

Q. 1826

Ameyo Zelik invented first electric motor.

His motor was patented along with several ~~prototypes~~

It included stator and rotor,



1865

In London Underground, Electric Train was introduced by Thomas Parker.



1886

Thomas Parker successfully built the first production electric vehicle;



1890

Morrison Carriage built by William Morrison in U.S.A. It carried 8 people and the speed was 20 mph (32 Kph).

The motor had 4 hp (3 Kw) and a 58V

112 Ah battery (6.5 KWh)

4 speed control → i) 12 V

ii) 24 V

iii) 48 V

iv) 58 V

1906 (Golden Era of EV)

Electric vehicles became so advanced

Vehicle : 100 mile range on single charge

45-50 Kph speed

Market : Steam engines : 48%.

Electric vehicle : 32%.

gasoline vehicle : 20%.

Reason for popularity : i) No emission

ii) Efficiency

iii) Low cost

iv) Easy start



1910

1. Henry Ford - Assembly line production

Reduced cost by 30% every year

2. Chevrolet - 1912 (Self start mechanism)

3. World War : EVs were unreliable

Reason : 1. Range

2. Charging Time

Soldiers preferred trucks

1950 (5dec - 6dec)

12000 deaths due to great smog

↓

1960s

In California: 600 cases/day due to pollution
CARB (California Air Resources Board) was introduced

↓

1970s

CARB - emission regulation

From ~~1970~~ 1970-2000: pollution decreased by 80%

↓

1991

LEV - I 2EV (Zero Emission Vehicle)

GM EV, Range Rover EV, Toyota Prius

↳ Lease agreement (No full ownership)

↓

2003 - LEV II

LEV → Low Emission Vehicle: 10%-15% emission

ULEV → Ultra Low Emission Vehicle: 70%-80% emission

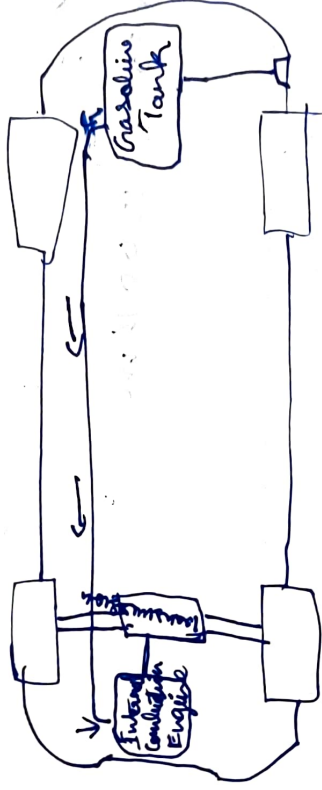
PZEV → Pure Zero Emission Vehicle: 0% ↓ emission

↓

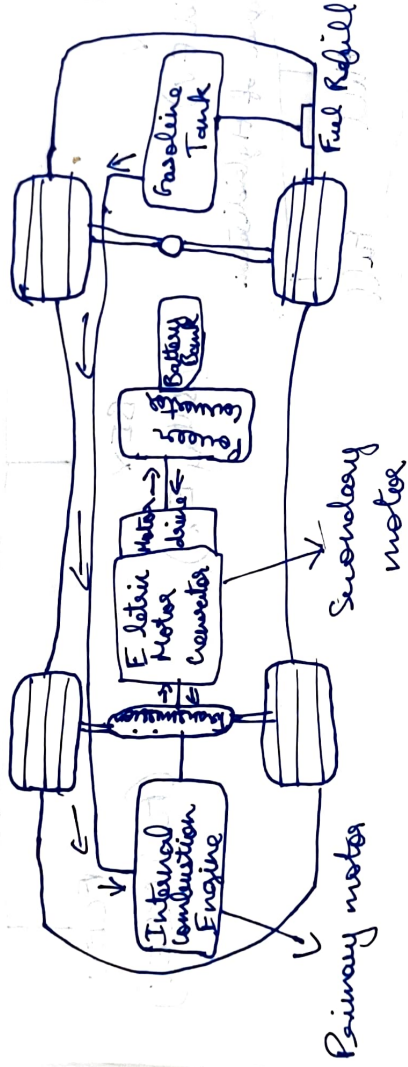
2006

Santa Monica Expo: Tesla Roadster
Performed great for an EV

I C (Internal Combustion):



HEV $\rightarrow$ Parallel:



