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EV Power Train

10

1769 - 1<sup>st</sup> vehicle Nicholas Cugnot [Steam Engine]

1806 - Isaac de Rivaz [1<sup>st</sup> IC Engine]

1826 - Anyoz Zedlitz (electric motor in toy car)

1886 - Thomas Parker 1<sup>st</sup> Electric vehicle

1884 - Carl Benz 1<sup>st</sup> IC Engine

1890 - William Morrison Invented Morrison's carriage

Speed - 20 mph (32 kmph)

Motor - 4 hp

3 kW

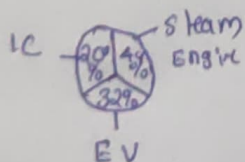
Battery - 58 kW

112 Ah

≈ 6496 watt hr

4 speed control - 12V, 24V, 48V, 55V

1906 - Golden Era of EV



Reason for popularity: no emission

low cost

efficient

easy start

1910 - End of Golden Era

1912 - Decline of EV:

Reasons:

- Assembly line production by Henry Ford

30% reduction in sales.

1912 • Chevrolet self start mechanism for IC Engine

- World War

Range

charging time

} Reliability issue

1929 - The Great US Depression  
(oil lobbies)

1950s - New Era in EV

• The Great Smog (5-9 Dec. 1950)  
12000 deaths

1960 - Pollution & death in California

1970 - California Air Resources Board formed (CARB)

1991 - LEV I (Low emission vehicle) introduced.

⇒ all manufacturer to provide EV alternative

⇒ ZEV - zero emission vehicle

lease agreement resulted in failure of LEV I

1996 - Filed case against CARB

1999 - companies won

2003 - LEV II

LEV - 10-15% ↓ emission

ULEV - 70-80% ↓

PZEV - 0%

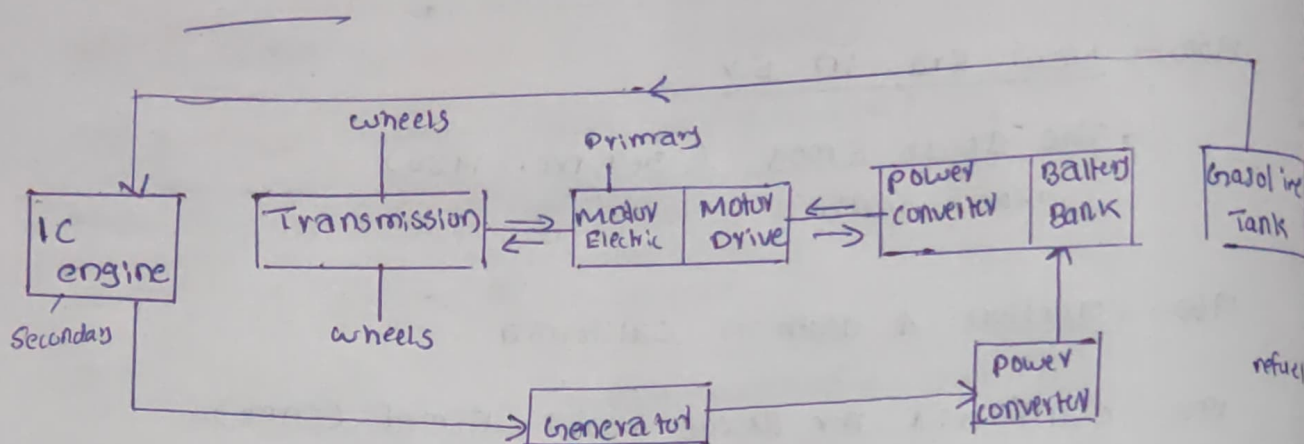
2004 - Emission regulation in India

2006/2008 = Santa Monica Auto Expo

Tesla Roadster is presented (180-200 m/hr)

