ELECTRIC VEHICLES INITIATIVE (EVI)

- The Electric Vehicles Initiative is a global policy forum established in 2010.
- EVI's main goal is to accelerate EV adoption around the world.
- Countries that are active in the EVI include:

- Canada
- Chile
- China
- Finland
- France
- Germany
- India
- Japan
- Netherlands
- New Zealand
- Norway
- Poland
- Portugal
- Sweden
- UK
- USA

ELECTRIC VEHICLE SEGMENTS IN INDIA

2-wheelers

e-scooter

E-motor cycle

3-wheelers

E-auto

E-rickshaw

goods carriage

4-wheelers

Passenger car

Light-commercial vehicle

Heavy-duty vehicles

Bus

Heavy-duty truck

https://theicct.org/sites/default/files/publications/India_EV_State_Guidebook.20191118.pd

ADOPTING PURE ELECTRIC VEHICLES

India's Mobility Vision

All new vehicles to be 100% pure electric by the 100th year of India's independence in 2047.

India's EV roadmap

- All new vehicle sales for intra-city transport to be pure electric by 2030.
- By 2030, India intends to have an electric vehicle (EV) sales penetration of
  - 30% for private cars
  - 70% for commercial vehicles
  - 80% for two and three-wheelers

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- All new vehicle sales to be pure electric vehicles by 2047

FAME INDIA

(Faster Adoption and Manufacture of [Hybrid and] Electric Vehicles)

- FAME is an incentive scheme for the promotion of EVs and HEVs in India.
- Launched in 2015, it is a part of the National Electric Mobility Mission Plan.

- Objective:
  - To promote electric mobility
  - The scheme gives financial incentives for enhancing EV production and creation of electric transportation infrastructure.

- FAME scheme operates in two phases.
  - Phase I : validity: 2015 to 31 March 2019
  - Phase II : started on 01 April 2019 to 31 March 2022
  - Fame India Scheme 2023 Phase II is valid up to 31 March 2024

FAME II

FEATURES OF FAME PHASE-II

- Fame India Scheme (phase II) aims to support, through subsidies
  - 10 Lakhs electric 2-Wheelers
  - 5 Lakhs electric 3-Wheelers
  - 55,000 electric 4-Wheelers
  - 7,000 electric Buses
- 2,700 charging stations will be setup.

FAME II subsidy

- 2-wheelers: ₹ 1,800 - 29,000
- 3-wheelers: ₹ 3,300 - 61,000
- 4-wheelers:
  - Private EV buyers: No incentives
  - Non-private buyers: ₹ 1.38 lakh

BENEFITS OF DRIVING ELECTRIC

- Very low running cost
- Regenerative braking
- More efficient
- Easy home charging + Own power
- Quick start + Quiet drive
- No gears to change
- No (or down sized) engine (BEV/HEV)
- No (or very low) tailpipe emissions (BEV/HEV)
- Energy Banking

BENEFITS OF DRIVING ELECTRIC

Vehicle Running Cost for 4-years

Attribute	Petrol Car	Electric Car (Mahindra e_2o)
Period of comparison	4 years	4 years
Distance travelled	40,000 km	40,000 km
Fuel/Energy consumption	3,333 litres of Petrol @12 kmpl	100 km / 10 kWh / charge (@ 10 km / kWh)
Refueling cost	₹ 2,66,640 (@ ₹ 80 / litre)	₹ 28,000 (4,000 units @ ₹ 7 / unit)
Maintenance & Servicing	₹ 40,000	₹ 20,000
Total Cost for 4 years	₹ 3,06,640	₹ 48,000

Expected life of EV battery: 8 years.

https://www.pluginindia.com/electricvehiclecosts.html

CHALLENGES OF ELECTRIC VEHICLES

- Limited driving range per charge
- Lengthy charging duration
- Limited life of battery
- Lack of sufficient charging infrastructure

CUSTOMER CONCERNS ABOUT BATTERY EV

Driving range	31%	31%	35%	4%	26%	25%	14%	18%	10%	24%
Cost/price premium	28%	32%	22%	19%	24%	9%	14%	31%	22%	26%
Lack of electric vehicle charging infrastructure	20%	16%	20%	44%	22%	18%	25%	23%	34%	22%
Time required to charge	9%	11%	11%	18%	13%	12%	11%	11%	17%	10%
Safety concerns with battery technology	5%	4%	5%	7%	6%	22%	22%	9%	11%	8%
An all battery electric powertrain is not offered in the type of vehicle I want (e.g., SUV, truck)	2%	3%	3%	4%	3%	11%	7%	3%	4%	5%
The brand I prefer doesn't offer electrified vehicles	3%	2%	2%	3%	4%	3%	7%	3%	1%	3%