Case I $\rightarrow$ I.C Engine Drive

I.C Engine $\rightarrow$ ON Motor $\rightarrow$ OFF

Case II $\rightarrow$ Electric Drive

I.C Engine $\rightarrow$ OFF Motor $\rightarrow$ ON

Case III $\rightarrow$ Hybrid

I.C Engine $\rightarrow$ ON Motor $\rightarrow$ ON

Case IV $\rightarrow$ Battery is low

I.C. Engine $\rightarrow$ ON

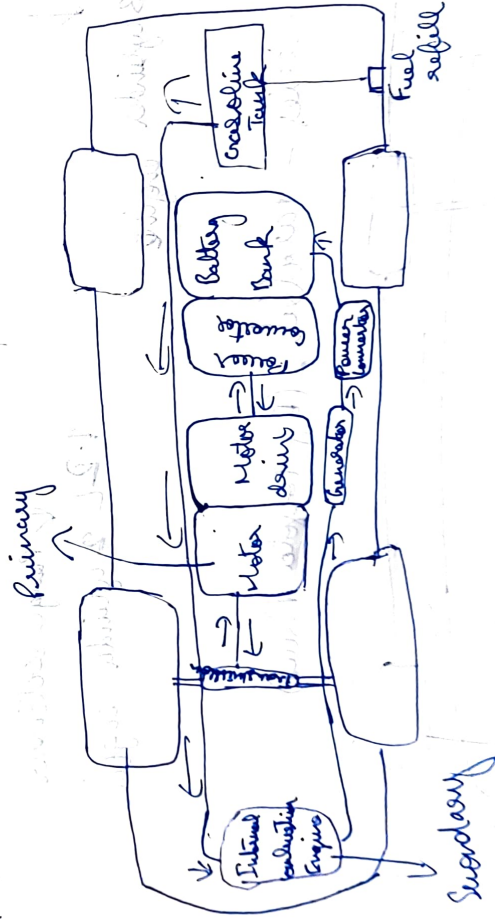
$\rightarrow$ Charge Battery

Case V $\rightarrow$ Regenerative braking

I.C. Engine $\Rightarrow$ OFF

Motor $\rightarrow$ Use inertia of vehicle to charge during braking.

HEV - Series:



Parallel Hybrid

- I.C engine vehicle fitted with powerful electric motor to assist engines.

I.C engine $\rightarrow$ Powerful

- Battery pack small size -

- BMW i8



2L 3 cylinder engine

↓ Range extender
1.2L 2 cylinder engine

Series Hybrid

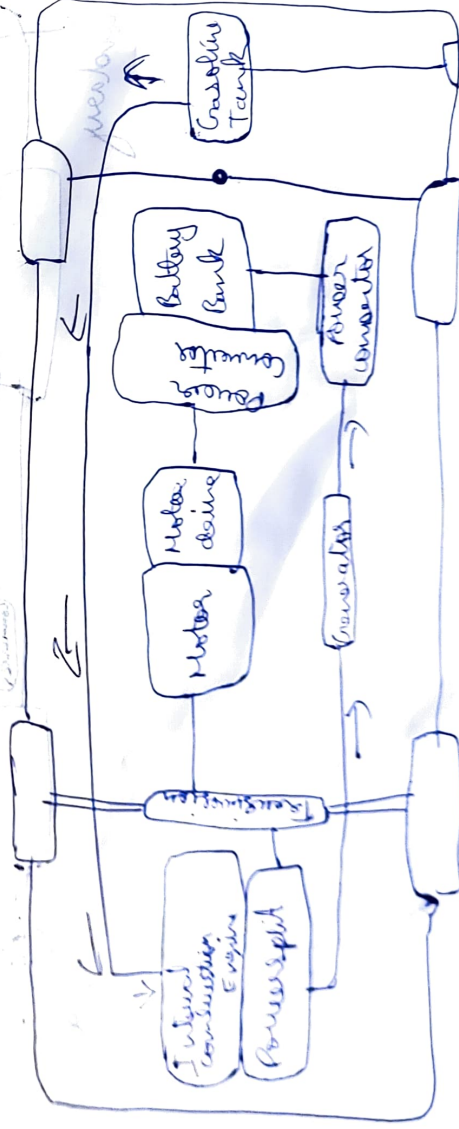
- Electric vehicle with
I.C engine for recharge
battery pack.

- Hotel $\rightarrow$ Breakfast

- Battery pack large size.

