



MECHANICAL ENGINEERING SCIENCE

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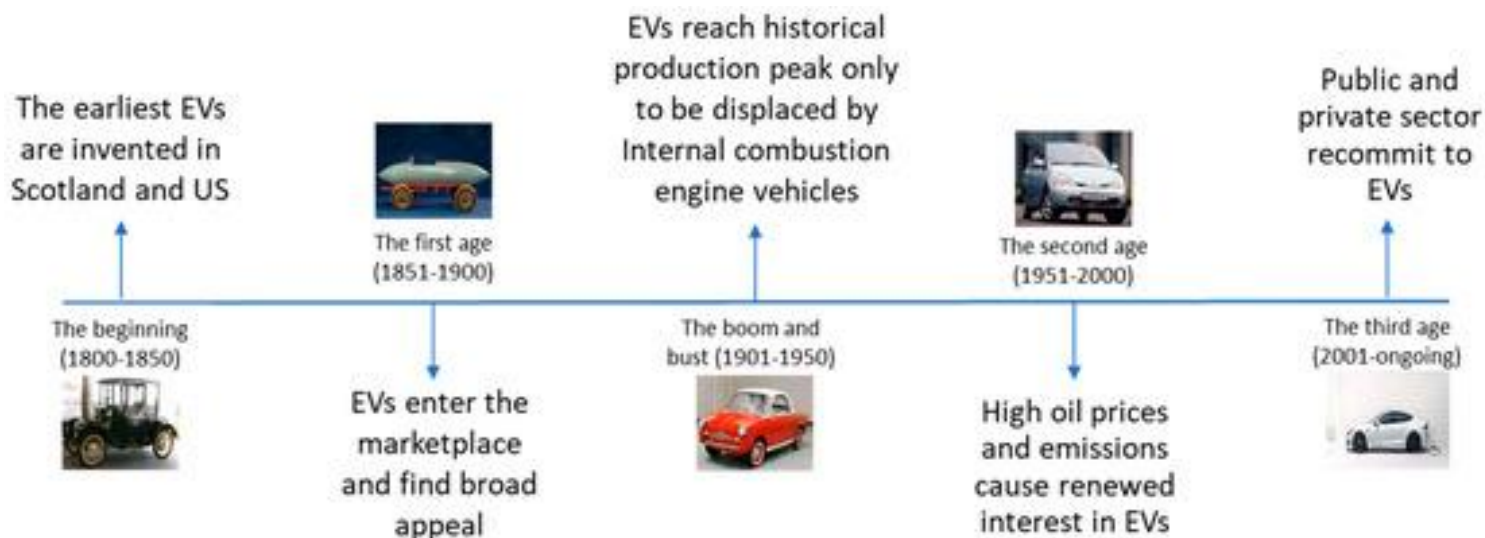
ELECTRIC AND HYBRID VEHICLES



INTRODUCTION TO ELECTRIC AND HYBRID VEHICLES

- The issues like **global warming**, **depleting fossil fuel reserves**, and **greenhouse gas (GHG) emissions** need attention for ensuring a sustainable future.
- Because the **transportation sector is one of the largest contributors to the rising harmful emissions**, the electrification of transportation is seen as a promising solution for this problem.