Source: Deloitte Global Automotive Consumer Survey 2018

AUTOMOBILE / VEHICLE TERMINOLOGIES

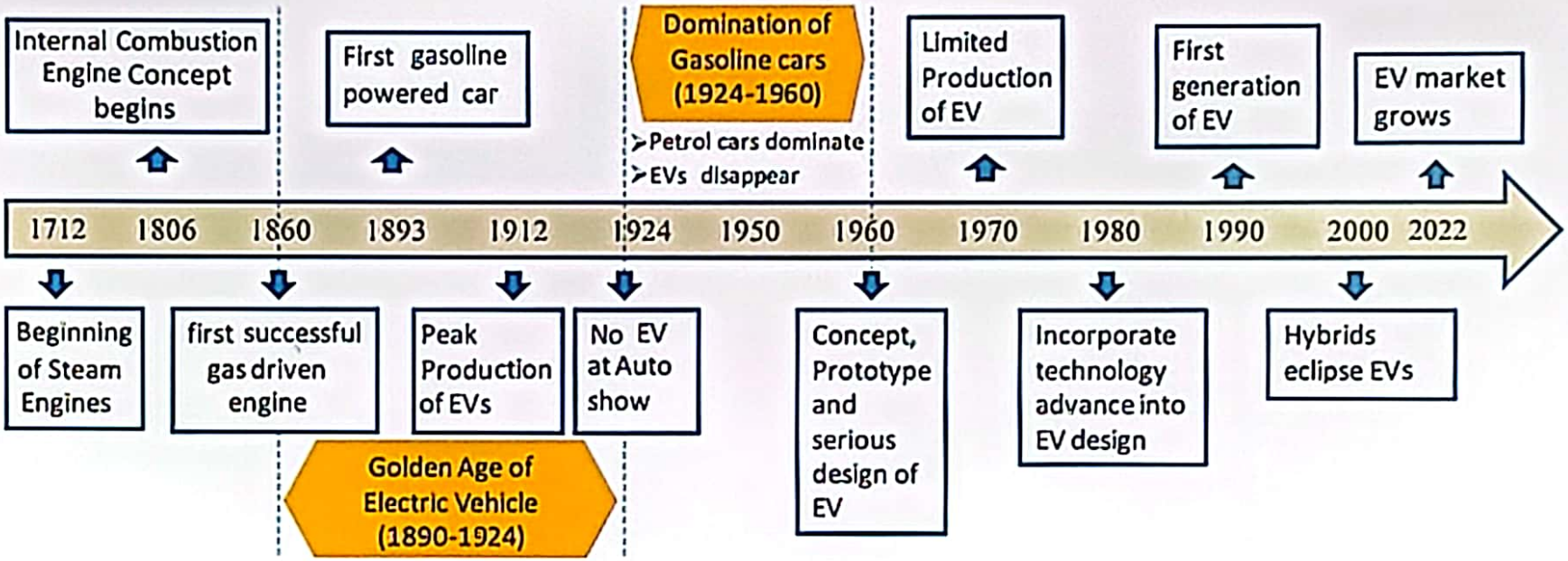
Internal Combustion Engine (ICE)	A heat engine that drives a piston by the hot gas produced by the combustion of a fuel such as petrol, diesel, kerosene etc.
Clutch	A mechanism for connecting and disconnecting a vehicle's engine from its transmission system.
Transmission	A gear assembly that provide speed and torque conversion between one rotating part to another.
Differential (D)	A gear train that splits the torque in two ways, allowing each wheel to spin at different speed when vehicle is turning.
Energy Management System (EMS)	A system that controls the flow of energy from multiple energy sources.

TOP 10 EVs WITH LONGEST TRAVEL RANGE

Status: June 2023

Model	Battery (kWh)	Drive Range	
		(miles)	km
Lucid Air	118	520	837
Mercedes EQS	107.8	453	729
Tesla Model S	100	405	652
Mercedes EQE	100	394	634
BMW i7	105	387	623
Hyundai Ioniq 6	77.4	382	615
BMW iX	105.2	380	612
Ford Mustang Mach-E	88	379	610
Tesla Model 3	82	374	602
Mercedes EQS SUV	108.4	365	587

DEVELOPMENT OF AUTOMOBILEs AND EVs



HISTORY OF ELECTRIC VEHICLES

1830's

- Battery EVs invented by Thomas Davenport
- Powered by non-rechargeable batteries

