



Introduction to EV

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Introduction to Electric Vehicles

Content



- Need for EVs
- EV functions and control system
- EV topology
- Regenerative Braking

EV – Need and Drivers

Introduction to Electric Vehicles

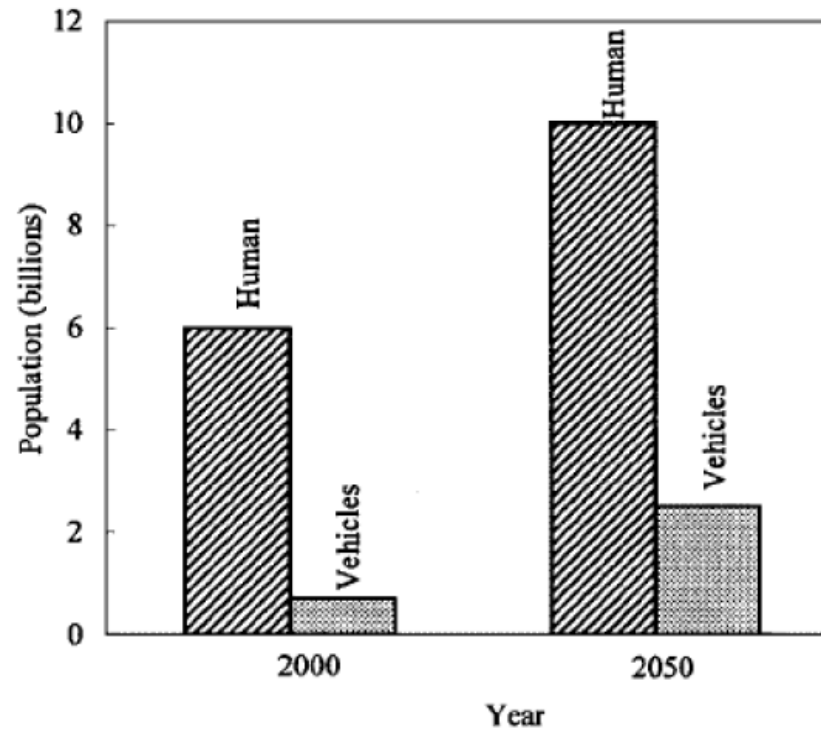
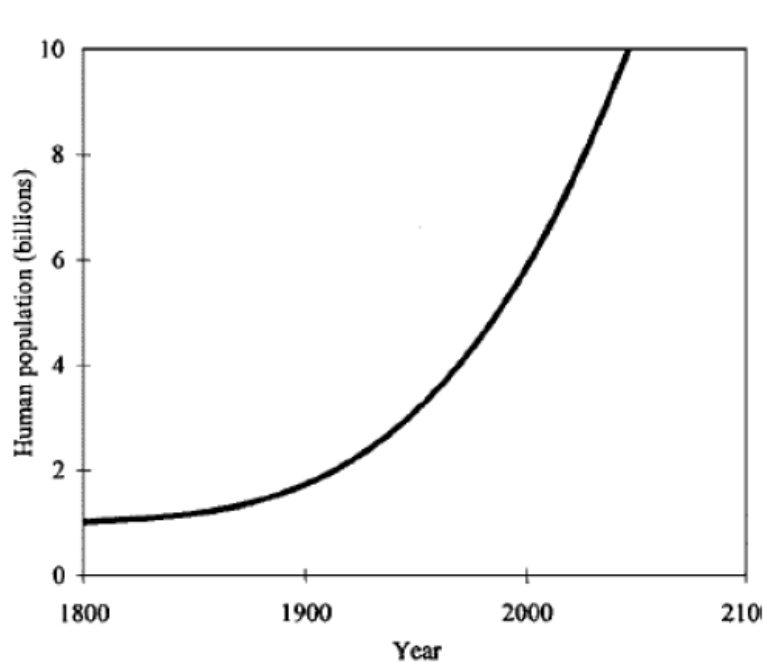
Needs for EVs.

- Vehicle populations
- Energy concerns
- Air pollution and Emission Norms (Euro Norms, BS standards)
- Environment (Global warming)
- Vehicle efficiencies

Electric and Hybrid Vehicles - Overview

Vehicle populations

- ❖ In the next 50 years *, the global human population will increase from 6 billion to 10 billion
- ❖ The number of vehicles will increase from 700 million to 2.5 billion.



Source : The State of the Art of Electric and Hybrid Vehicles, IEEE

* Data as on year 2000

The year 2037 “gasoline runs out year” means, petroleum will no longer be used for personal mobility.

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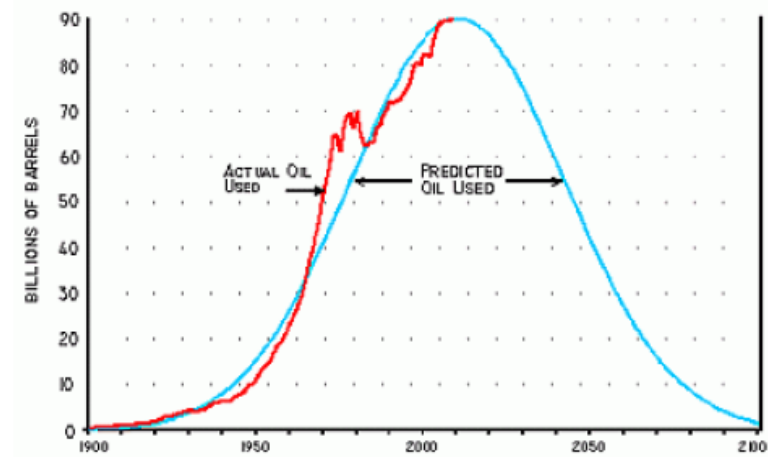
Conservation of petroleum products...



India Will be World's Third Largest Energy Consumer in Two Decades

The primary energy demand in India is projected as 770 Mtoe (million tonnes of oil equivalent) in 2015 and 1300 Mtoe in 2030.

By 2030, India will be the 3rd largest energy consumer in the world after China & USA.



Dr. Hubbert (1950s) noticed over 60 years ago that crude oil production would peak and then decline - See more at: http://evsroll.com/Peak_Oil_Facts.html#sthash.Zk26hQqu.dpuf

The transport sector accounts for nearly 50% the petroleum products consumed in India annually.

Source : <http://www.smeworld.org/story/interviews/india-will-be-worlds-third-largest-energy-consumer.php>

Introduction to Electric Vehicles

Facts on Air pollution and Emission Norms



| | |
|---------|---|
| US | Vehicle contribute to 40%–50% of ozone, 80%–90% of carbon monoxide and 50%–60% of air toxins in urban areas |
| Germany | Transport is responsible for over 20% of the energy consumption and CO ₂ emissions. |
| India | The transport sector accounts for nearly 50% of the petroleum products. |

| Region | Pollution Type | Annual Fatalities |
|-----------|----------------|-------------------|
| East Asia | PM 2.5 | 1,000,000 |
| | Ozone | 203,000 |
| India | PM 2.5 | 397,000 |
| | Ozone | 118,000 |
| SE Asia | PM 2.5 | 158,000 |
| | Ozone | 33,000 |
| Europe | PM 2.5 | 154,000 |
| | Ozone | 32,800 |
| Total | | 2,095,800 |

Powertrain Electrification of vehicles will have a high potential for energy saving and reduced pollution.

Air pollution kills 2.1 million per year in various regions according to Jason West, co-author a study published in the Journal of Environmental Research Letters - See more at: http://evsroll.com/interesting_air_pollution_facts.html#sthash.F4rDOLpq.dpuf

CAFE Norms - corporate average fuel efficiency

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Facts on Air pollution and Emission Norms

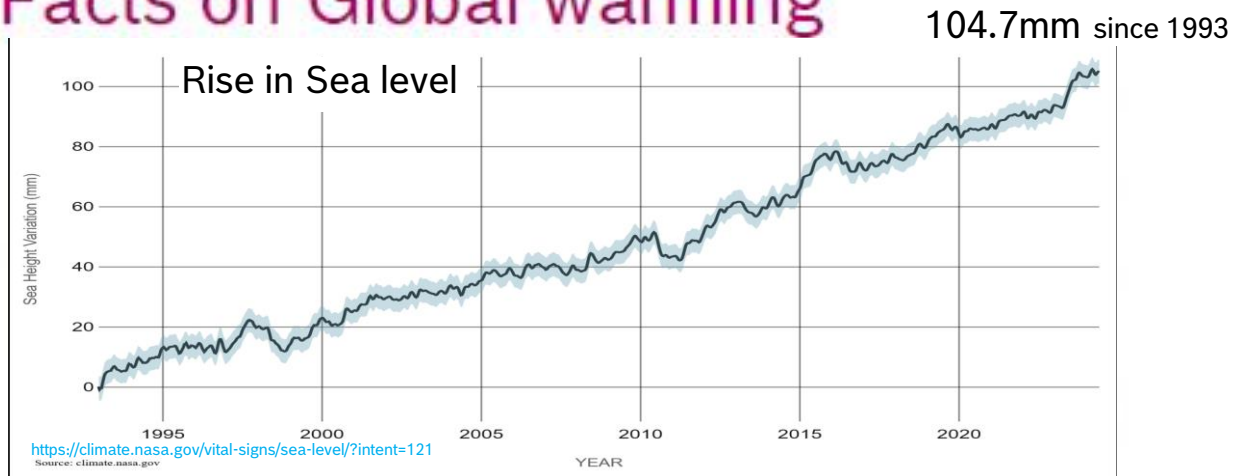
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Oxygen showroom opened at New Delhi !!
Rs.299 to Inhale pure oxygen for 15 min.

