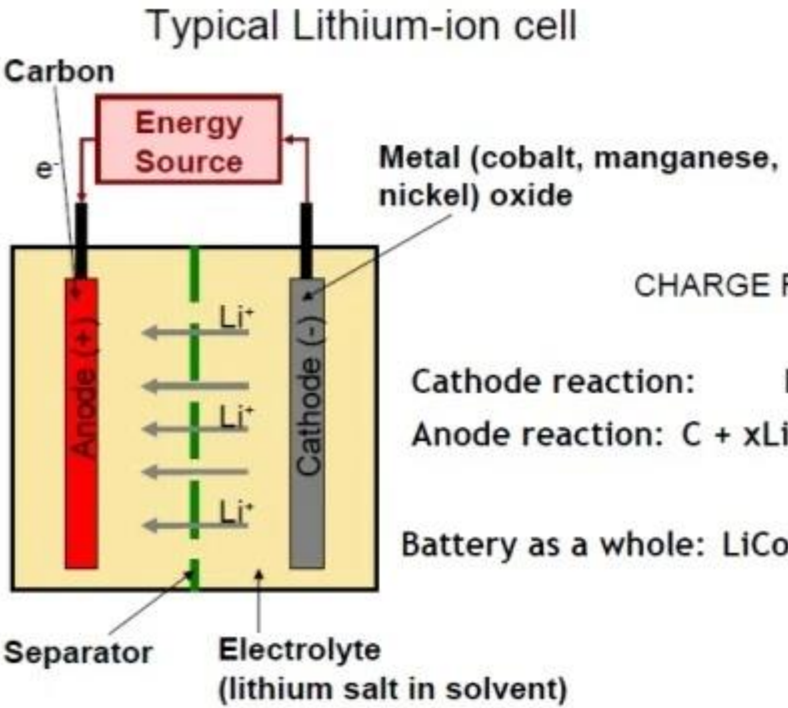
– Maximum power (Watts) that the battery can provide per unit mass, function of internal resistance of battery

Some Important Battery Terms

Specific Attention of EVs Motors Compared to Ordinary Industrial Application Motors

– Requires high rate starts and stops
– High rate of acceleration / deceleration
– High torque low speed hill climbing
– Low torque high speed cruising
– Wide speed range of operation

A battery stores electricity through reversible chemical reactions



CHARGE REACTIONS

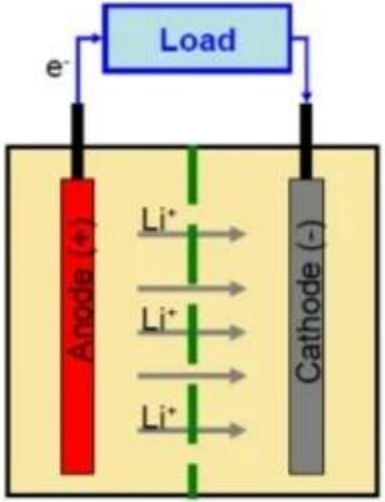
Cathode reaction: $LiCoO_2 \rightarrow Li_{1-x}CoO_2 + xLi^+ + xe^-$

Anode reaction: $C + xLi^+ + xe^- \rightarrow CLi_x$

Battery as a whole: $LiCoO_2 + C \rightarrow Li_{1-x}CoO_2 + CLi_x$

A battery stores electricity through reversible chemical reactions

Typical Lithium-ion cell



DISCHARGE REACTIONS

Cathode reaction: $LiCoO_2 \leftarrow Li_{1-x}CoO_2 + xLi^+ + xe^-$

Anode reaction: $C + xLi^+ + xe^- \leftarrow CLi_x$

Battery as a whole: $LiCoO_2 + C \leftarrow Li_{1-x}CoO_2 + CLi_x$

Number of electrons generated determines the current provided by a given size battery

Battery voltage is determined by the energy of the reactions

Cathode (Reduction) Half-Reaction	Standard Potential E ° (volts)
$Li^+ (aq) + e^- \rightarrow Li(s)$	-3.04
$K^+(aq) + e^- \rightarrow K(s)$	-2.92
$Ca^{2+}(aq) + 2e^- \rightarrow Ca(s)$	-2.76
$Na^+(aq) + e^- \rightarrow Na(s)$	-2.71
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	-0.76
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	0.34
$O_3(g) + 2H^+(aq) + 2e^- \rightarrow O_2(g) + H_2O(l)$	2.07
$F_2(g) + 2e^- \rightarrow 2F^-(aq)$	2.87

Best Anode

Best Cathode

http://www.mpoweruk.com/chemistries.htm

Higher voltage → higher power and efficiency at lower pack cost and weight, more stable voltage profile

Nickel-Metal Hydride and Lithium-ion Batteries are the best for EVs today

<u>Nickel-Metal Hydride (Ni-MH)</u>

+ high specific power (kW/kg)
+ long cycle life
+ good safety and stability
~ moderate specific energy
- high initial cost