1890's

- EV's outsold gas cars 10 to 1

1904

- Krieger Company builds first hybrid vehicle

1910's

- Mass-produced Ford cars undercut EV's

1920's

- EV's persist until Great Depression

1990

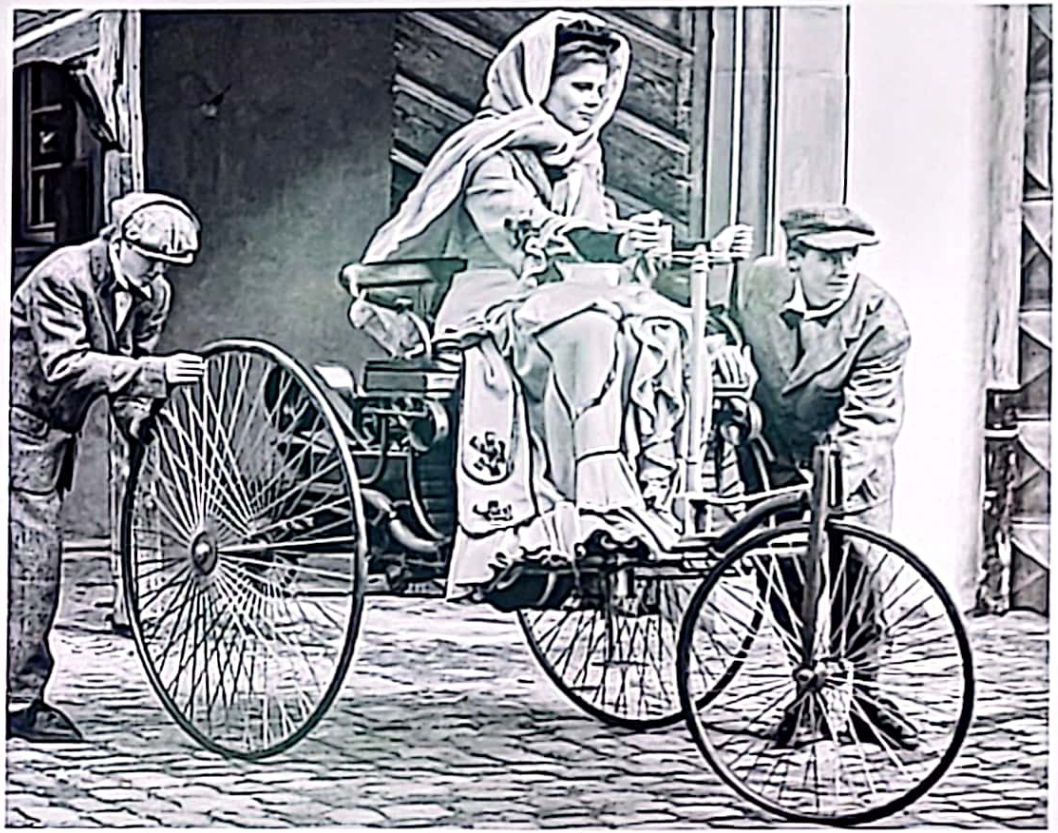
- EV's re-introduced

Figure 52. Ford Electric Car No. 2. (From the collections of Henry Ford Museum & Greenfield Village, neg. 188.72082)

Ford Electric #2

Detroit Electric

WORLD'S FIRST PATENDED AUTOMOBILE



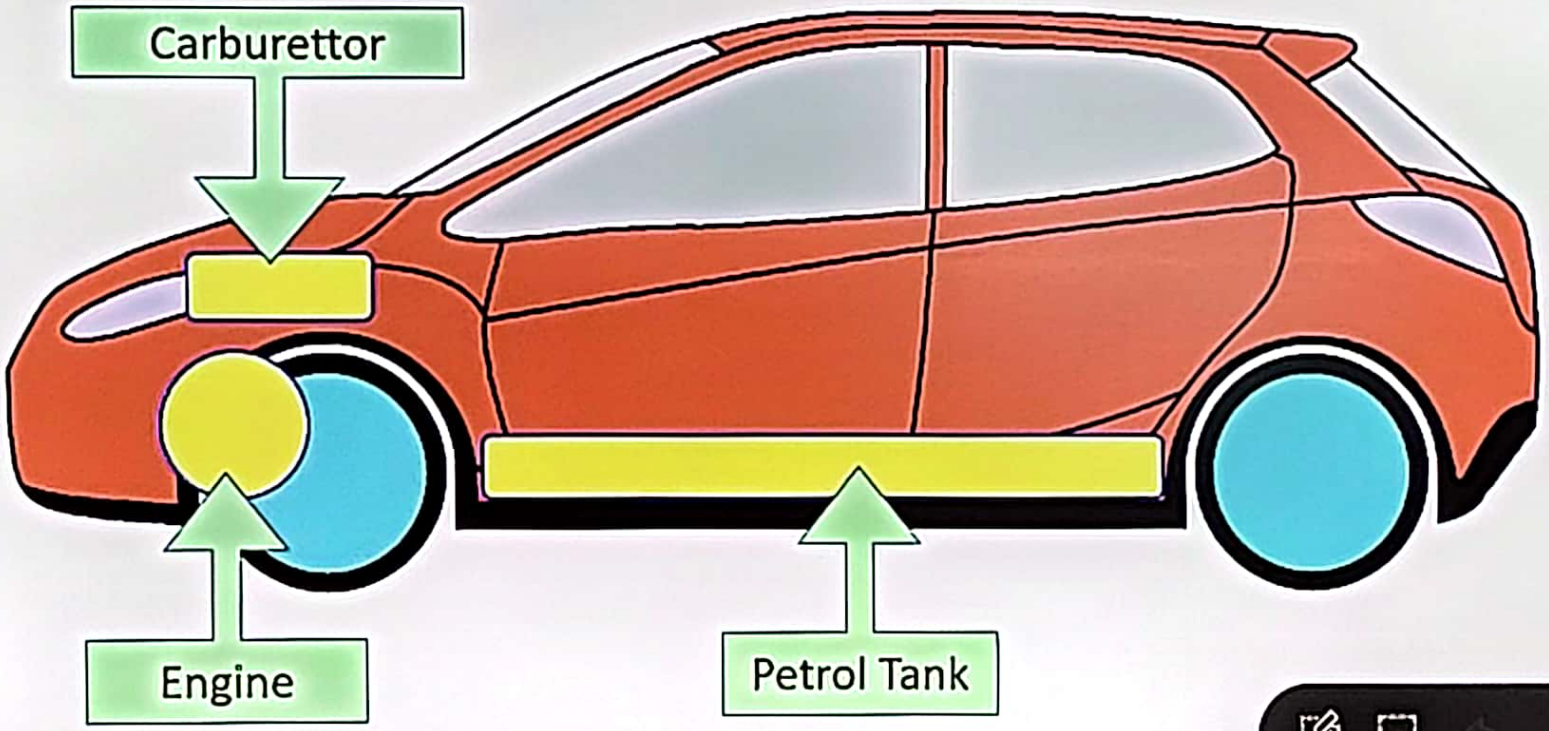
Inventor: Carl Benz (of Germany)

- Designer of the world's first patented automobile with gas engine (Jan. 1885).
- In Aug. 1888, Bertha, wife of Carl Benz, made the first road trip in the history of automobiles.
- Covered a distance of 90 km in 12 hours.