History of Electric Vehicles –

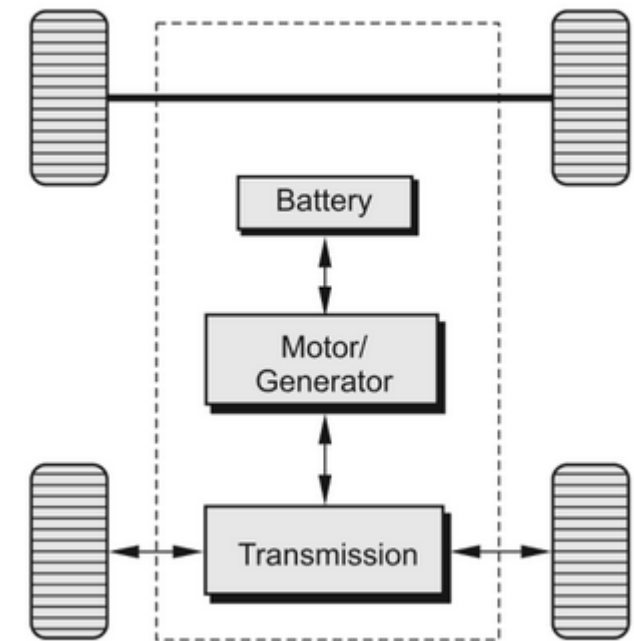


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INTRODUCTION TO ELECTRIC AND HYBRID VEHICLES

- Electric vehicles are defined as vehicles which use an electric motor for propulsion.
- They are propelled by one or more electric motors, receiving power from an onboard source of electricity such as batteries, fuel cells, ultra capacitor, flywheel etc.
- EVs include a large range of vehicles from electric two wheelers, three wheelers (rickshaws), cars and electric buses and trucks.

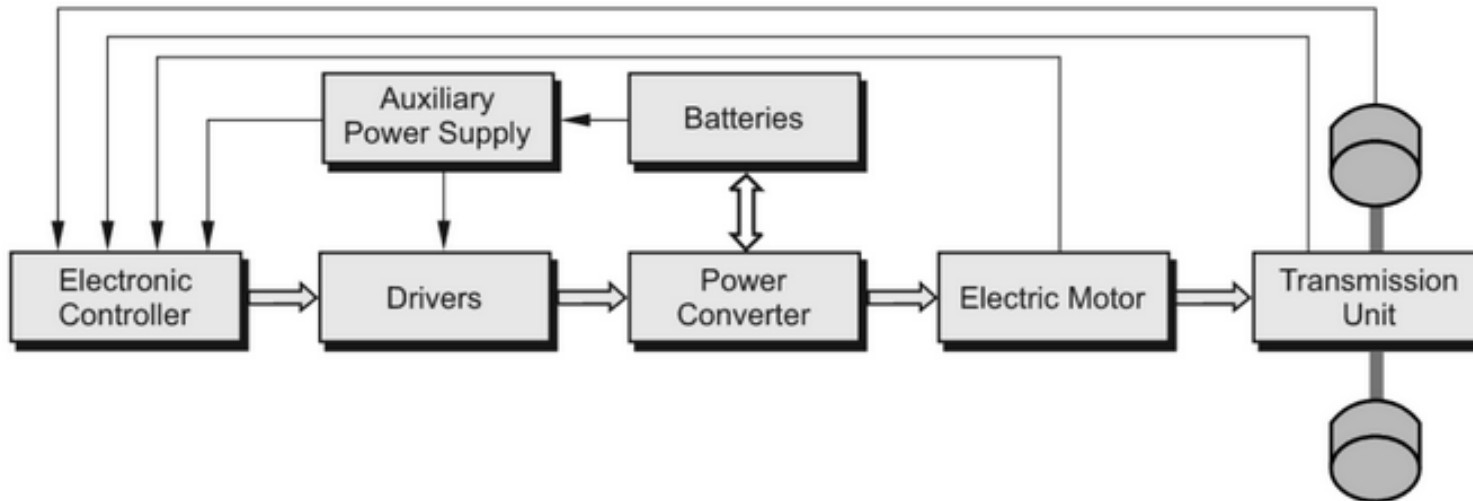


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Major Components of EV:



- An electric vehicle consists of a
 - **Battery** that provides energy,
 - **Electric motor** that drives the wheels
 - **Controller** that regulates the energy flow to the motor.
 - There are no gear box and clutch in these vehicles.

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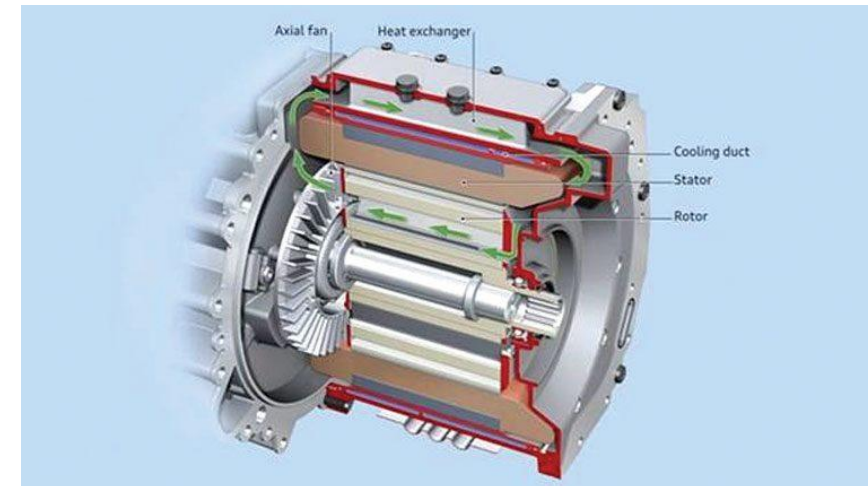