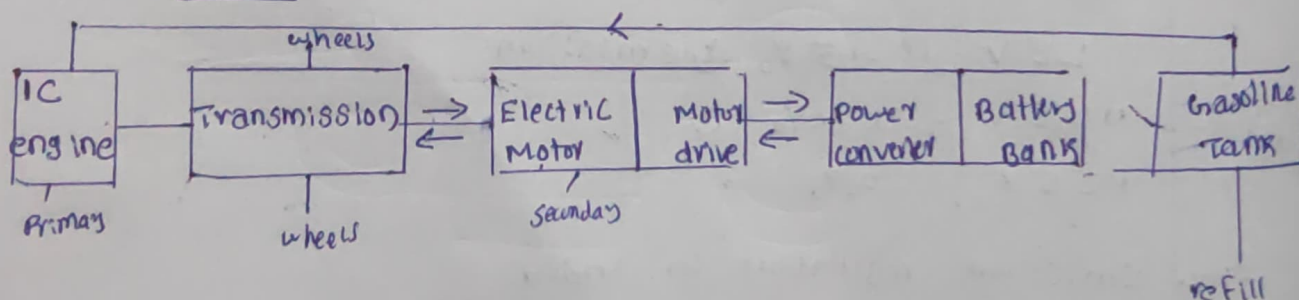
2010 - Nissan Leaf (1<sup>st</sup> affordable 5 door hatchback EV)

## a) Series Hybrid EV



- IC engine is to recharge Battery Bank
- powerfull electric motor
- larger Battery pack
- Motor at back
- has range extender
- rarely used
- BMW i3

## b) parallel Hybrid



- most commonly used
- intelligent Plug in hybrid
- IC engine powerfull
- small Battery pack
- BMW i8