MAJOR COMPONENTS OF ELECTRIC CARS

- An automobile generally has
  - An energy source
  - A controller
  - An energy converter

- In an Electric Vehicle, these are the
  - Battery
  - Converter + BMS
  - Motor

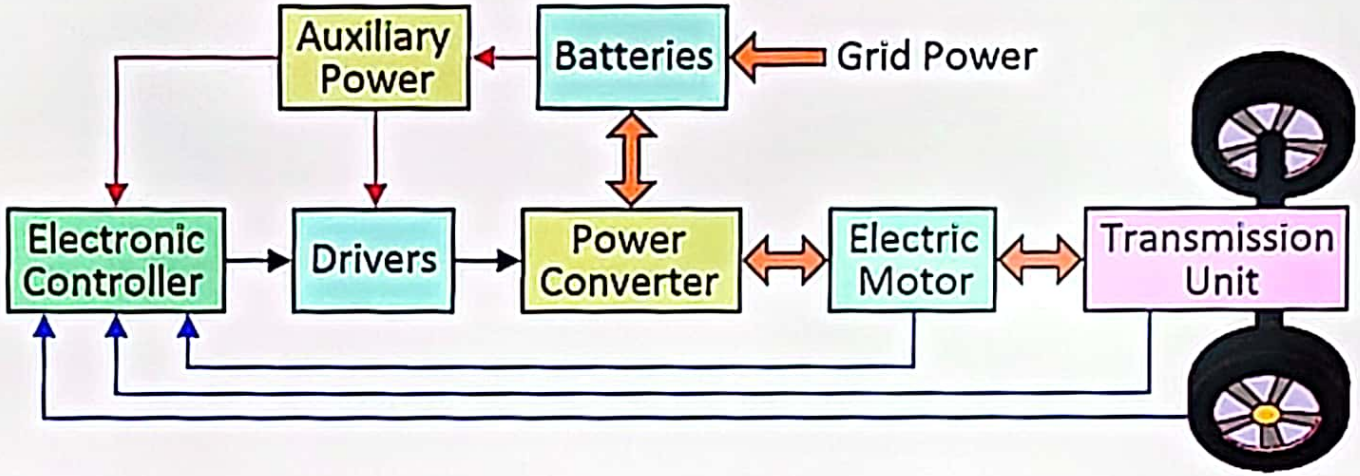


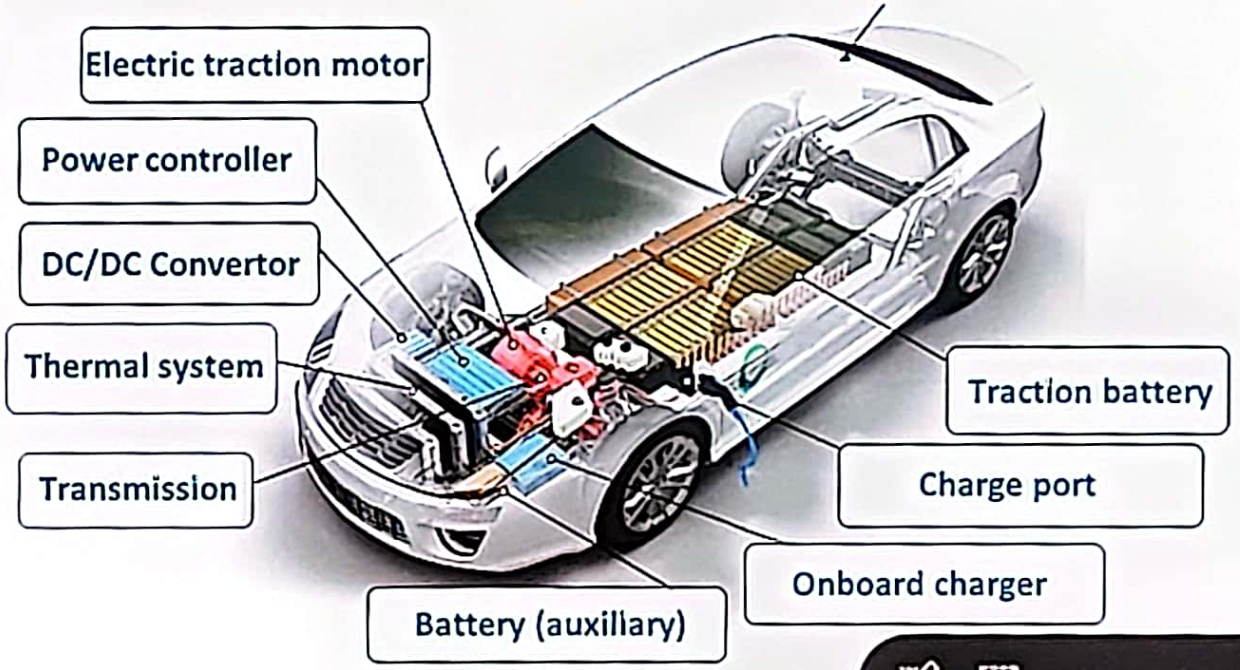
COMPARISON OF ICV & BEV

Function	ICE Vehicle	Battery Electric Vehicle
Energy storage	Fuel Tank	Battery
Replenish the energy	Petrol Pump	Charger
Production of motive force	IC Engine	Electric Motor
Controls speed and power	Carburetor	Electronic Controller
Auxiliary power supply	Alternator	DC/DC converter

MAJOR SYSTEMS OF ELECTRIC VEHICLES

- Battery
- Motor
- Controller
- Charger
- DC/DC Converter
- Instrumentation
- Safety Equipment