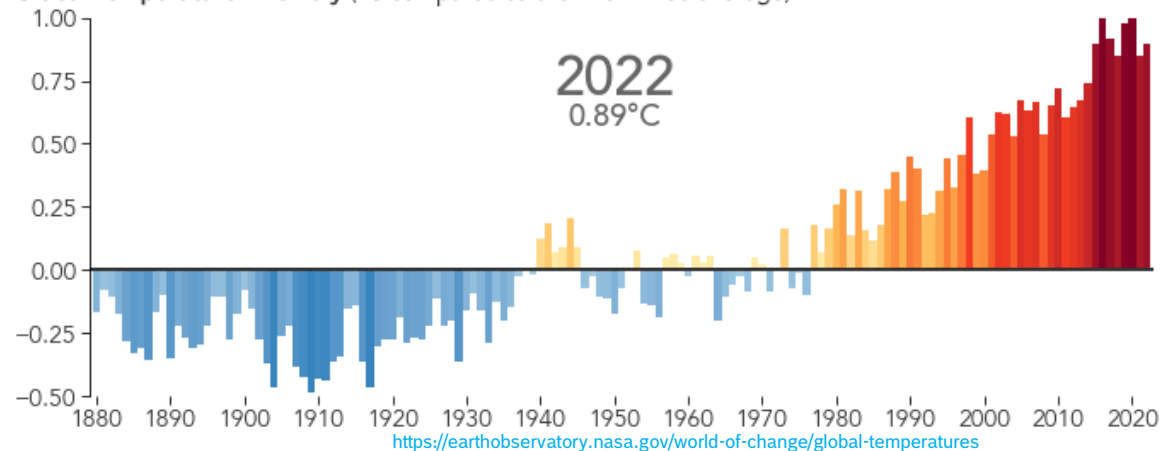
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Facts on Global warming

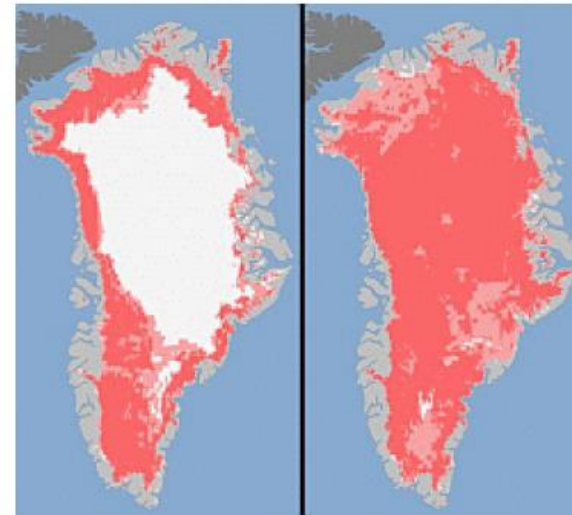


Last 9 Years Warmest on Record

Global Temperature Anomaly (°C compared to the 1951-1980 average)



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Greenland surface melted in just four days in July of 2012. Courtesy NASA - See more at:
http://evsroll.com/True_Facts_about_Global_Warming.html#sthash.zyqgioNO.dpuf

Transportation accounts for **41%** of the sources of **global warming**. Electric vehicles can help dramatically reduce the production of greenhouse gases.

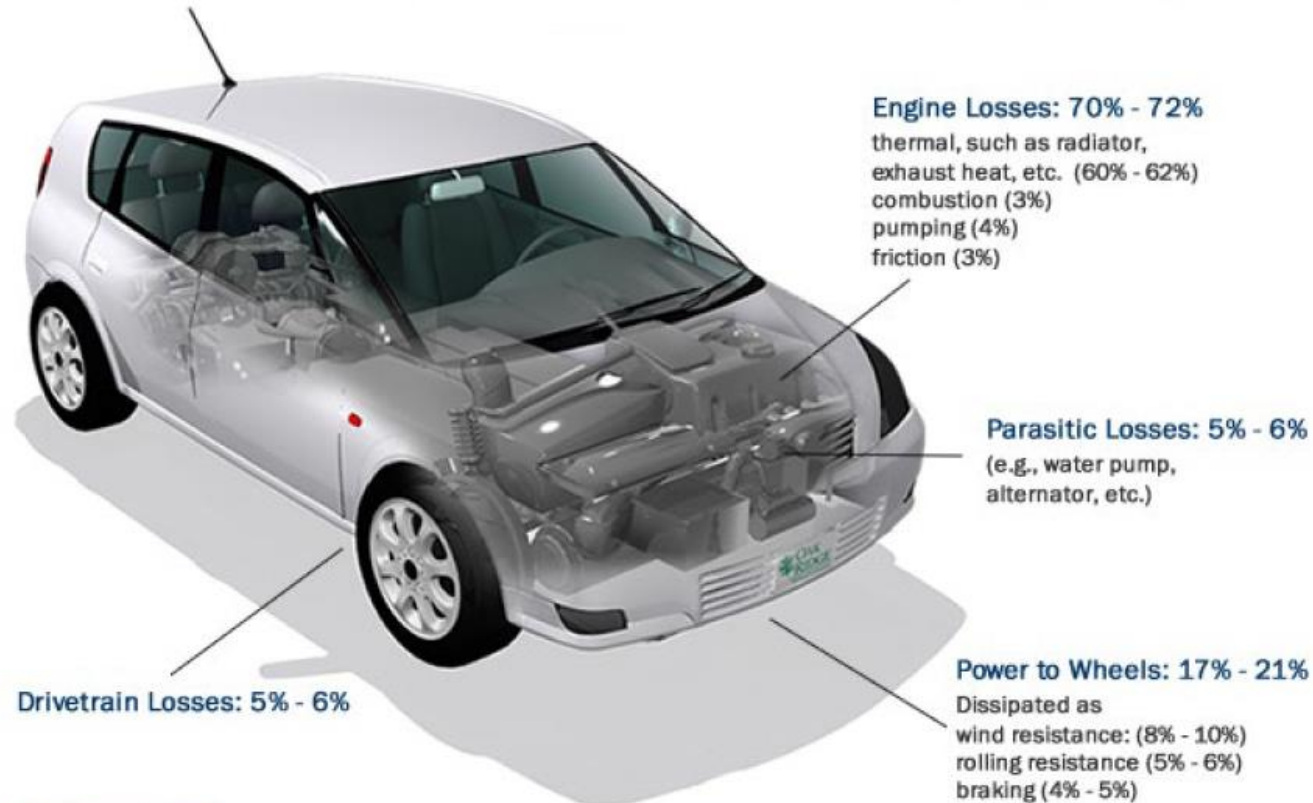
Source :http://dolcera.com/wiki/index.php?title=Hybrid_Electric_Vehicle_Battery_System