5 different cases

case I

(M) Motor-off

IC - on

case II

runs in IC engine & recharge battery

case III

M-on

IC-off

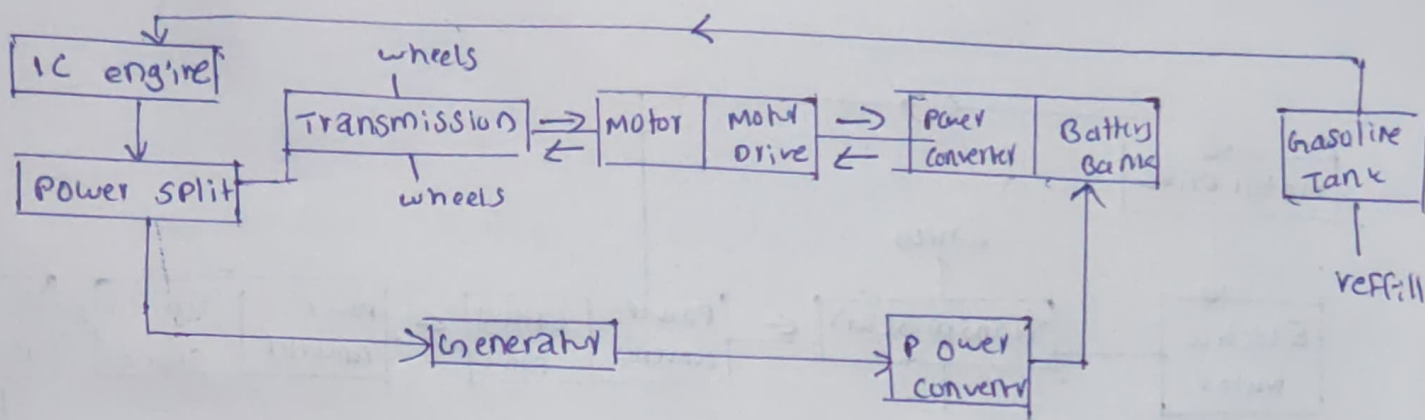
case IV

hybrid both on

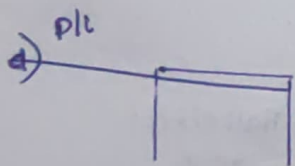
case V

regenerative braking

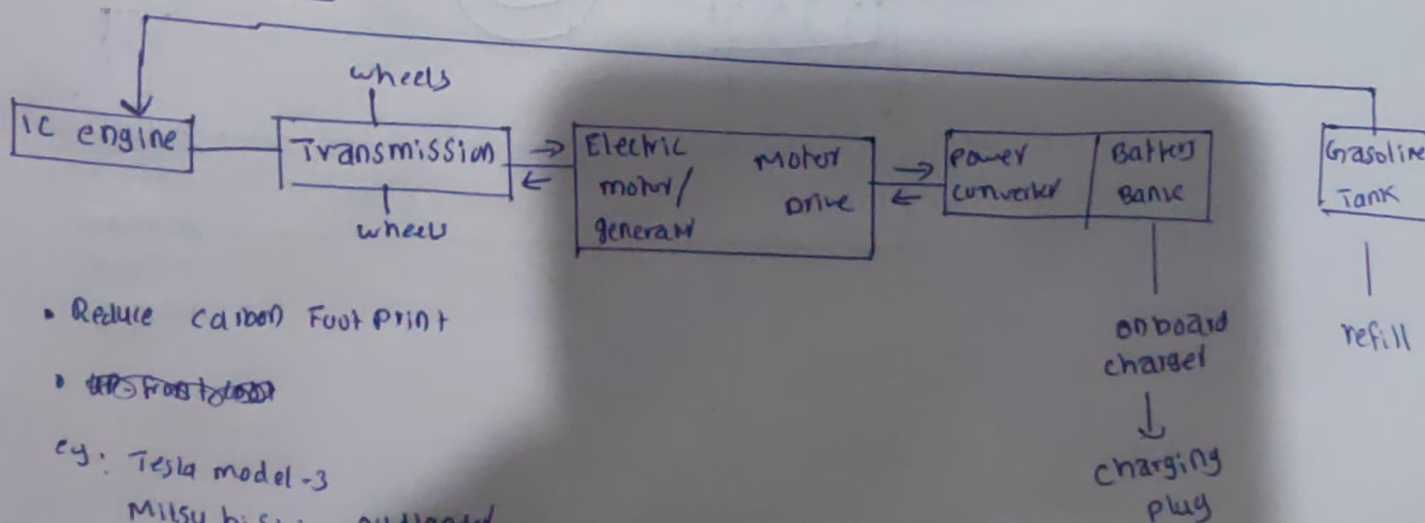
## c) Series Parallel



- Powersplit divides power between generator & Transmission
- heavy setup - drawback
- motor connected to Ring gear
- IC engine connected to Sun gear
- Back disc - gearbox
- small rotor - generator
- Toyota Prius
- only 1 vehicle is introduced

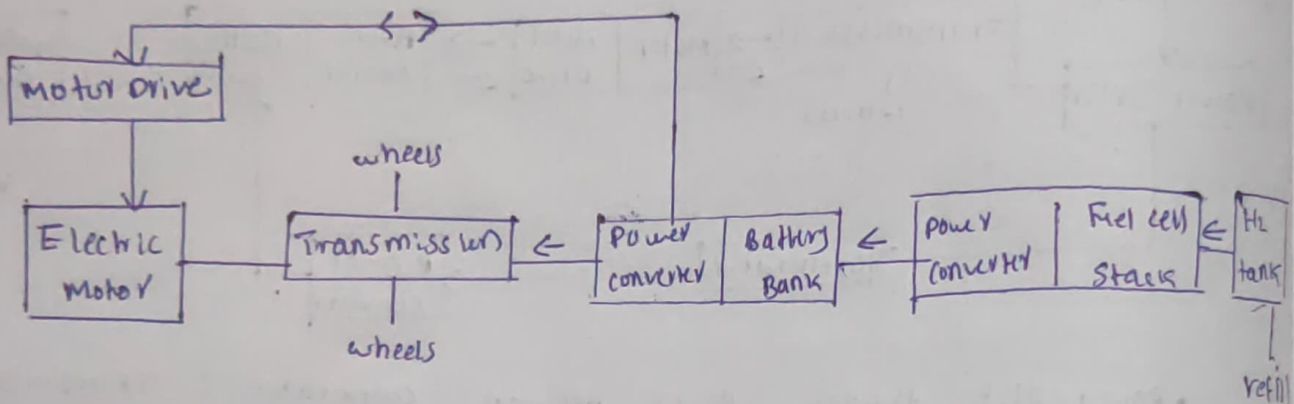


## d) Plug-in hybrid EV (PHEV)



- Reduce carbon Foot Print
- ~~low cost~~
- eg: Tesla model-3
- Mitsubishi outlander