ENGINE vs. ELECTRIC VEHICLES

Engine Vehicle	Electric Vehicle
❖ Emits greenhouse gases	❖ No tailpipe emissions
❖ Travels 500+ km per fill	❖ Travels ~300 km per charge (average)
❖ Short refilling time (< 5 min.)	❖ Long charging time (0.5 to 10 hr.)
❖ Energy costs high	❖ Energy costs low
❖ Higher maintenance costs	❖ Lesser maintenance costs
❖ Generally uses fossil based energy	❖ Can use renewable energy

EARLY ELECTRIC CARS

GM - EV1	Nissan Hypermini	Toyota RAV4 EV
1996-2003	1999 -2001	1997–2003, 2012–2014
❖ Body style: 2-seat, 2-door ❖ 3-phase Induction Motor ❖ 102 kW IGBT inverter Battery: ❖ 16.5-18.7 kWh lead-acid (old) ❖ 26.4 kWh Nickel Metal Hydride ❖ Plug-in charging	❖ Body style: 2-seat, 3-door ❖ 3-phase PM syn. motor ❖ Max Power 24 kW	❖ Body style: 4-door ❖ 27 kWh battery ❖ 153 km ❖ Single speed gearbox ❖ Charges inductively

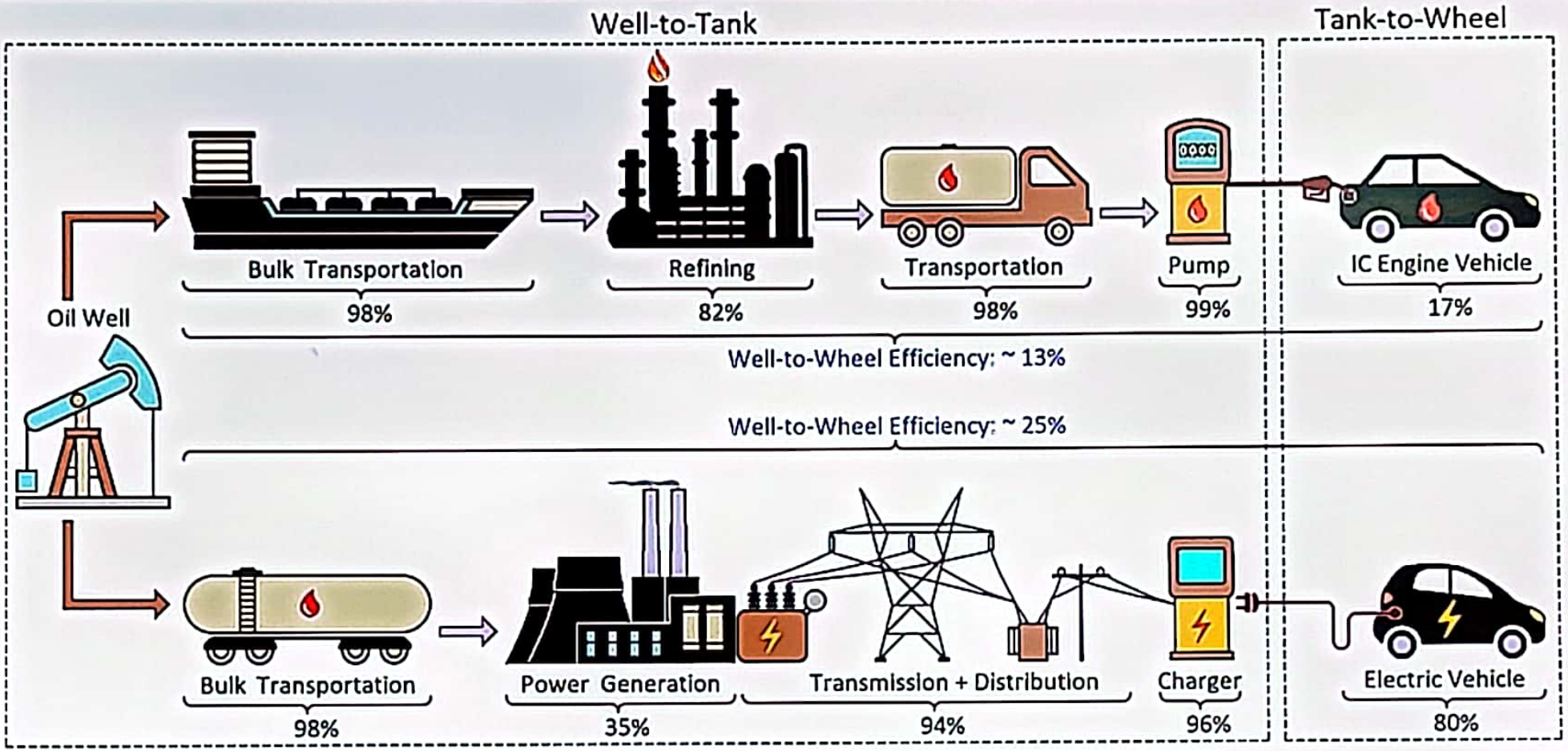
THE RISE & FALL OF GENERAL MOTOR EV1

- Due to heavy smog during 1990s, California Air & Resources Board passed a Zero Emission Vehicle (ZEV) mandate, requiring all new cars to be ZEVs.
- In 1996, General Motors(GM) introduced the first electric car, the EV1.
- These cars were not available for purchase, only leasing was possible.
- In 2003, GM took back all EV1s, and crushed them.