Energy efficiency – ICE, Hybrid and EV

Introduction to Electric Vehicles

Energy efficiencies in ICE vehicles

Energy Requirements for Combined City/Highway Driving



Idle Losses: 3%

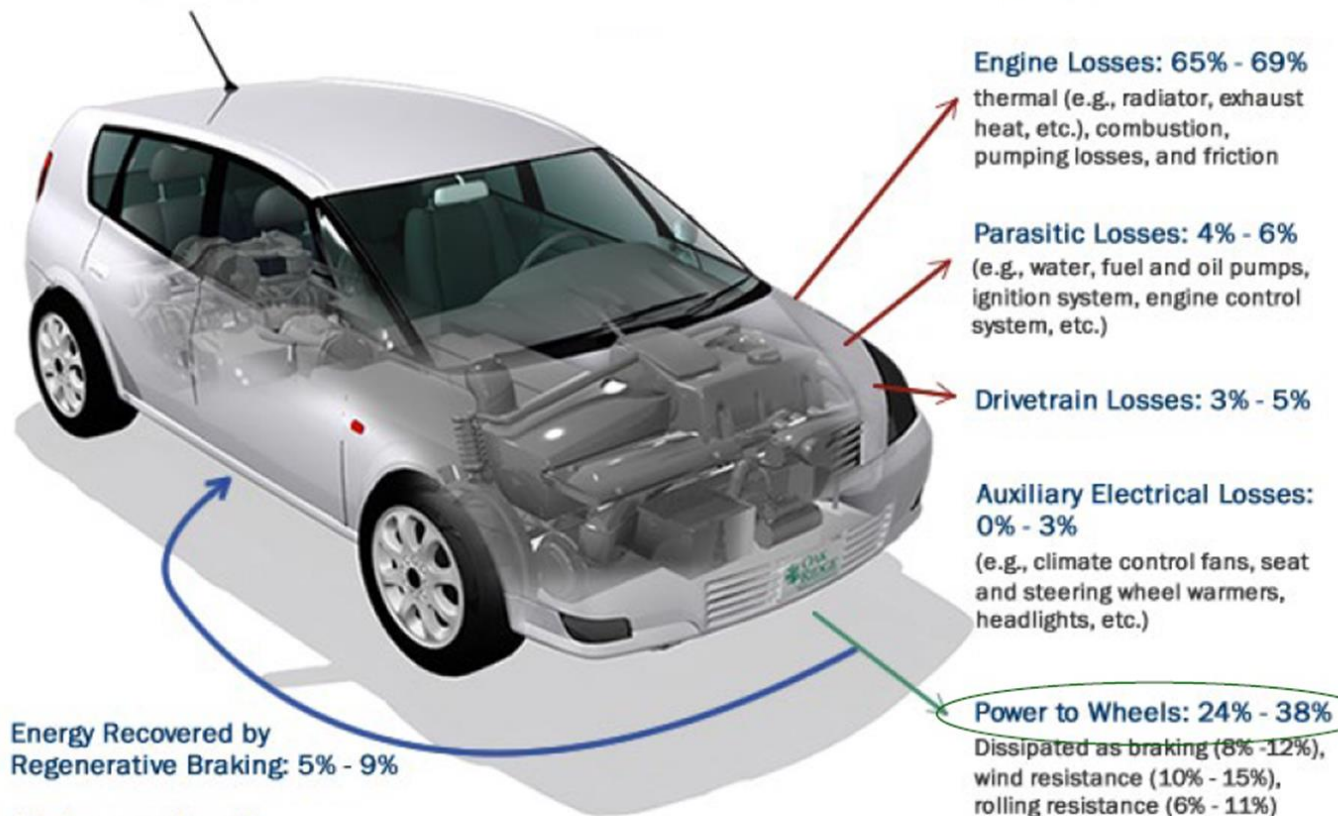
In this figure, they are accounted for as part of the engine and parasitic losses.

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Energy efficiencies in Hybrid vehicles

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Energy Requirements for Combined City/Highway Driving - Hybrid Vehicles

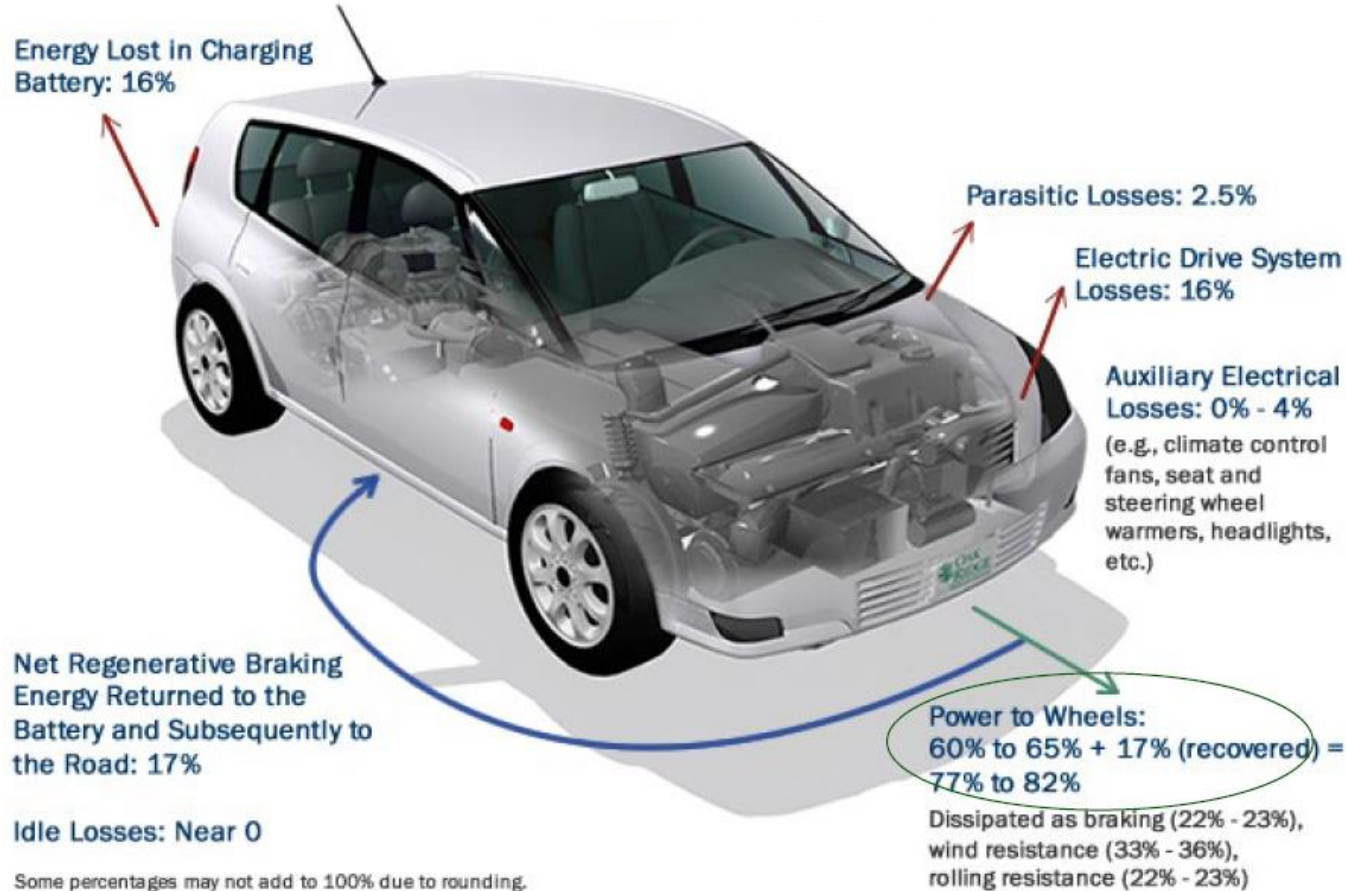


Some percentages may not add to 100% due to rounding.

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Energy efficiencies in Electric vehicles

Energy Requirements for Combined City/Highway Driving - Electric Vehicles

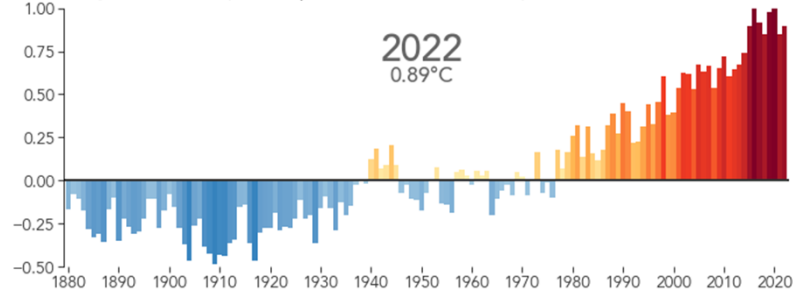


EVs – Drivers and Trends

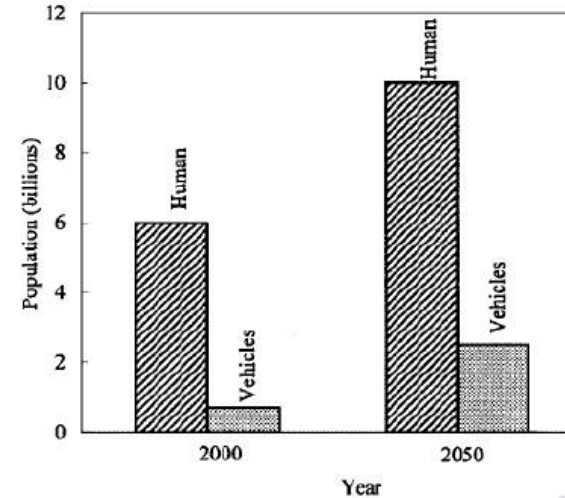
- Vehicle populations
- Energy concerns
- Air pollution and Emission Norm
- Environment (Global warming)
- Vehicle efficiencies