INTRODUCTION TO ELECTRIC AND HYBRID VEHICLES

Major Components of EV:

Motor –

- The prime mover in electric vehicle is the high torque electric motor.
- It converts the **energy stored in the power pack into mechanical motion**. The power is directly delivered to the wheels or through the transaxle that propels the vehicle.
- While braking, it acts like a generator (**regenerative braking**) and recharges the batteries.



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Power pack (Battery) –

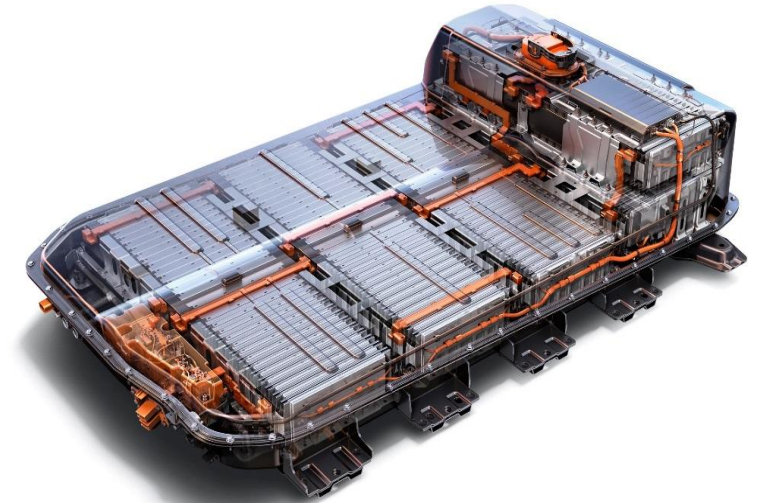
- Automobile manufacturers use **three types** of rechargeable batteries. Those are
 - lead acid batteries,
 - nickel metal hydride (NiMH) batteries and
 - lithium ion (Li – ion) batteries.

Charger –

- EVs have an on – board charger, which converts AC into DC power to charge the power pack.

Controller -

- EVs also have a computerized motor controller. This **regulates the flow of energy from the power pack to the motor in direct relation to the pressure applied on the accelerator.**



DC/DC converter –

EVs have two electrical systems:

1. **High-voltage system (HV)** – for the **electric motor, inverter, HV battery, and fast charging**
2. **Low-voltage system (12V)** – for **lights, dashboard electronics, wipers, horn, ECU, and safety systems**

- The DC/DC converter **replaces the alternator** in a traditional combustion engine vehicle.
- A **DC/DC converter** takes **high-voltage DC** from the **main traction battery** (usually 200V–800V) and **steps it down to low-voltage DC** (typically 12V) to power the **auxiliary systems**
- A 12V auxiliary battery is normally used in an electric car to power all 12V accessories such as **lights, dashboard electronics, wipers, horn, electronic control units (ECUs)** i.e airbags, ABS etc.

Energy Management System –

- The **brain of EVs is the energy management system** that monitors and controls all required functions.
- It is a computer based system that optimizes charging and energy output of batteries to maximize operating range and improve performance.

Classification of EVs –

There are 3 types of electric vehicle:

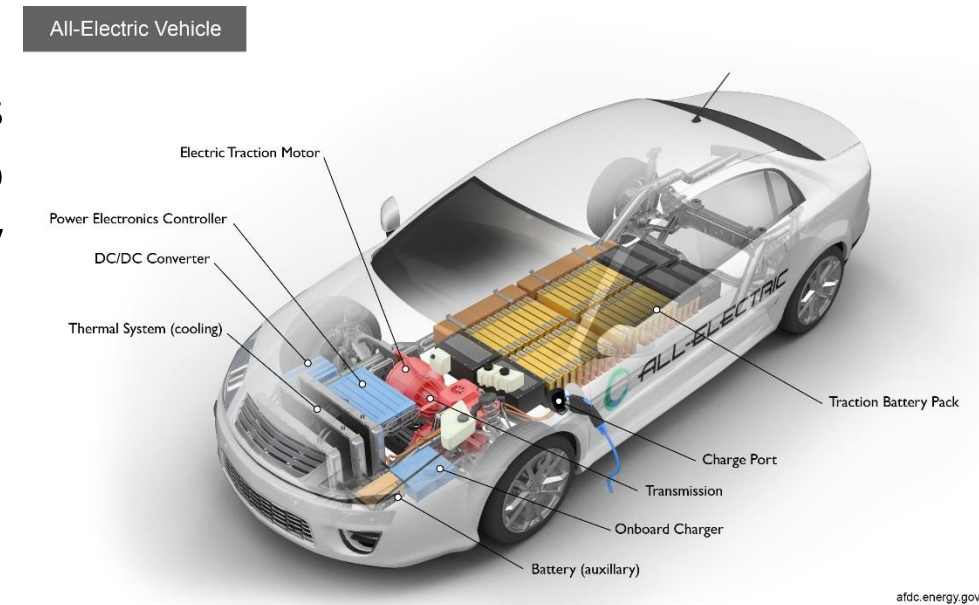
- i) Battery Electric Vehicle (BEV)**
- ii) Hybrid Electric Vehicle (HEV)**
- iii) Plug in Hybrid Electric Vehicle (PHEV)**

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i. Battery Electric Vehicle (BEV) –

- A **Battery Electric Vehicle (BEV)** is a type of electric vehicle that runs **entirely on electricity** stored in a **high-capacity battery pack**, with **no internal combustion engine** and **no fuel tank**.
 - BEVs can also **recharge their batteries through a process** known as **regenerative braking**, which uses the vehicle's electric motor to assist in slowing the vehicle and to recover some of the energy normally converted to heat by the brakes.
- Examples – Tesla Model S Nissan Leaf, BMW i3, Mitsubishi iMi etc.

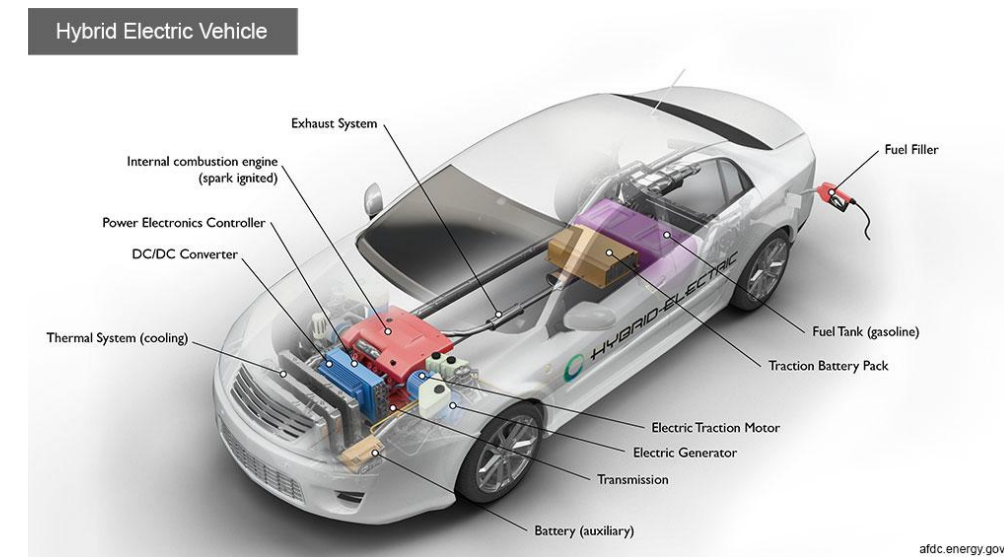


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Hybrid Electric Vehicle (HEV) –