GM - EV1 (Production: 1996–1999)

2003: EV1's [illegible] for crushing

WELL-TO-WHEEL EFFICIENCY

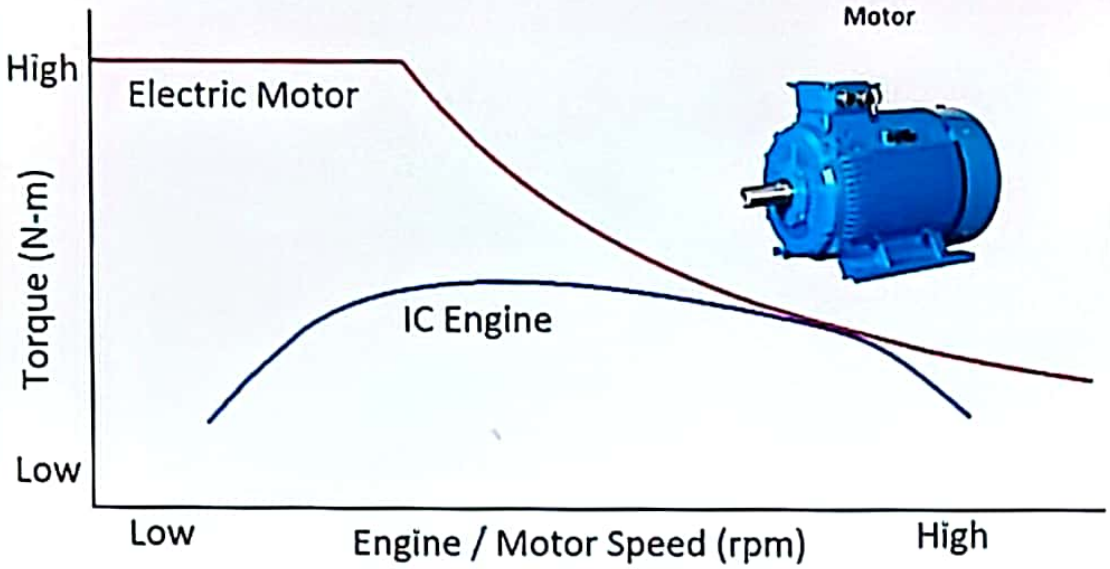


WELL-TO-WHEEL EFFICIENCY

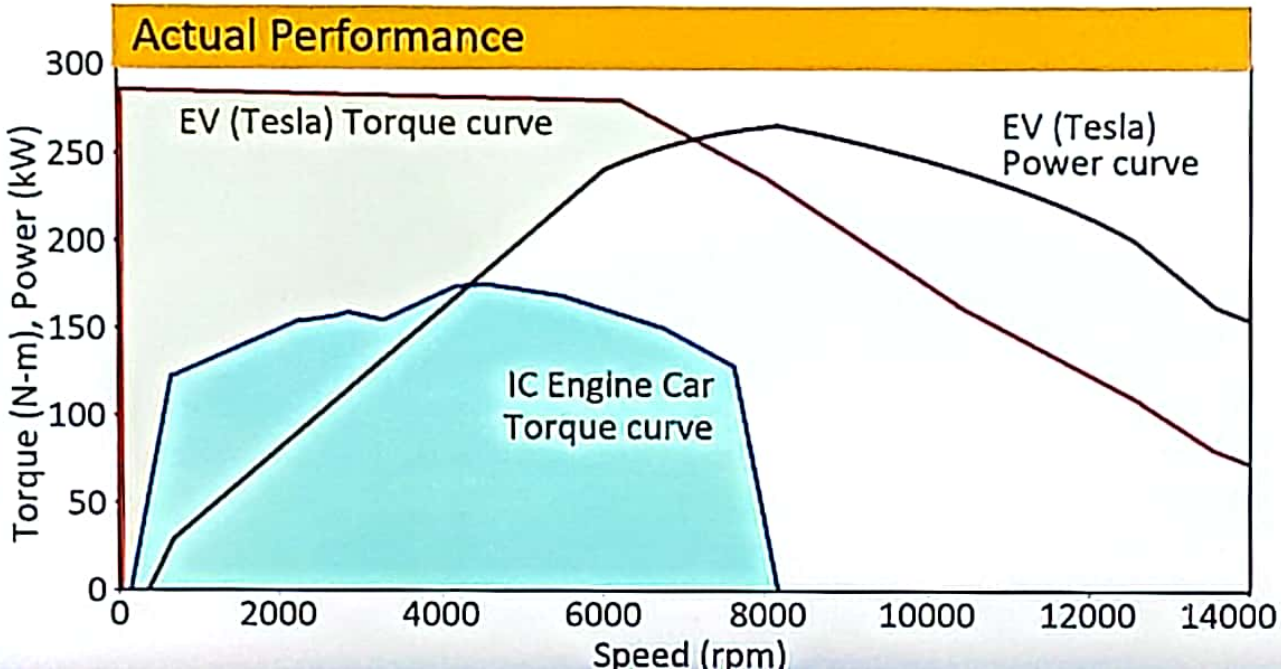
Vehicle Type	Power Train Efficiency (%)	Well-to-Wheel Efficiency (%)
Petrol (SI)	17	14
Diesel (CI)	20	17
Battery EV	80	27
Petrol Series HEV	25	21
Petrol Parallel HEV	28	24
Hydrogen FCHV	45	27