Last 9 Years Warmest on Record

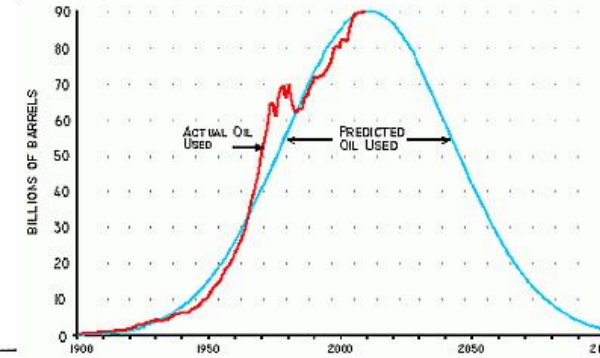
Global Temperature Anomaly (°C compared to the 1951-1980 average)



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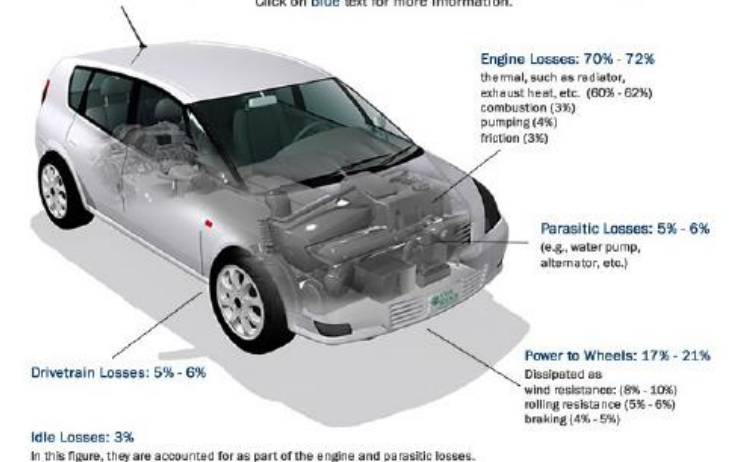


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Energy Requirements for Combined City/Highway Driving

Click on blue text for more information.



EVs – Drivers and Trends

1. Phase out of Diesel and Petrol vehicles

2. Govt. Incentives

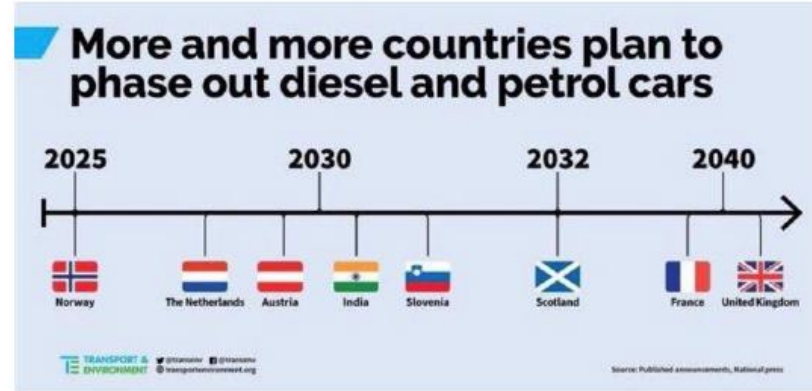
- FAME in India

3. New developments.

- Green energy development
- High power density e Drives
- High energy density batteries

4. Development in charging Infra. Structure.

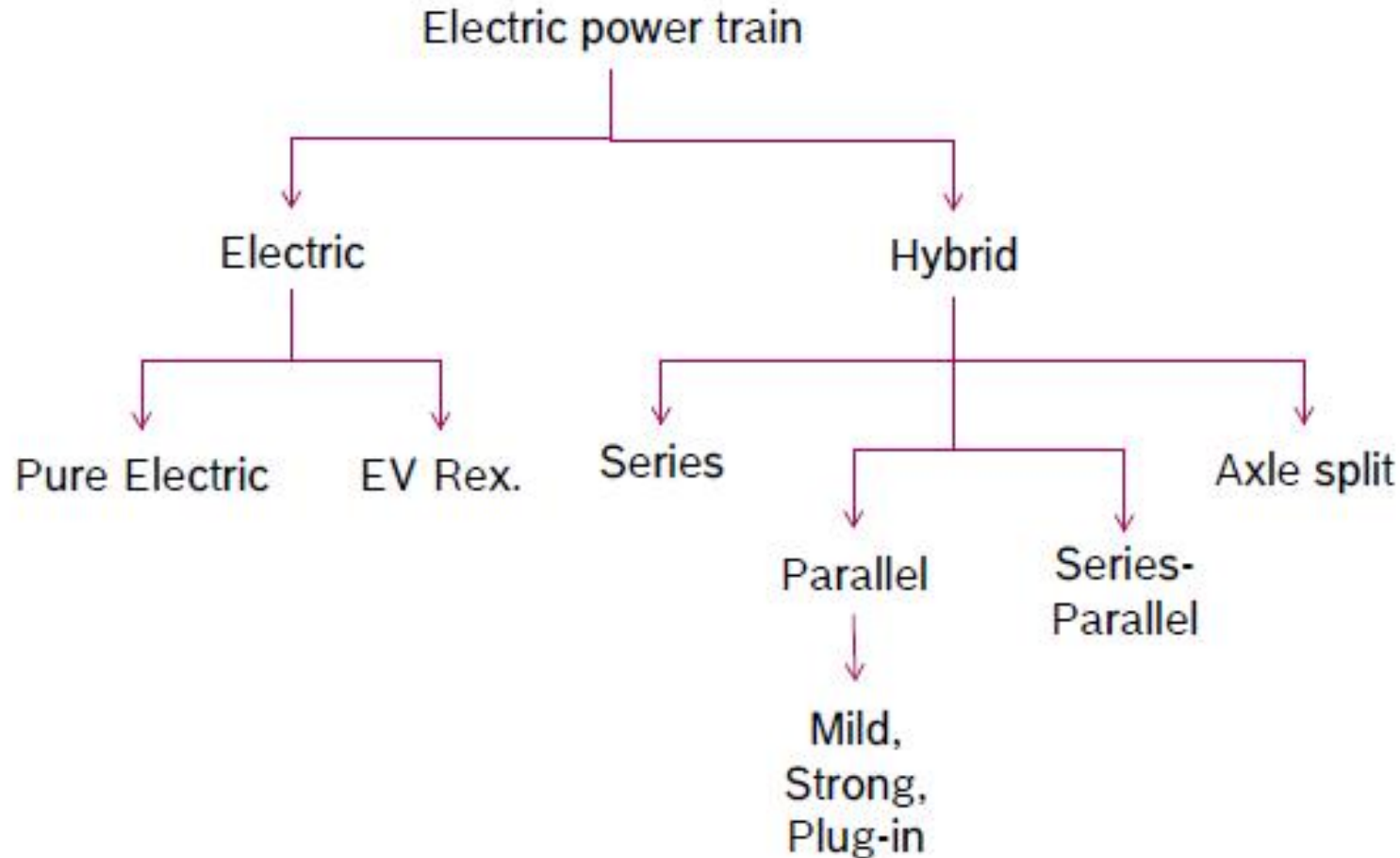
- Inductive charging
- Solar panel



E V – Function and control system







Introduction to Electric Vehicles

Types of electric power train



Introduction to Electric Vehicles

Types of electric power train

| | Mild Hybrid | Strong Hybrid | Plug-In Hybrid | EV w/ REX | Electric Vehicle |
|---|--|--|---|---|--|
| Electric Power | 5 – 15 kW | 20 – 60 kW | 40 – 80 kW | 40 – 120kW | 40 – 150 kW |
|  | <p>No possibility of pure electric drive</p>  | <p>Limited electric driving range</p>  | <p>Entry into electric driving without restrictions</p>  | <p>Enhanced electric driving with "Range Extender" (REX).</p>  | <p>Zero emission driving w/ regenerative energies.</p>  |
| CO2 Reduction | 15% | 25% | 50 – 80% | 50 – 90% | 100% |

Types of electrification differ concerning cost/CO2-benefit and will penetrate regions differently.