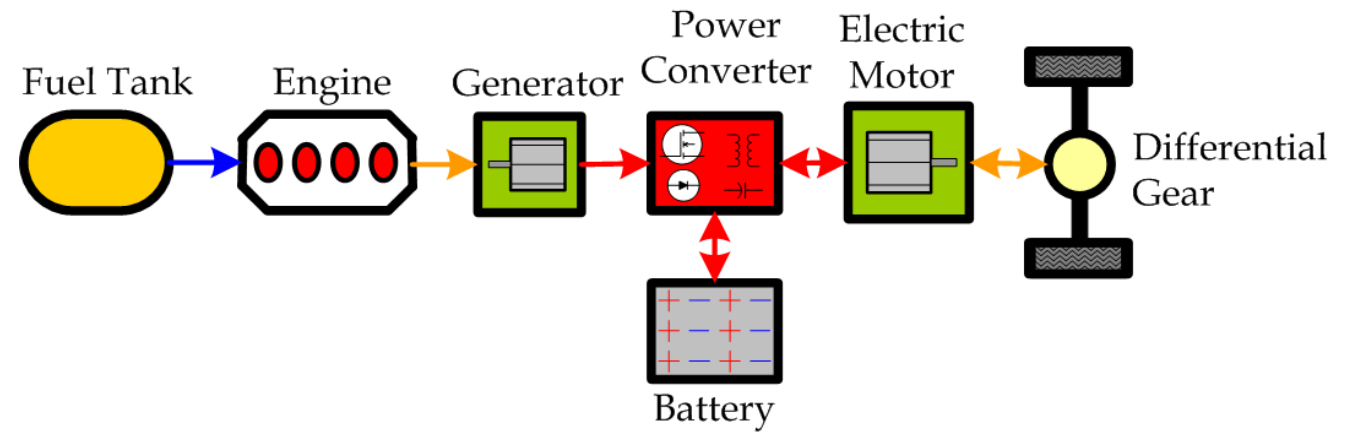
- Hybrid electric vehicles have a supplemental fuel source to produce electricity on – board. They have two complementary drive systems: an **IC engine with a fuel tank and an electric motor with a battery**.
- Both the drive systems can be used to turn the transmission and the transmission then turns the wheels.
- HEVs cannot be recharged from the electricity grid – all their energy comes from fuel and from regenerative braking.



Hybrid Electric Vehicle (HEV) – Architectures

i) Series Architecture

- In case of series hybrid system, the mechanical output is first converted into electricity using a generator.
- The converted electricity either charges the battery or can bypass the battery to propel the wheels via the motor and mechanical transmission.
- Conceptually, it is an ICE assisted Electric Vehicle (EV).
- Example: BMW i3



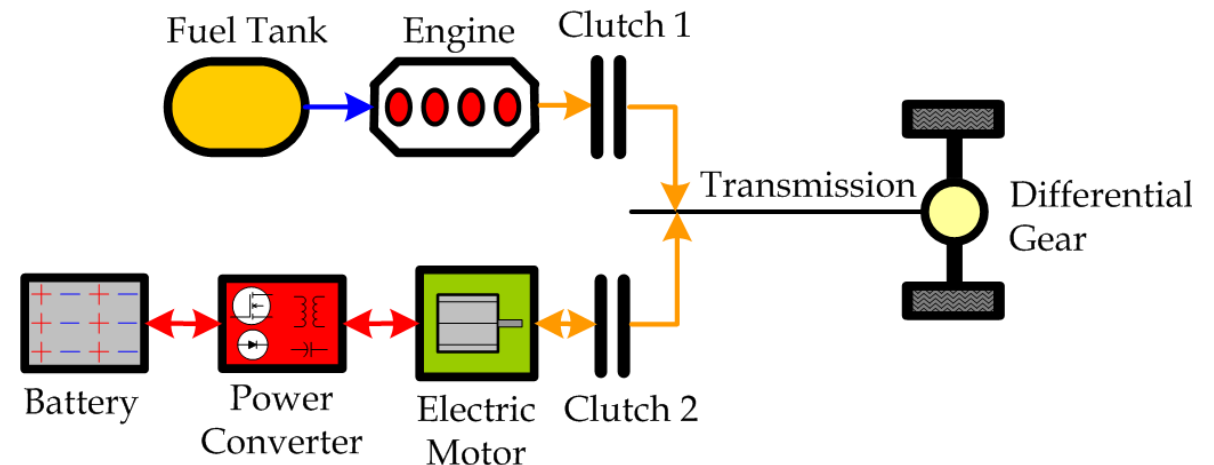
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Hybrid Electric Vehicle (HEV) – Architectures

