THE ERA OF ELECTRIC VEHICLES: A SUSTAINABLE FUTURE ON WHEELS

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Biography

- Moha Abbaszadeh
- Engineer Analyst at TMMC (Toyota Motor Manufacturing Canada)
- Six years of Engineering experience.
- McMaster Graduate with a Master of Manufacturing Engineering, Class 2021
- Bachelor degree in Chemical Engineering, Ferdowsi University, Class 2012
- Chair of WIE IEEE Hamilton Section
- Member of WIIT (Women Influencing and Impacting Toyota)

Interests:

🌮 An Engineer in the Manufacturing Industry, a Food Enthusiast in the World

🏭 Connecting the Dots: From Chemical Engineer to EV Visionary: A Journey of Innovation and Sustainability

🔌 Fueled by Innovation, Powered by Progress

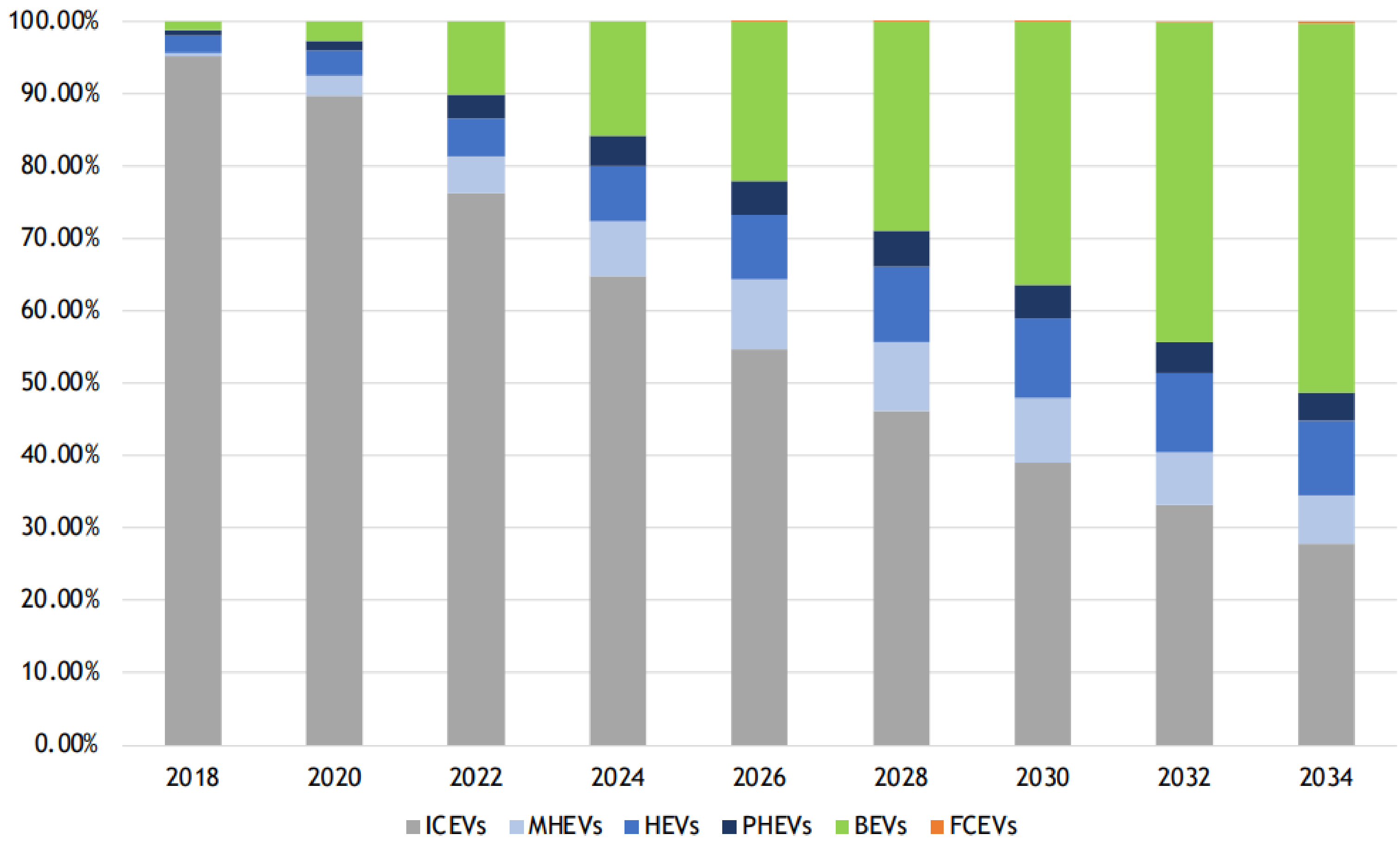
IEEE Women in Engineering
Wie

Agenda

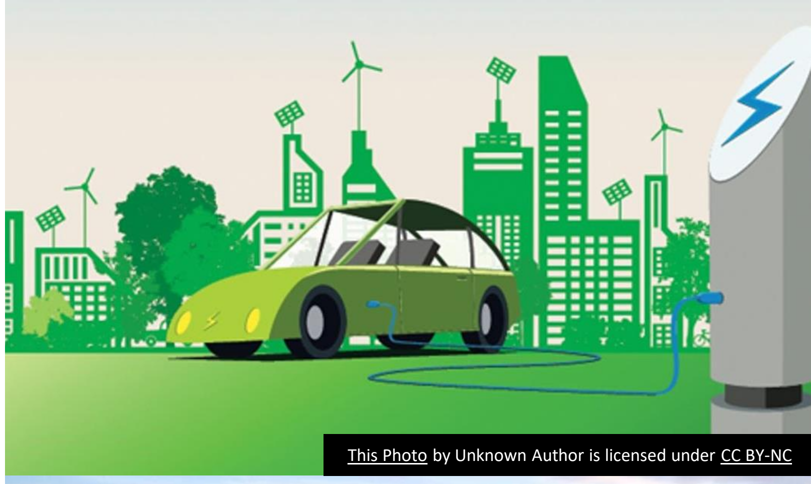
- Introduction
- History
- Progress
- Types of EVs
  - HEV
  - HEV plug in
  - BEV
- Pros and Cos
- EV's Competitor
- Toyota Strategy

Introduction

Projected global light-duty vehicle sales by powertrain type



Source: Marklines - GlobalData Automotive Sales Forecast



History

Competition between (Late 1800-early 1900):

- ❖ Steam:
  - Long startup times -- sometimes up to 45 minutes in the cold.
  - Not suitable as a personal car
- ❖ Gasoline:
  - Unpleasant smells
  - Vibrations
  - Hand cranking mechanism
- ❖ Electric versions:
  - 1800s the first electric vehicle on the road
  - In the US, William Morrison (1890) made the first successful six-passenger EV capable of a top speed of 14 miles per hour.
  - A few years later, U.S. New York City even had a fleet of more than 60 electric taxis.

William Morrison functional EV

- The Model T, Henry Ford introduced in 1908,
  - Affordable; by 1912, the gasoline car cost only $650, while an electric roadster sold for $1,750.
  - Simple to operate; in 1912, Charles Kettering introduced the electric starter, eliminating the need for the hand crank and giving rise to more gasoline-powered vehicle sales.
  - With the discovery of Texas crude oil, gas became cheap and readily available for rural Americans.