Introduction to Electric Vehicles

Electric power train – Functions

| Functions | Mild HEV (5–15 kW) | Strong HEV (20–60 kW) | PHEV (40–80 kW) | EV Rex (40–120 kW) | BEV (40–150 kW) |
|----------------------|-----------------------|--------------------------|--------------------|-----------------------|--------------------|
| Start/Stop | ■ | ■ | ■ | ■ | ■ |
| Regenerative Braking | ■ | ■ | ■ | ■ | ■ |
| Torque Support | ■ | ■ | ■ | | |
| E-Driving | | ■ | ■ | ■ | ■ |
| Grid Charging | | | ■ | ■ | ■ |

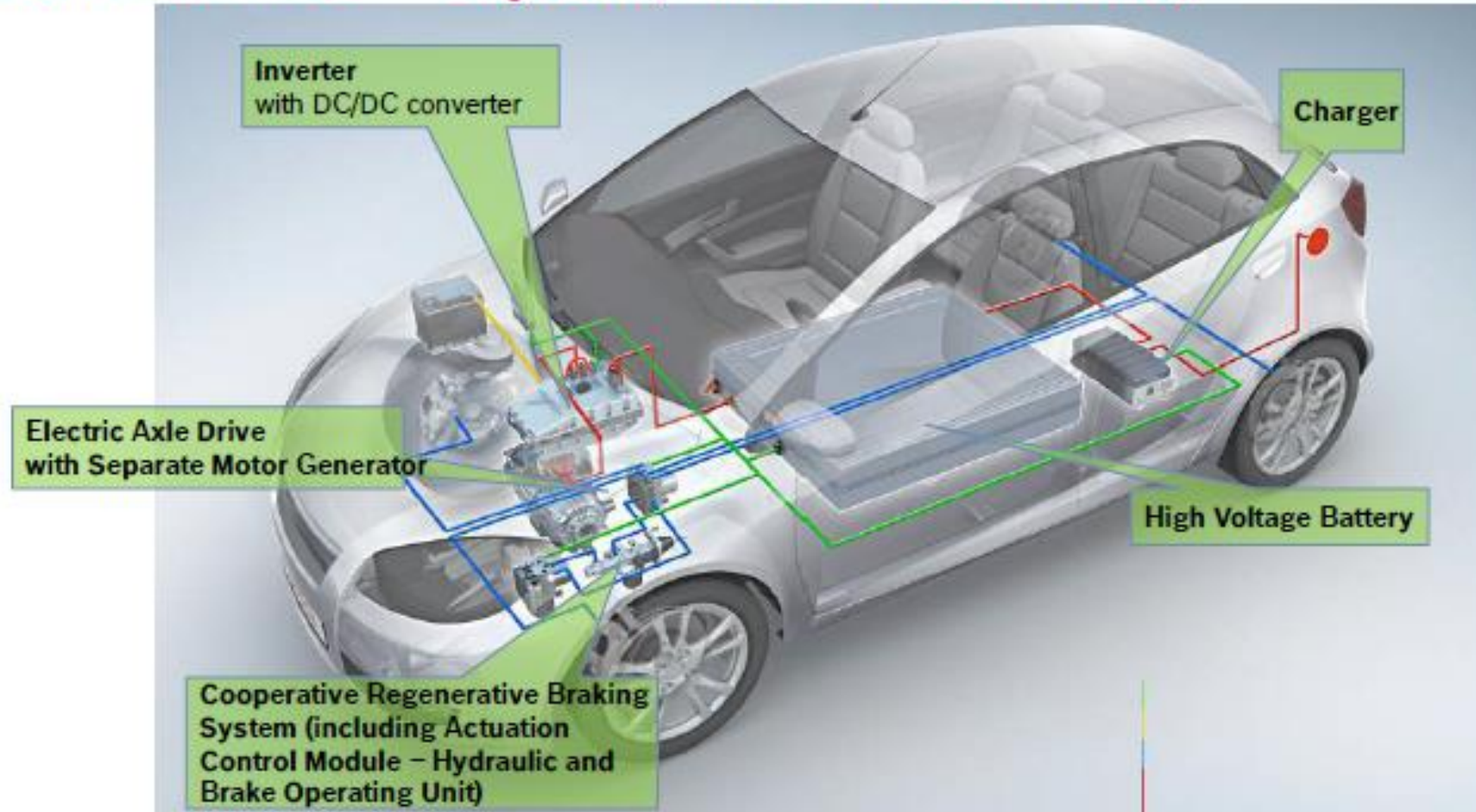
Customer Benefit

| | | | | | |
|-------------------|--|--|-----------------------------|---|------------------------|
| Primary Benefit | Reduction of fuel consumption and emissions up to 15 % | Improved “Fun to Drive” | Zero emission capability | Zero emission capability | Zero emission |
| Secondary Benefit | “Fun to Drive” | Reduction of fuel consumption and emissions up to 25 % | Electric inner-city driving | Extended E-Drive range and limp home mode | Extended E-Drive range |

Introduction to Electric Vehicles

Electric vehicle – Layout (Front wheel drive)

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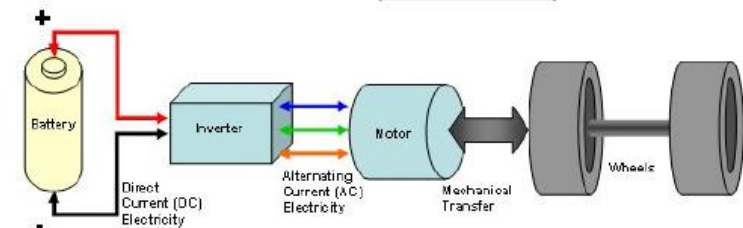
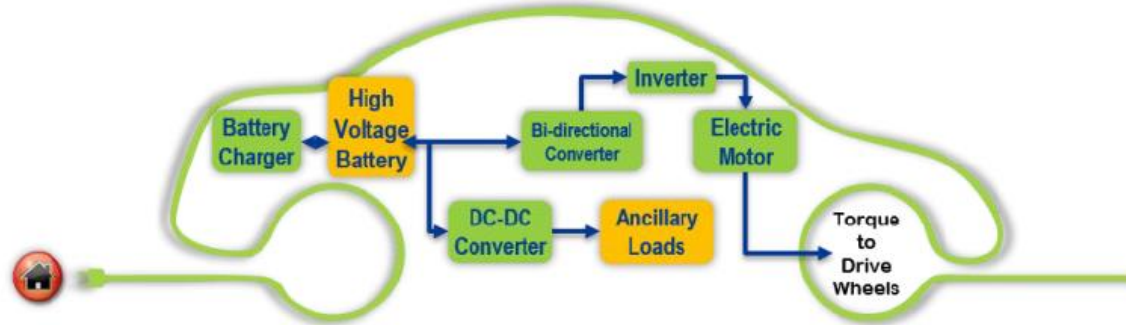
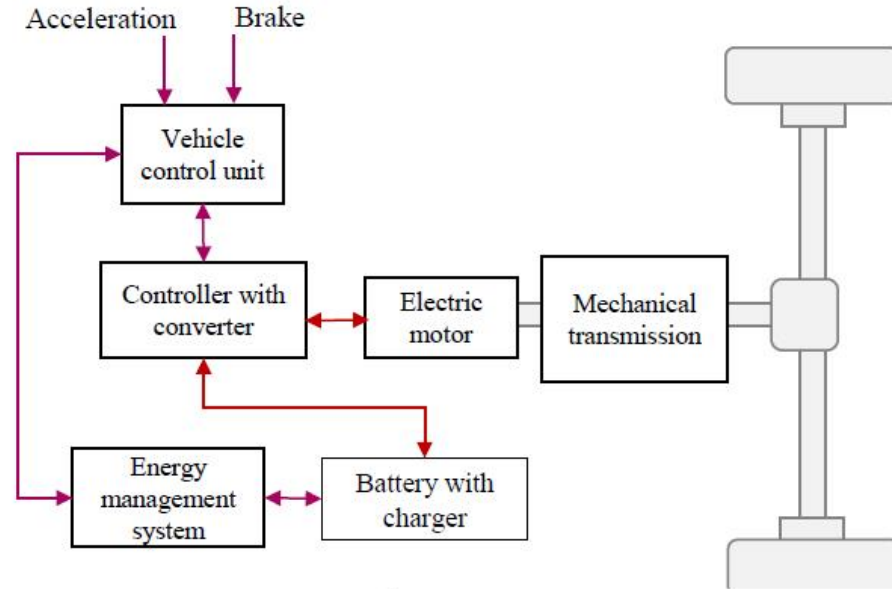


Introduction to Electric Vehicles

Electric vehicle – Layout

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- ✓ Electric motor is the prime mover
- ✓ No Internal Combustion engine
- ✓ Energy from Grid stored in battery
- ✓ Heavy battery capacity
- ✓ Separate electric motor for each wheel
- ✓ Simplified drive train