ii) Parallel Architecture

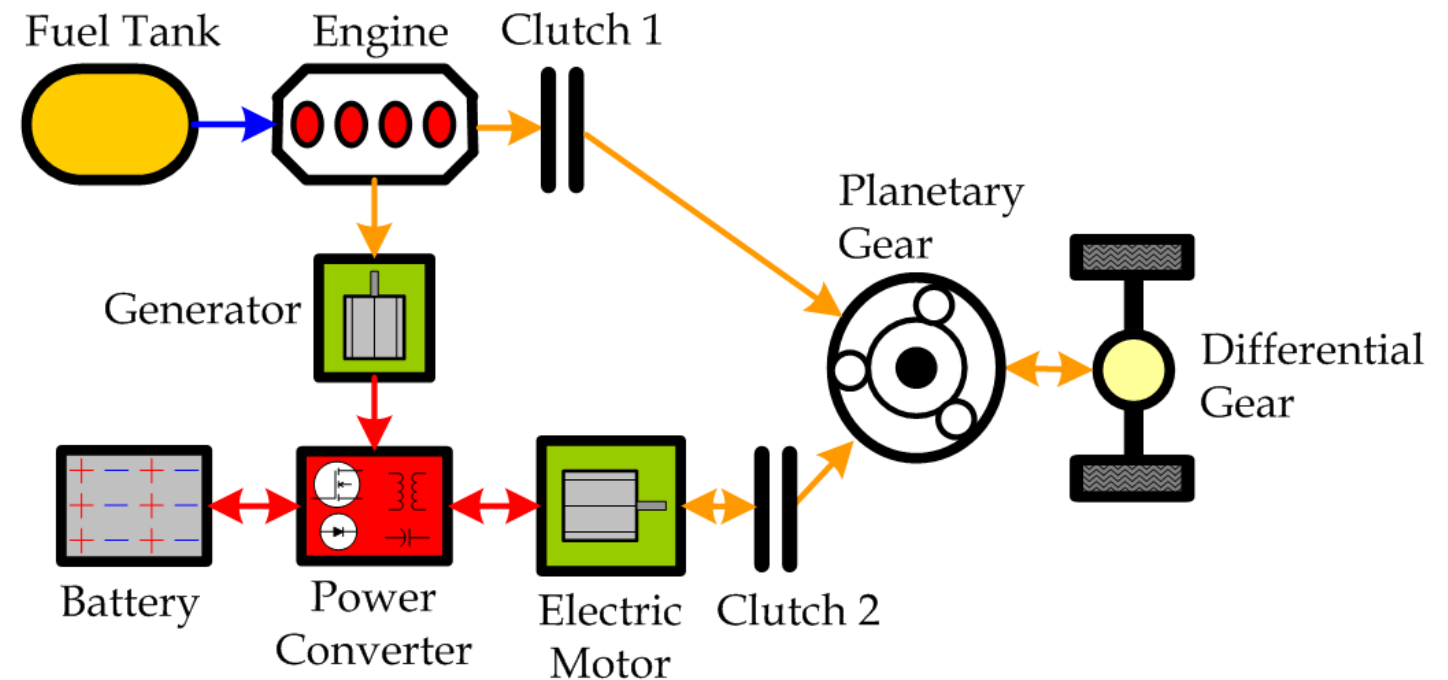
- The parallel HEV allows both ICE and electric motor (EM) to deliver power to drive the wheels.
- Since both the ICE and EM are coupled to the drive shaft of the wheels via two clutches, the propulsion power may be supplied by ICE alone, by EM only or by both ICE and EM.
- The EM can be used as a generator to charge the battery by regenerative braking or absorbing power from the ICE when its output is greater than that required to drive the wheels.
- Example: Toyota Camry Hybrid Honda Accord Hybrid Hyundai Sonata Hybrid Kia Niro HEV



Hybrid Electric Vehicle (HEV) – Architectures

iii) Series - Parallel Architecture

- In the series-parallel hybrid, the configuration incorporates the features of both the series and parallel HEVs.
- However, this configuration needs an additional electric machine and a planetary gear unit making the control complex.
- Examples: Toyota Prius Hybrid, Toyota Camry Hybrid, Ford Escape Hybrid, Lexus RX Hybrid