### 8) Fuel cell EV



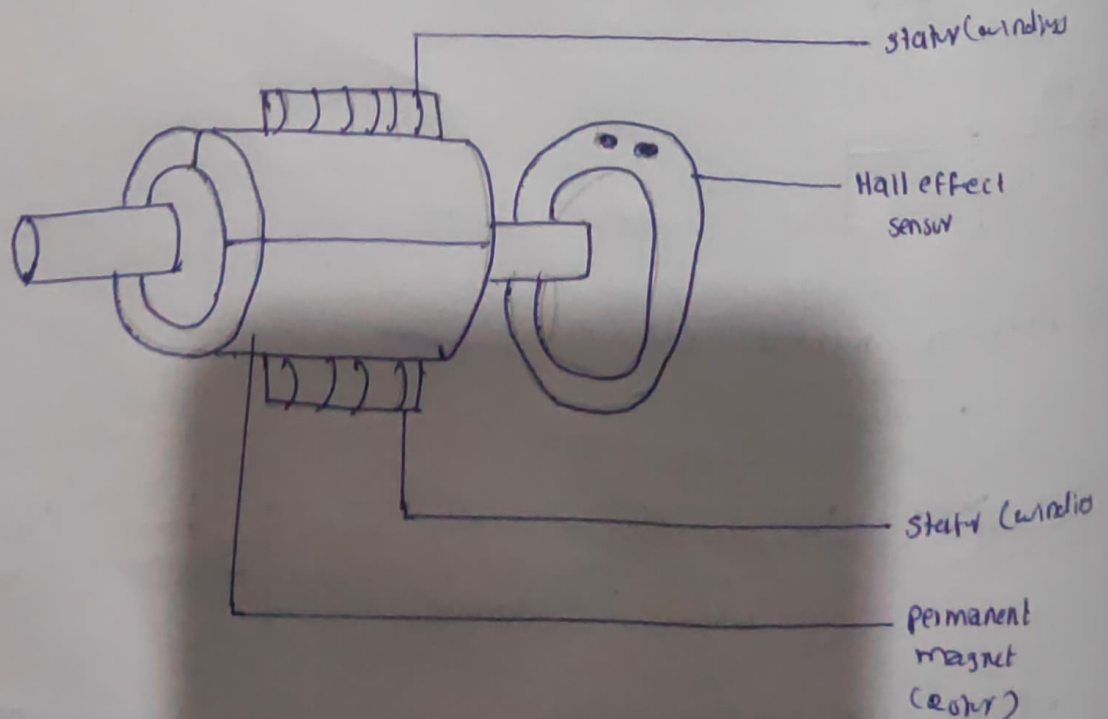
- Difficult to handle H<sub>2</sub>

- <sup>more</sup> space is required

- cost is high

eg: ~~Hyundai~~ Hyundai Nexo

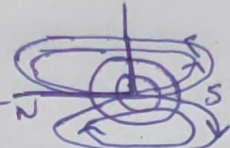
### Q3) BLDC Motor



## • Working principle

### Lorentz Force Law

states that whenever a current carrying conductor is placed in a magnetic field it experiences a force. As consequence, the magnet will experience an equal & opposite force. In BLDC motor, conductor windings are stator & magnet<sup>net</sup> is rotor.

- Radial Flux BLDC :- 
- Axial Flux BLDC :- Better flux density  
:- rotating according to axis

$$\eta_{\max} = 95\%$$

$$\eta_{\min} = 35\%$$

Application : 2 wheeler / 3 wheeler

Peak Power  $\Rightarrow$  max. power motor can deliver

~~t = 30 sec~~

$t = 10 \text{ sec}$   $\Rightarrow$  motor cannot operate in max. power for more than ~~30~~<sup>10</sup> sec.

Rated power = max. power delivered for continuous operation.

$t = 30 \text{ min}$

Peak torque = max. torque delivered by motor

Peak torque = initial torque.

Rated Torque = torque delivered at Rated RPM / Power.

• we can manipulate torque by controlling V & I.

Strong magnetic field means Strong Torque.