Introduction to Electric Vehicles

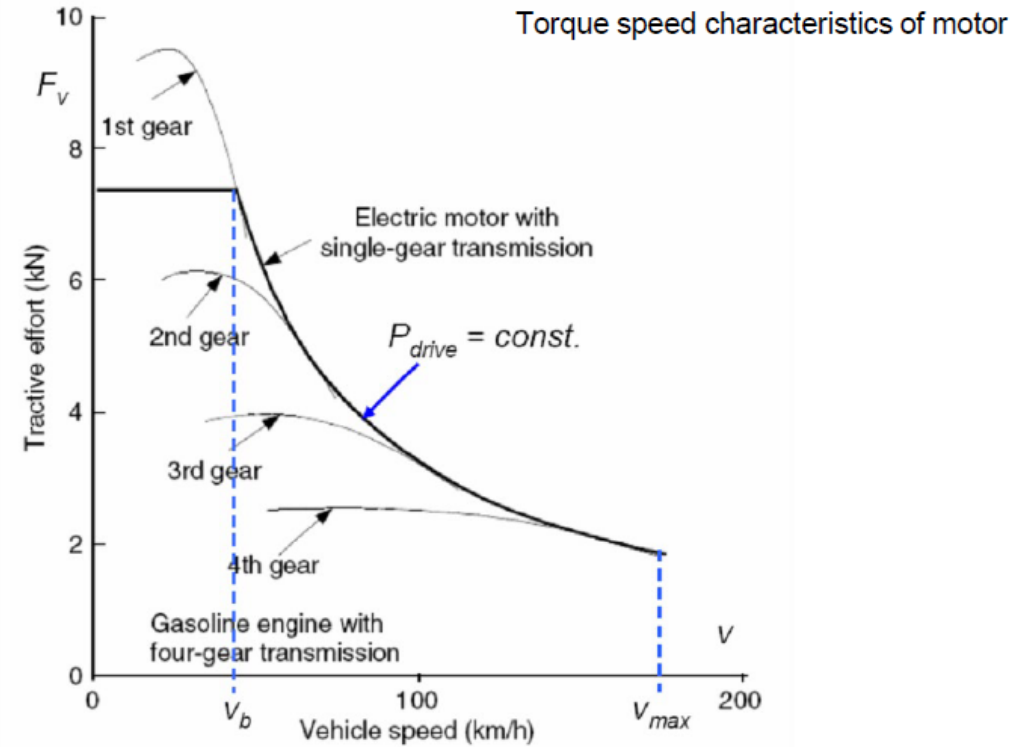
Electric vehicle – Advantages and Limitation

Advantage

- Zero emissions
- Low operating cost (< 1 Rs/km)
- Maximum energy regeneration
- Single gear transmission

Limitation:

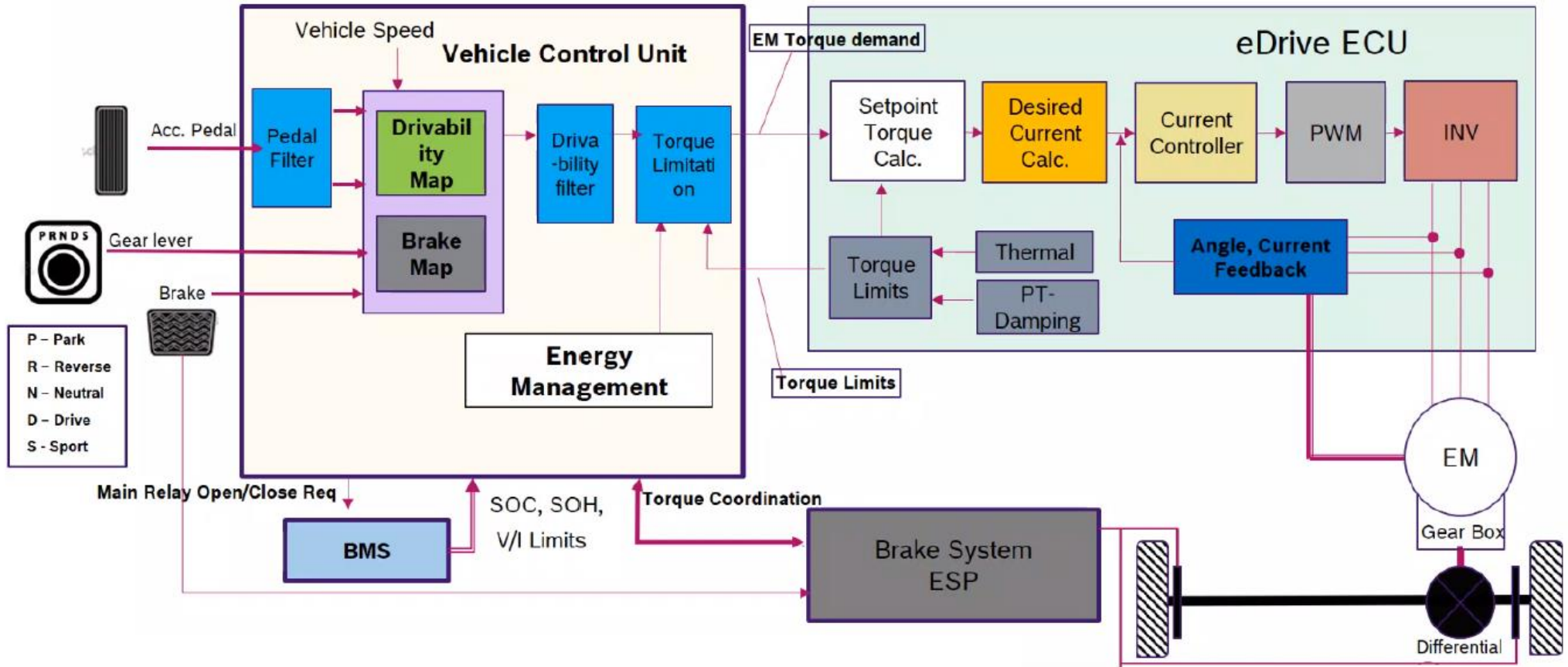
- High motor rating
- Range
- Battery Charging time
- Battery life and replacement cost
- High Voltage hardware (> 48V)
- Safety



Because Electric motor torque-speed profile is close to Ideal for traction.
No need for multi gear transmission in EV topology.