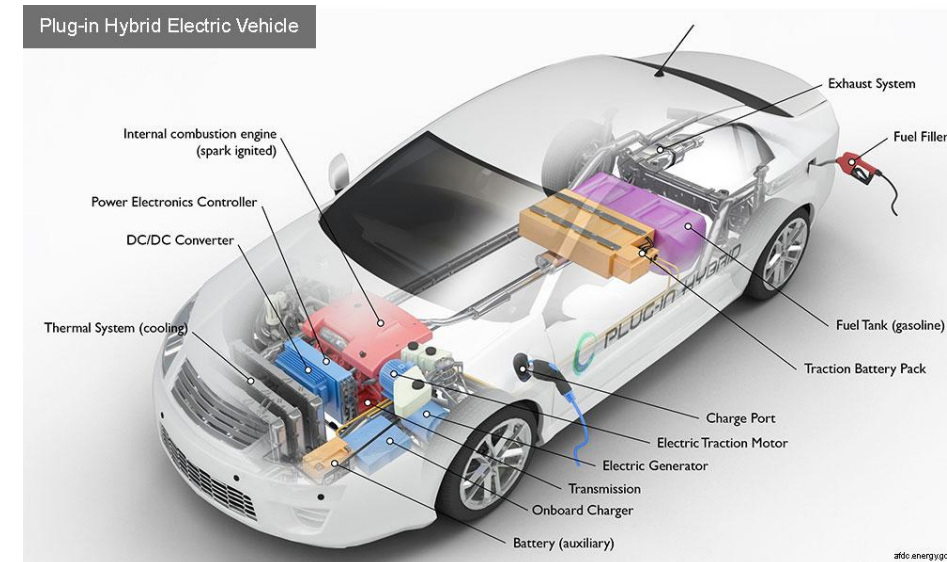


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iii. Plug in Hybrid Electric Vehicle (PHEV) –