Henry Ford's Model T

In the end, electric vehicles all but disappeared by 1935

History

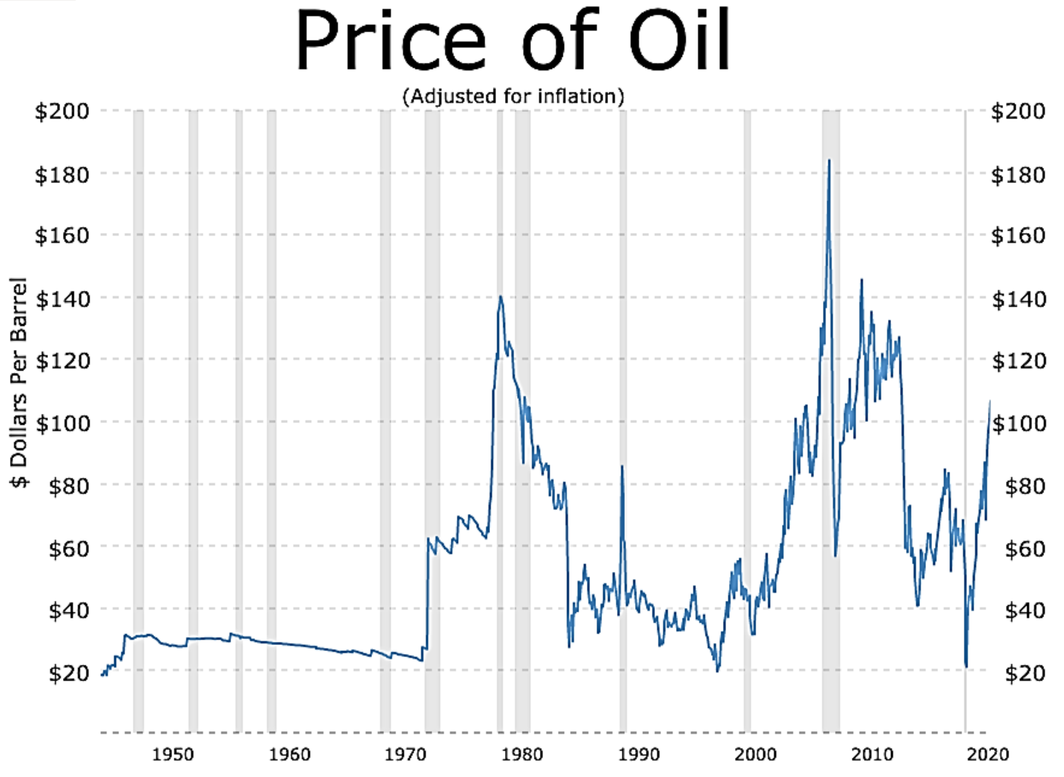
Rebirth

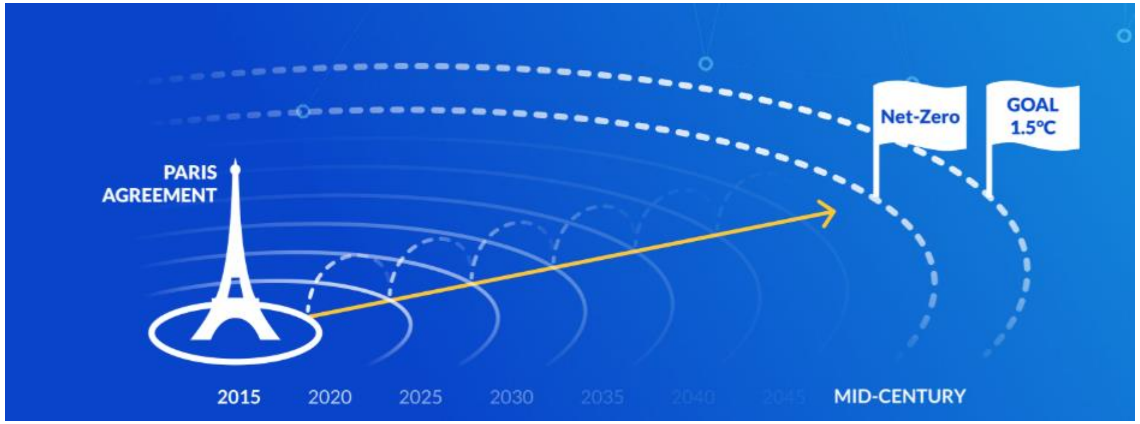