COMPARISON: IC ENGINE vs. EV MOTOR

ENGINE vs. ELECTRIC VEHICLES



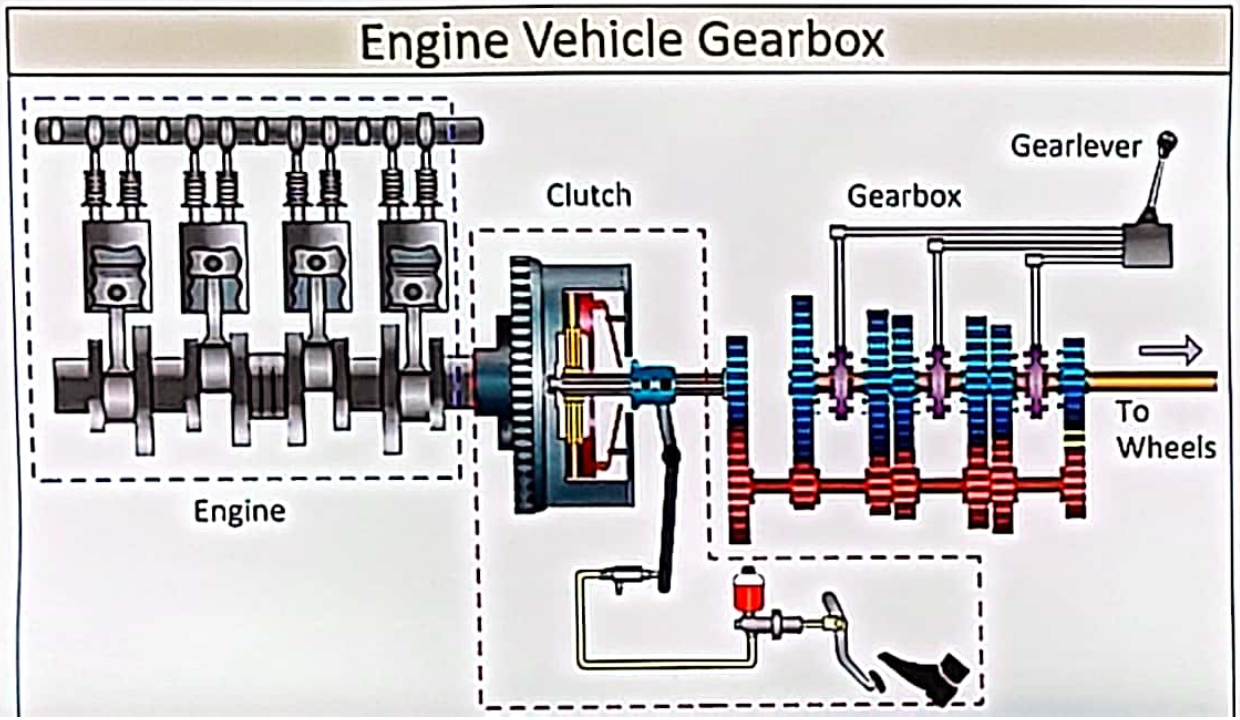
- Electric vehicle motors produce maximum torque from standstill.



- Engines need to pick up some speed to deliver maximum torque.