<u>Lithium-ion (Li-ion)</u>

+ higher cell voltage
+ higher specific power (kW/kg)
+ higher specific energy (Wh/kg)
+ low self-discharge
- higher initial cost
- lower cycle life
- need for control and protection

Ni-MH provides needed power and energy for HEVs, but does not meet the higher energy needs of PHEVs and BEVs
→ Emphasis on Li-ion research to meet future needs

Not all Lithium-ion batteries are equal

	Name	Description	Automotive Status	Power	Energy	Safety	Life	Cost
Unsafe for EVs	LCO	Lithium cobalt oxide	Limited auto applications (due to safety)	Good[4]	Good[4]	Low[2,4], Mod.[3]	Low[2,4]	Poor[2,3]
In prototype EVs, reaching production	NCA	Lithium nickel, cobalt and aluminum	Pilot[1]	Good[1-3]	Good[1-3]	Mod.[1]	Good[1]	Mod.[1-3]
	LFP	Lithium iron phosphate	Pilot[1]	Good[1]	Mod.[2,6]	Mod.[1,2,4]	Good[1,4]	Mod.[1], Good[2,3]
	NCM	Lithium nickel, cobalt and manganese	Pilot[3]	Mod.[3]	Mod.[3], Good[7]	Mod.[3]	Poor[3]	Mod.[7]
In R&D stages	LMS	Lithium manganese spinel	Devel.[1]	Mod.[2]	Poor[1,2,3]	Excel.[1], Good[2]	Excel.[1] Mod.[6]	Mod.[2]
	LTO	Lithium titanium	Devel.[3]	Poor[3], Mod.[7]	Poor[3]	Good[3]	Good[3]	Poor[3]
	MNS	Manganese titanium	Research[1]	Good[1]	Mod.[1]	Excel.[1]	Unkwn.	Mod.[1]
	MN	Manganese titanium	Research[1]	Excel.[1]	Excel.[1]	Excel.[1]	Unkwn.	Mod.[1]

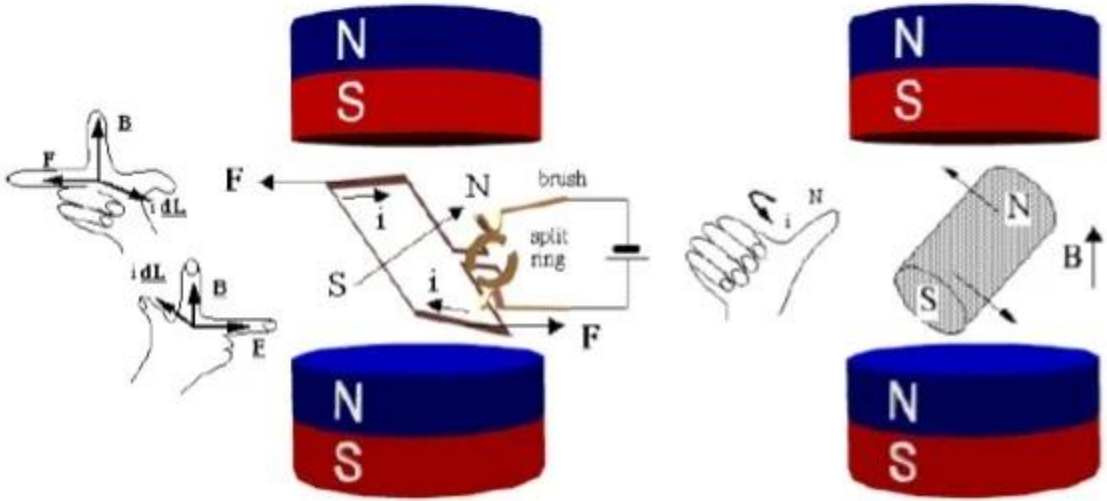
[Axsen, Burke, and Kurani 2008]

Electric Motors of EV's

Electric Motors and Generators

Fundamentals of Electric Motors and Generators
• Various types of motors
– Motor characterization + Commutator motors
– Commutatorless motors
• DC Motor Drives
• Induction Motor Drives
• Permanent Magnetic Brushless Motor Drives
• Switched Reluctance Motor Drives
• Performance Curve of Electric Motors vs. Engine
• Regenerative Braking (1 slide)
• In-Wheel Motor Technology (2 slides of pure animation)
• Summary: Comparison different motor types (DC Brushless vs. inductance)