1- Gas shortages spark interest in electric vehicles

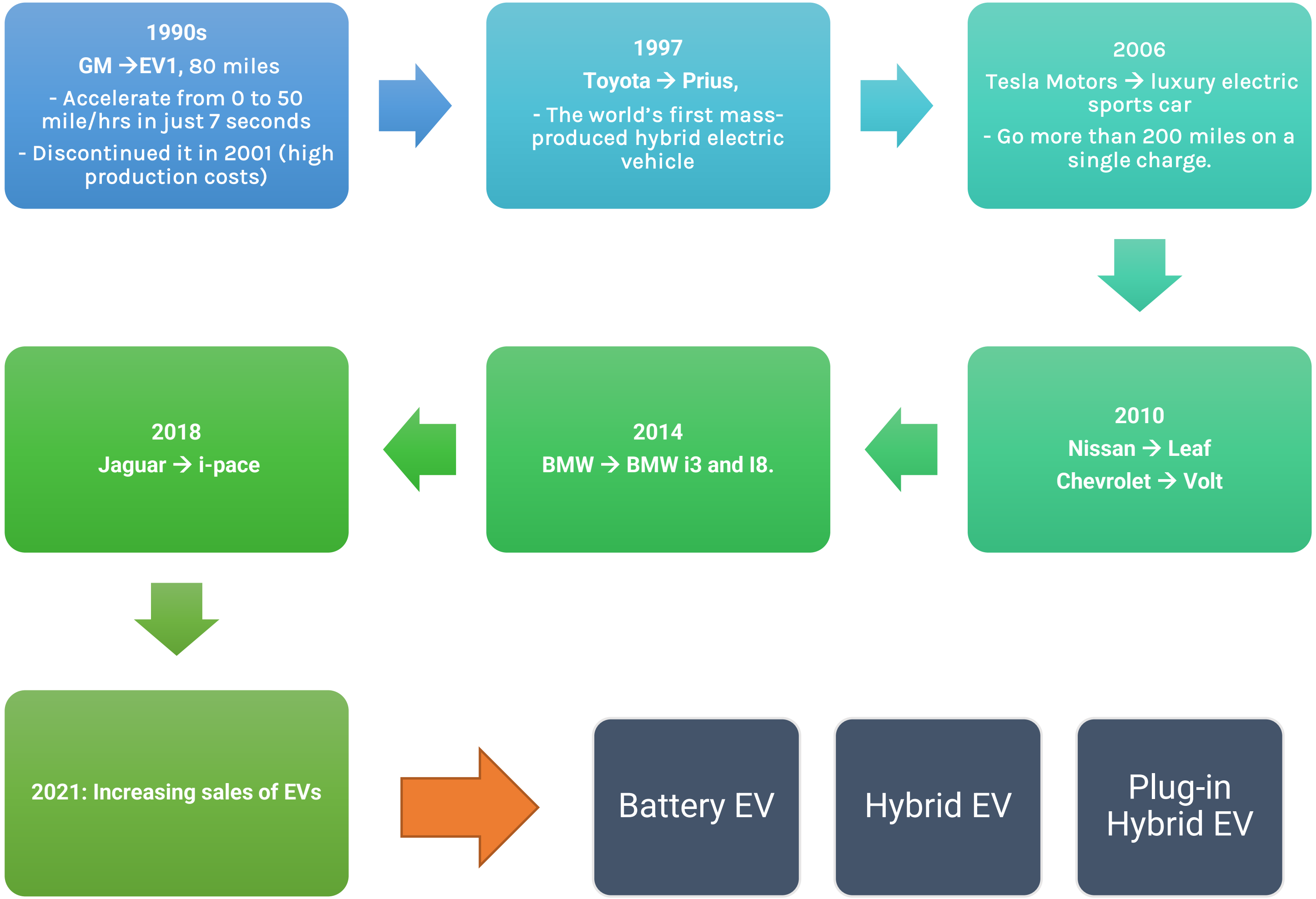
- First oil shock: 1973; Arab Oil Embargo.
- Second oil shock: 1979; Iranian Revolution.