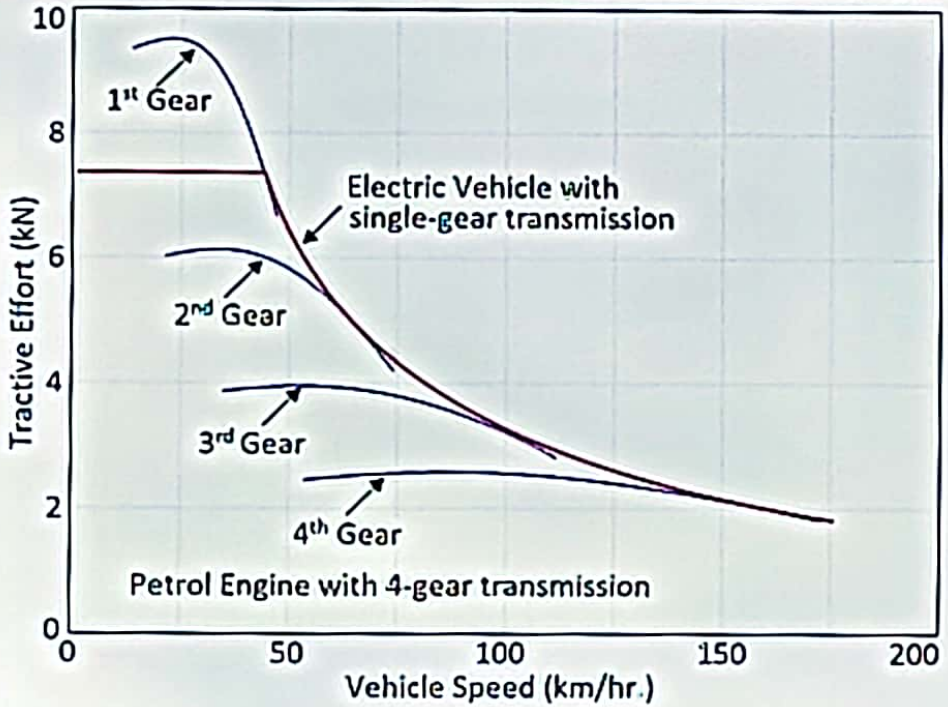
ENGINE vs. ELECTRIC VEHICLES

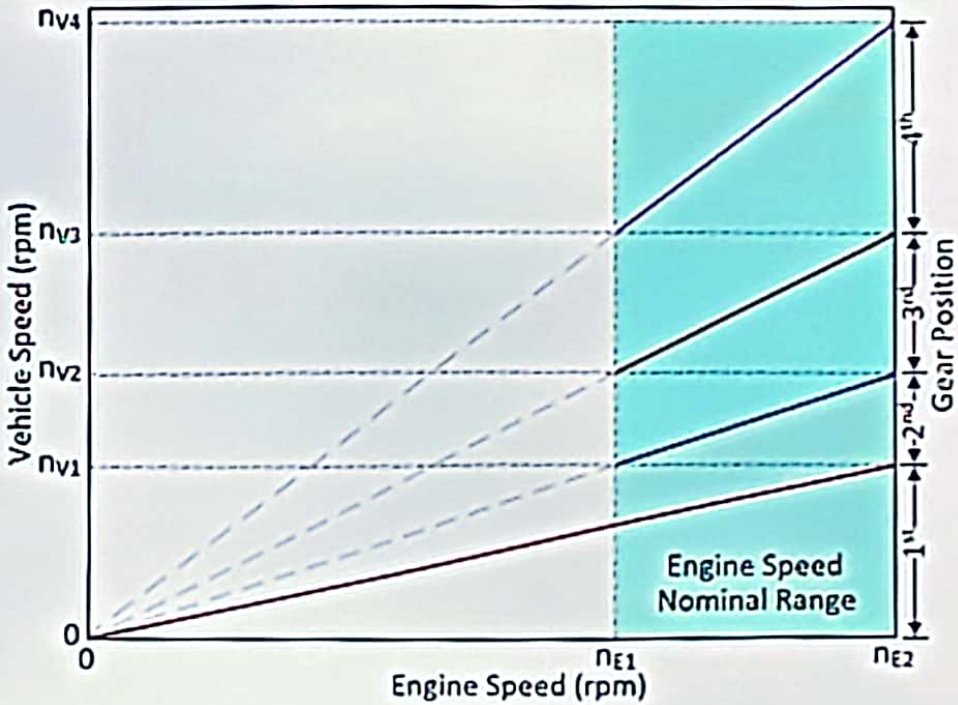
- Gears in vehicles enable an IC engine to run at its most efficient speed.
- Since each gear is matched for a specific range of speeds, the performance of the vehicle can be altered for each range of speeds by shifting gears.
- In EVs, the wheels are connected to the motor either directly or via a fixed ratio gearbox.



ENGINE vs. ELECTRIC VEHICLES

✦ A single-gear in EVs provide the same torque-speed capabilities as in multi-gear ICE vehicles.



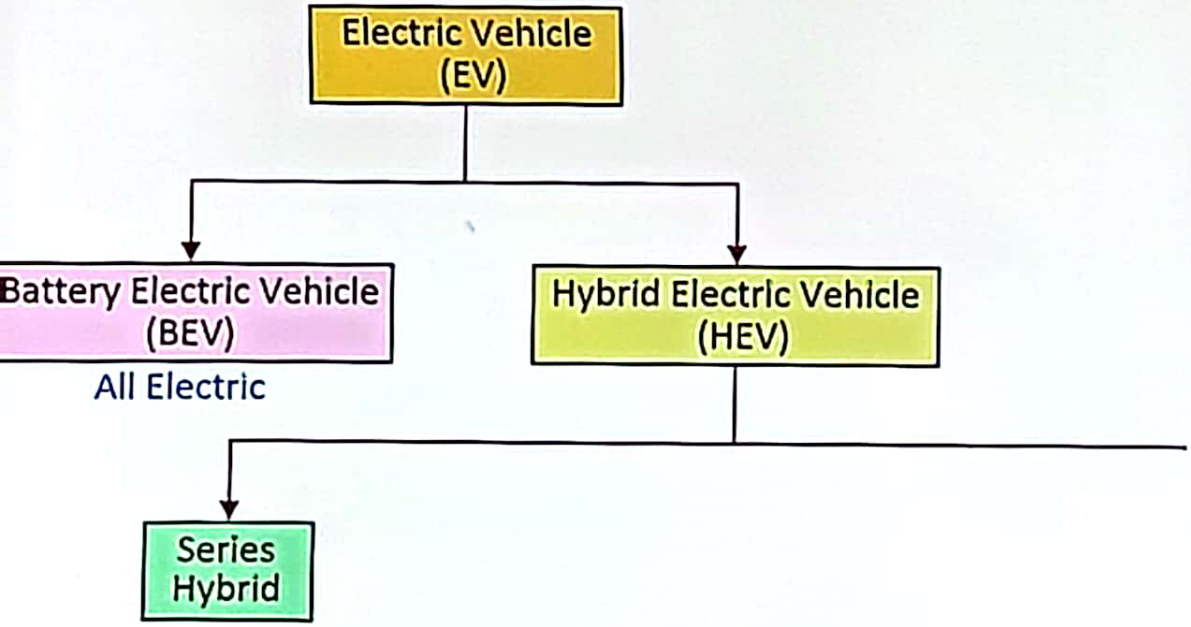


Multi-Gear

Single-Gear

P	Parking
R	Reverse
N	Neutral
D	Forward
S	Speed (Eco)
B	Braking

CLASSIFICATION OF ELECTRIC VEHICLES



- BEVs are powered by batteries.
- They use electric motors.
- EVs produce zero emissions.

- HEVs are zero-emission EVs for short range (30-50 km).
- For longer trips, HEVs run on petrol / diesel.

- HEVs are further classified according to configuration, share of electric, and energy source.