• BWW i3

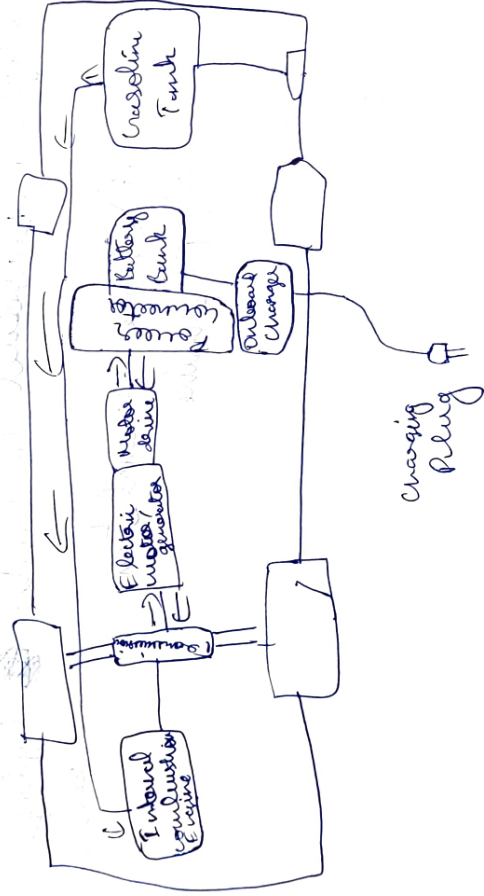
Time Series - Parallel (Eg: Toyota Prius)



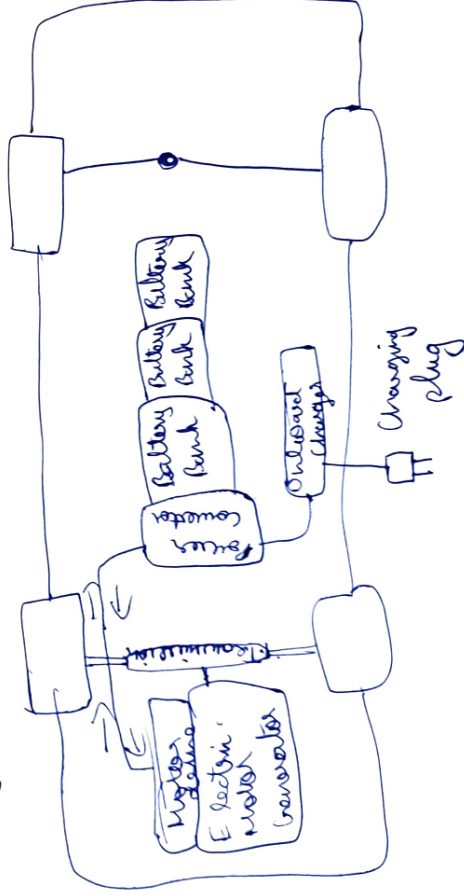
Power split : Divide power between generator and transmission.

Power split $\rightarrow$ Use transmission directly
 $\rightarrow$ Charge battery when needed from I.C engine.

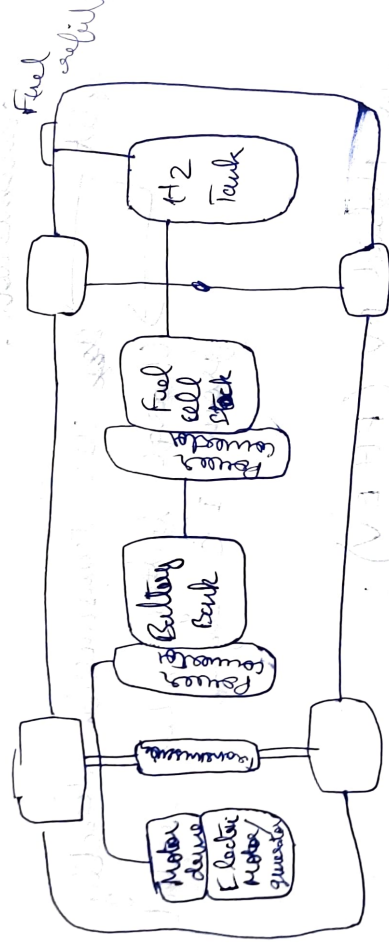
Plug-in Hybrid EV (PHEV):



Battery electric vehicle (BEV):



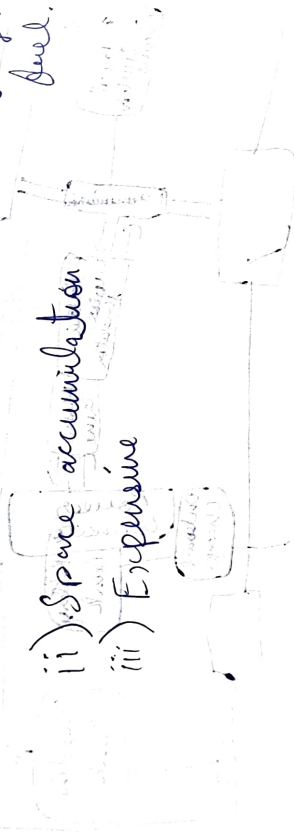
Fuel cell Electric vehicle (FCEV):



Disadvantages: i) Difficult to handle ~~hydrogen~~ hydrogen fuel.

ii) Space accumulation

iii) Expensive



Hydrogen fuel cell

Hydrogen fuel cell vehicle