Electric Motors



The force F on a wire of length L carrying a current i in a magnetic field B:

$$F = BIL \cos \alpha$$

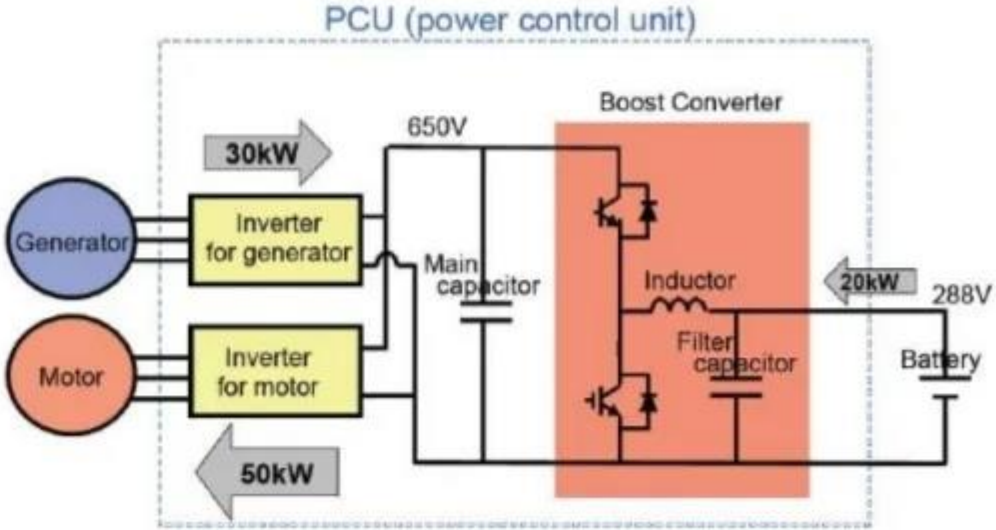
Electric Motor Comparisons

Motor Type	Advantages	Disadvantages
Induction Motor	Low initial cost High power High average efficiency Light weight	Rotation slips from frequency Accumulation of rotor heat
Switched Reluctance Motor	Low initial cost High average efficiency Highly reliable and robust Very simple control	High acoustic noise Require large filter capacitor
PM Brushless DC Motor	Long lifespan Least rotor heat generated Low maintenance High peak efficiency	High initial cost Requires a controller Poor high speed capability Unadjustable magnetic field
Brushed DC Motor	Low initial cost Simple speed control	High maintenance (brushes) Low lifespan High heat

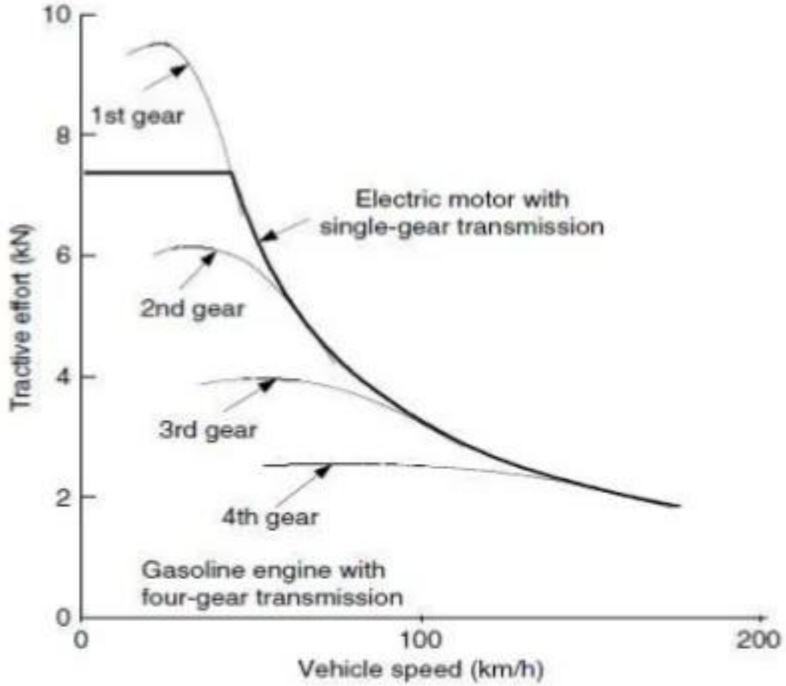
Motor and Generator controls

Key enabling technology:

- IGBT high power transistors



Transmission Characteristics



Internal Environment

- The concern for the environment has never been bigger than at the turn of the century.
- This plus the unpredictable oil price spikes and hikes, is intensifying the race to build the ideal car of the future at a greater height.
- The small car market is set to grow by about 50% over the next ten to twelve years from the 8.4 million units sold in 2012.
- Many customers will not compromise safety, quality, driving characteristics, and individuals. Though EV200 currently caters to the premium automotive market, other high-end competitors such as Mercedes also have products
- positioned to capture the entry market.

Think Blue....

The technical scope from the following concepts is combined under the umbrella term “Think Blue”:

- “Blue Motion”
- “Blue Motion Technologies”
- “Eco-Fuel”
- “Blue TDI”
- “Bi-Fuel”
- “Hybrid”
- “blue-e-motion”
- “Think Blue. Factory.” Low-emissions automobile production

The “blue-e-motion” brand stands for electro mobility within the framework of the “Think Blue.” idea. The cornerstones of “Think Blue.” are:

1. Environmentally compatible products and solutions
2. Environmental behavior
3. Environmental commitment

Acknowledgment

Thanks to technological enhancement, e-cars are getting greener all the time. The batteries are becoming more and more powerful and durable. At a number of universities, scientists are developing ways to recycle used electric vehicle batteries. All of this helps to reduce the carbon footprint of e-cars and could make them a real alternative to gasoline and diesel engines.