Introduction to Electric Vehicles

Vehicle control system



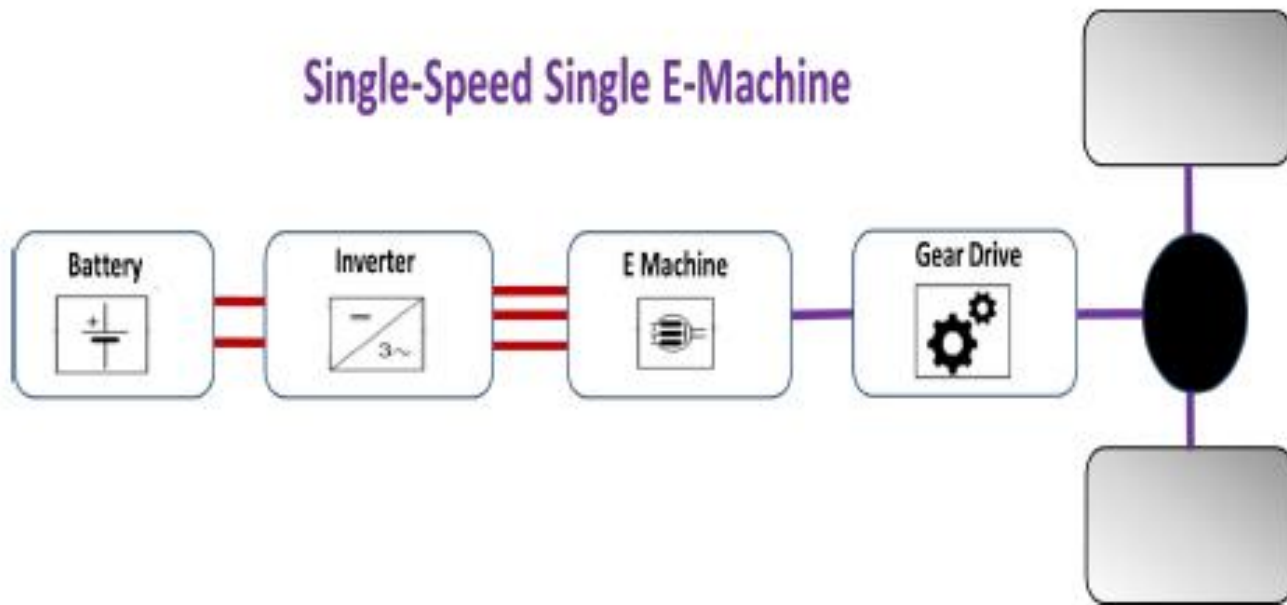
Electric Vehicle Topology

Electric Vehicle Configurations

Different Topologies

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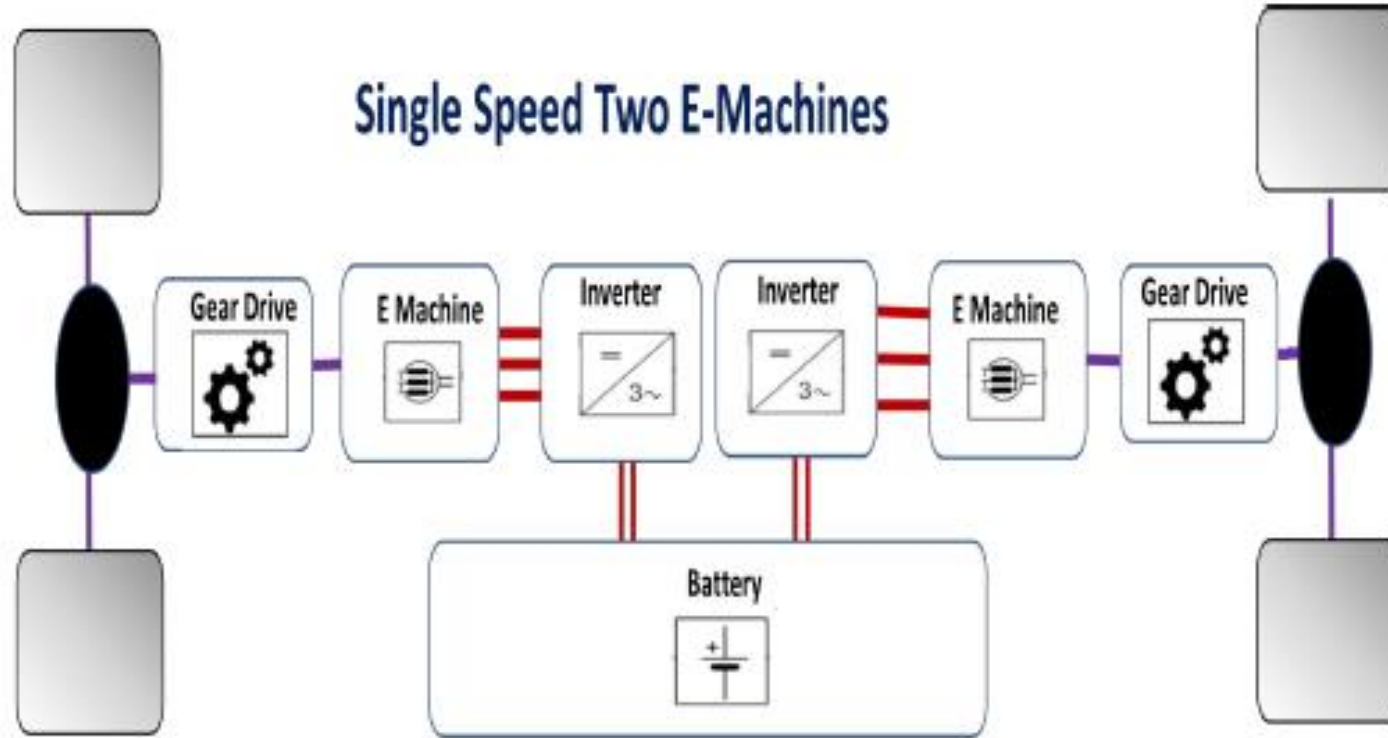
Single-Speed Single E-Machine