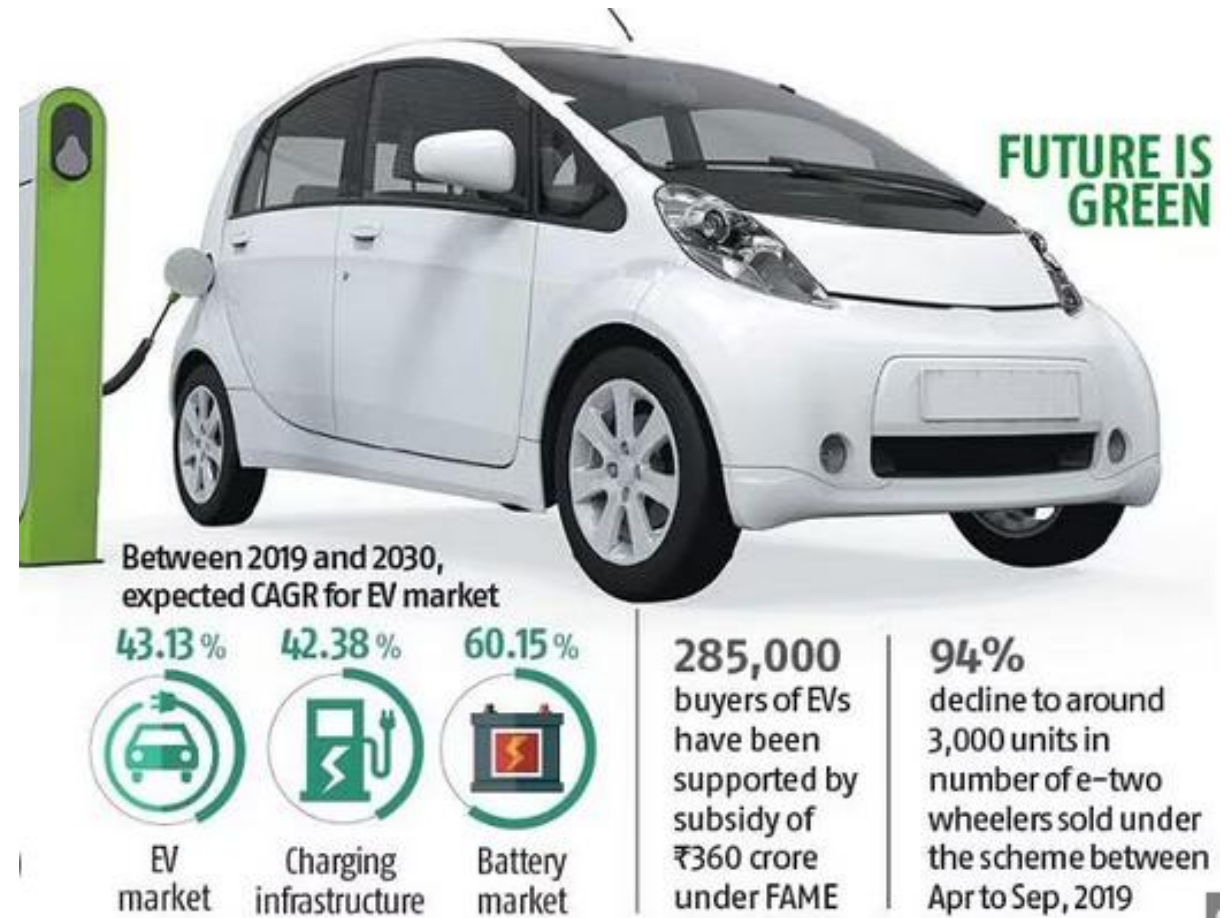
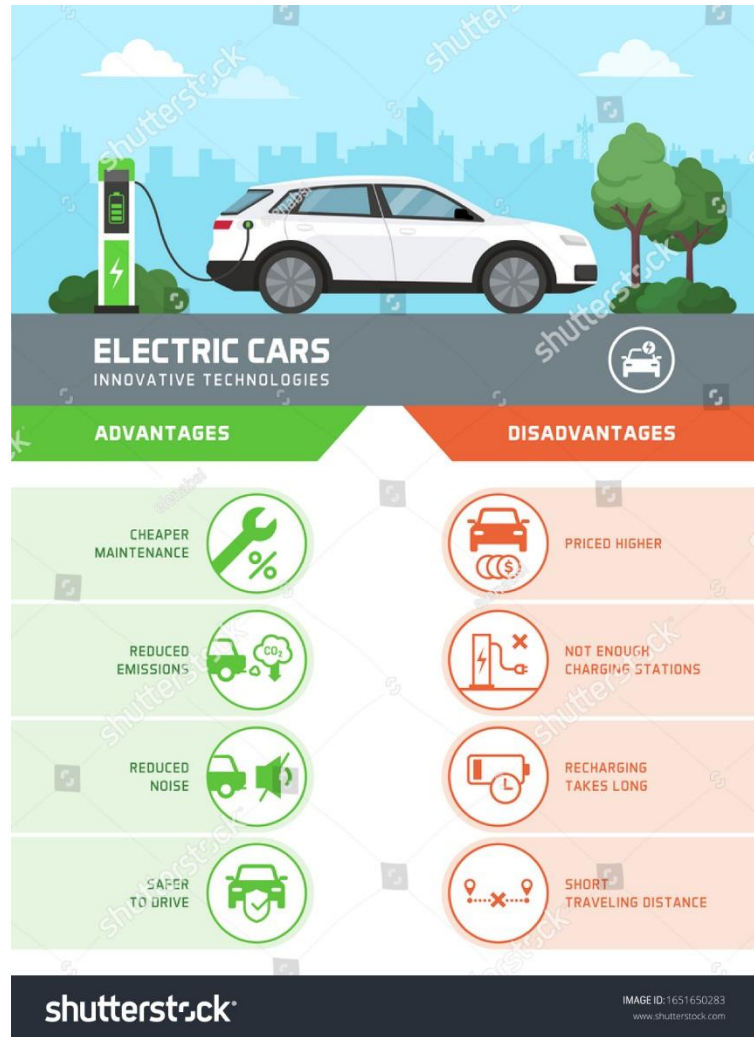
- A **Plug-in Hybrid Electric Vehicle (PHEV)** is similar to a regular hybrid but with a **larger battery** that can be **charged externally** via a power outlet. This allows PHEVs to drive longer distances on **electric power alone** before switching to hybrid mode.
 - Also have the support of an internal combustion engine that may be used to recharge the vehicle's battery and/or to replace the electric motor when the battery is low.
- Because Plug in hybrids use electricity from the power grid, they often realize more savings in fuel costs than tradition hybrid electric vehicles (HEV).
- Examples – Toyota Prius Prime, Chevrolet Volt, Ford Escape PHEV, BMW i3 Rex etc.



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THANK YOU

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