VW eGolf

Electric Vehicle Configurations

Different Topologies

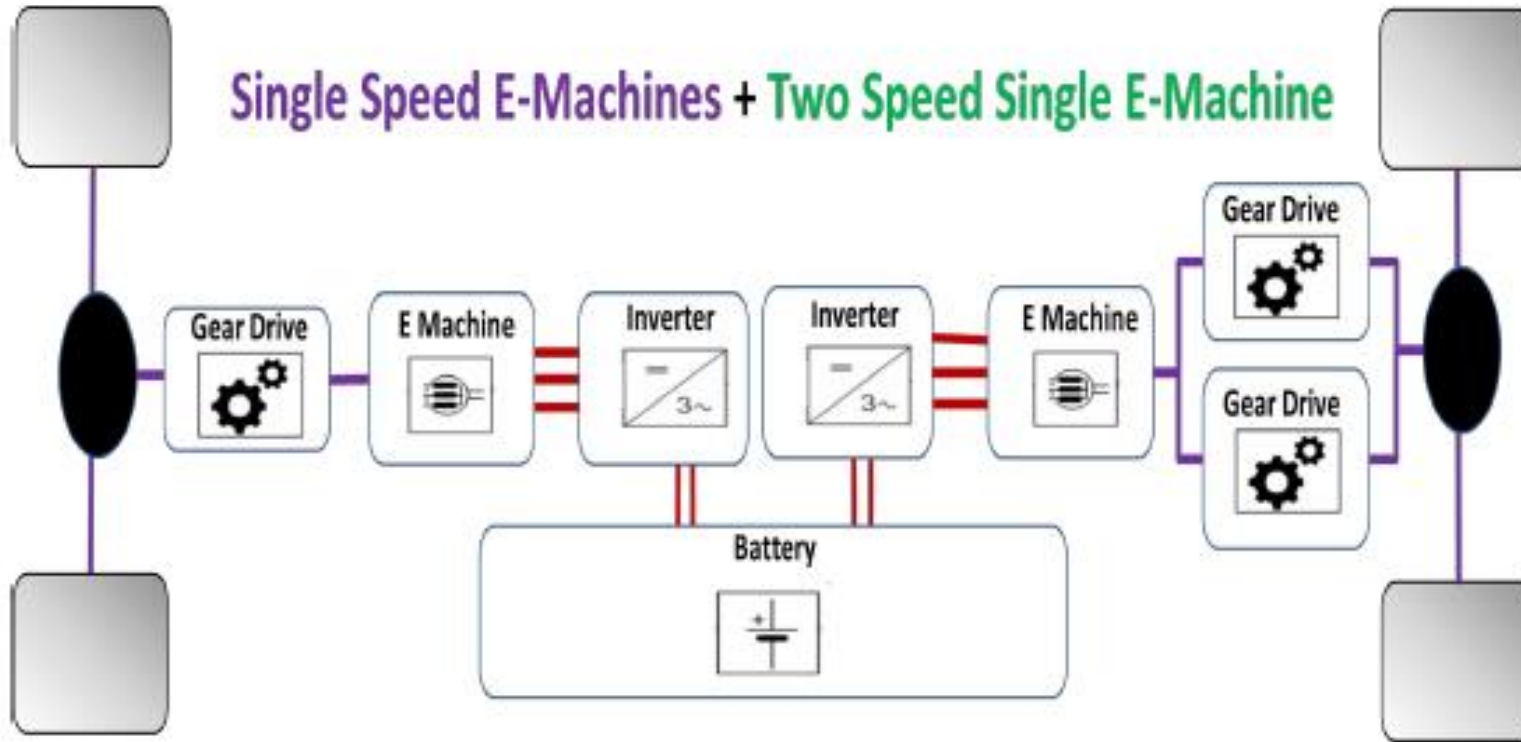


Porsche Taycan

Electric Vehicle Configurations

Different Topologies

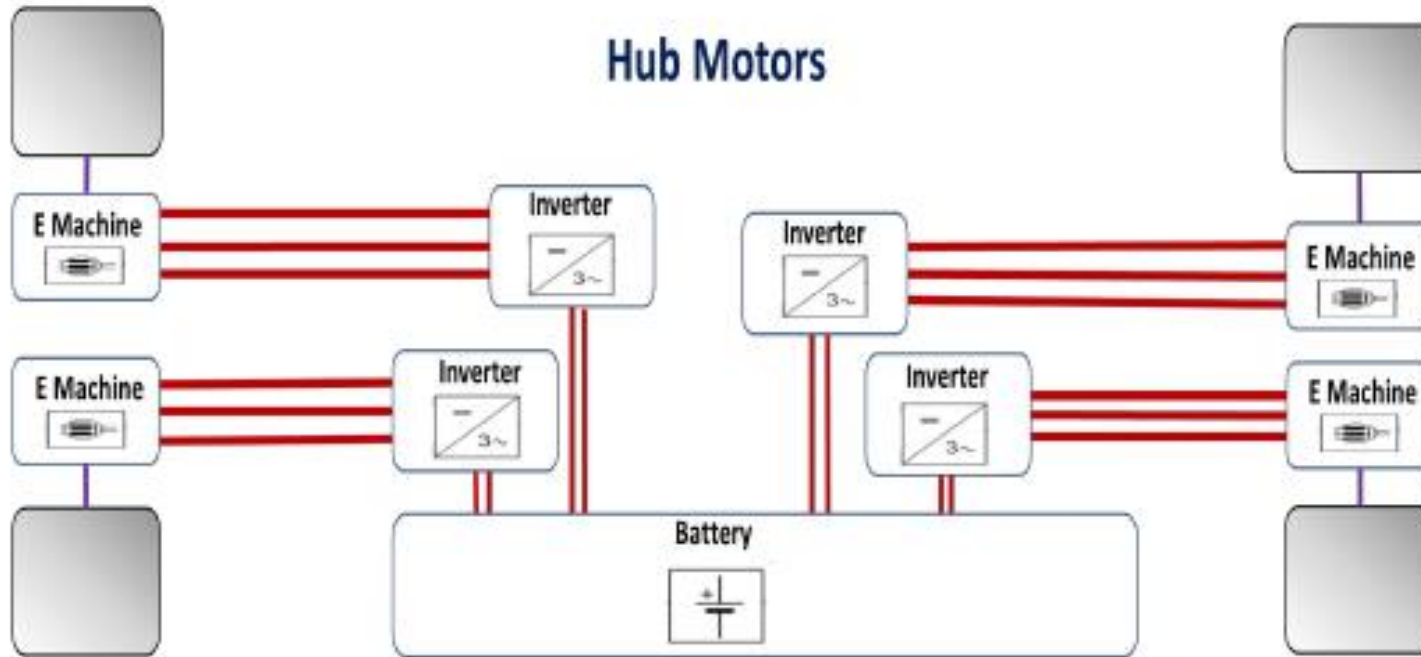
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Tesla Model S

Electric Vehicle Configurations

Different Topologies



Regenerative Braking system

Electric Powertrain Components

Regenerative braking System

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Every time a car has to be decelerated, a lot of Energy gets lost with an conventional Braking system. The kinetic Energy is only transformed into heat.

Recuperation saves Energy of the Brake application. => Fuel consumption and emission of Hybrid cars can be reduced (less ICE adoption).

In electric vehicles the charging of the Battery with Braking Energy can be used to extend the driving range.



Electric Powertrain Components

Regenerative braking System



Key technology that **improves the overall efficiency** in EVs and HEVs from 20% to 50%

The **kinetic and potential energies** of the vehicle are converted into electrical energy and stored in battery or super capacitor for driving.

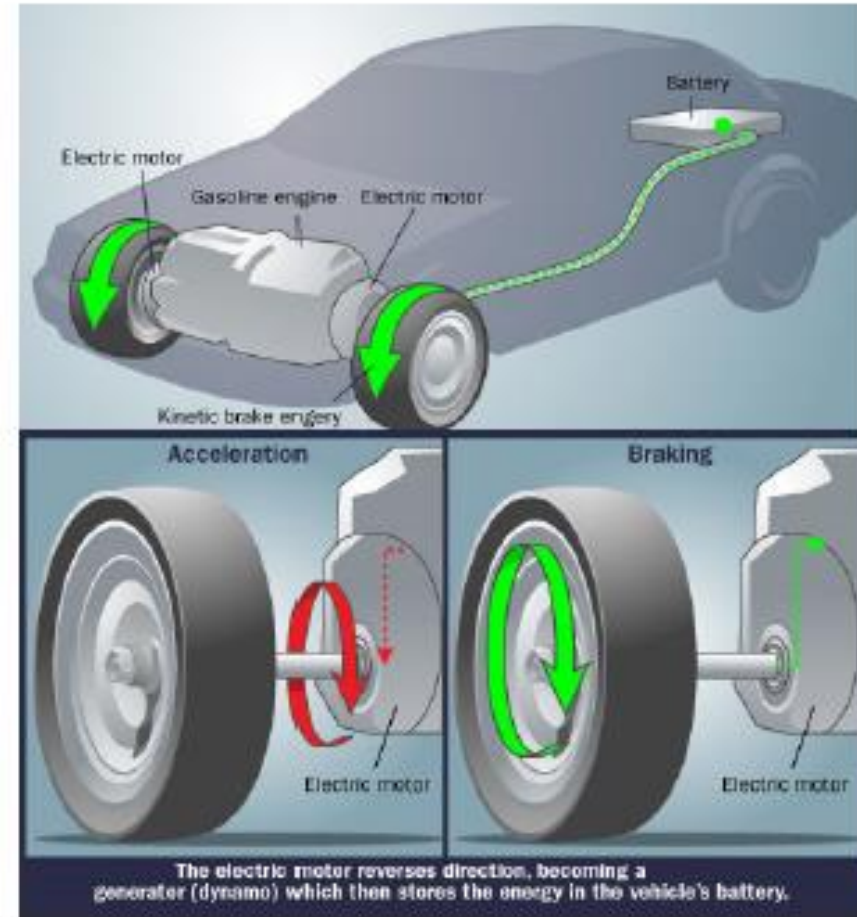
More **effective in city driving** conditions (one third to half of the energy is consumed in braking in urban driving, which can be potentially recuperated)

Electric Powertrain Components

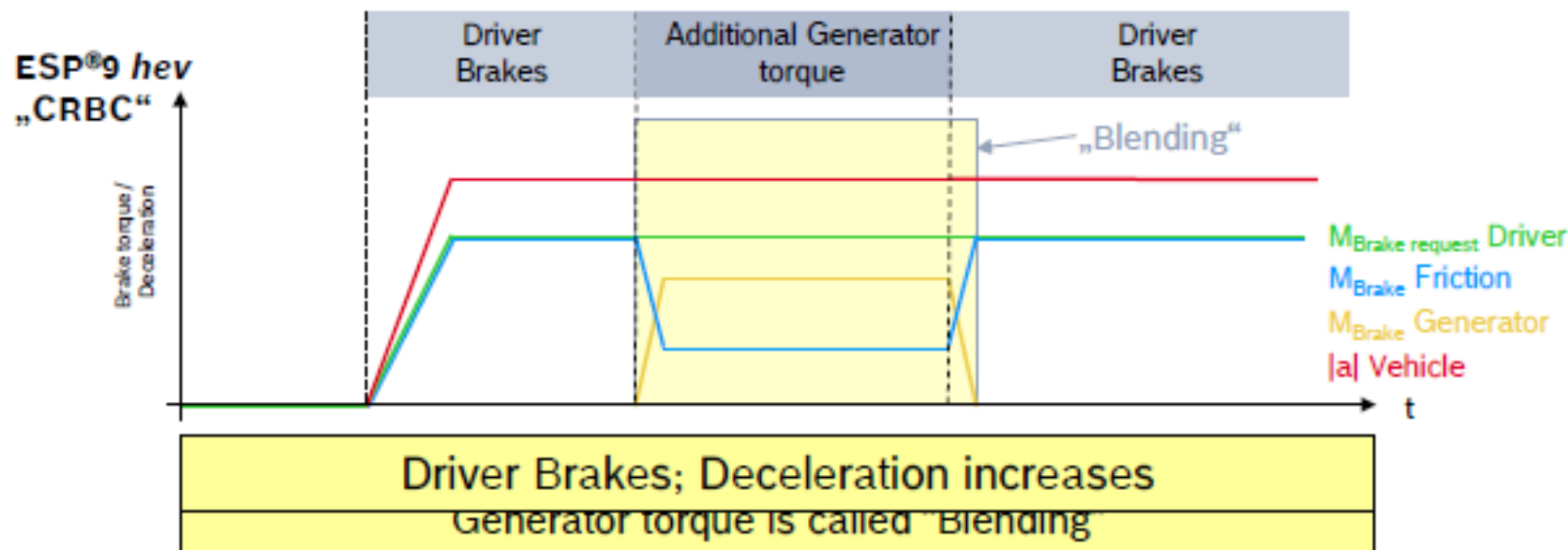
Regenerative braking System - Function

The electric motor is connected to the wheels (at one axle) during the Brake application. By reversing it's direction, the electric motor becomes a Generator, which induces voltage.

The induced voltage can be used to charge the Battery.



Co-operative Regenerative braking Control



Cooperative Regenerative Braking Control (CRBC):

An CRBC reduces the Braking torque of the friction, if the Generator steps in the brake application. The deceleration of the vehicle remains constant as the Driver requests it.



Q & A



Thank You!