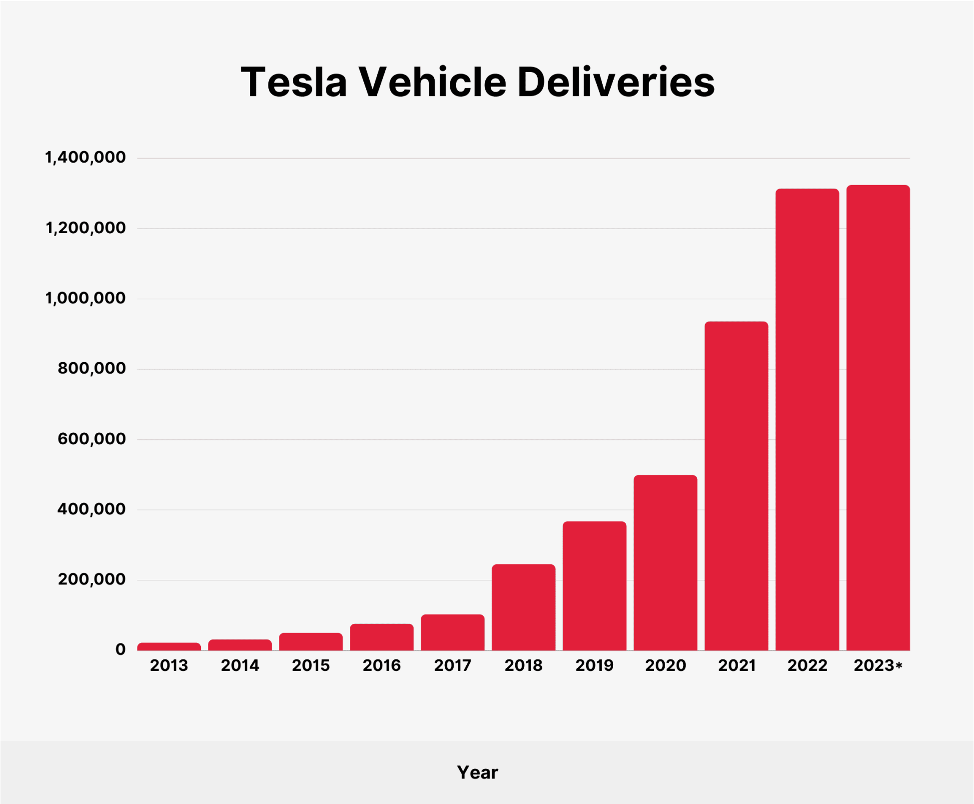
2- Environmental concern drives electric vehicles forward

- 2015: 196 countries joined "The Paris Climate Agreement"
- 2015: 57 countries including the United States, Japan, Canada, Germany, and Mexico — also developed long-term plans to decarbonize their economies.



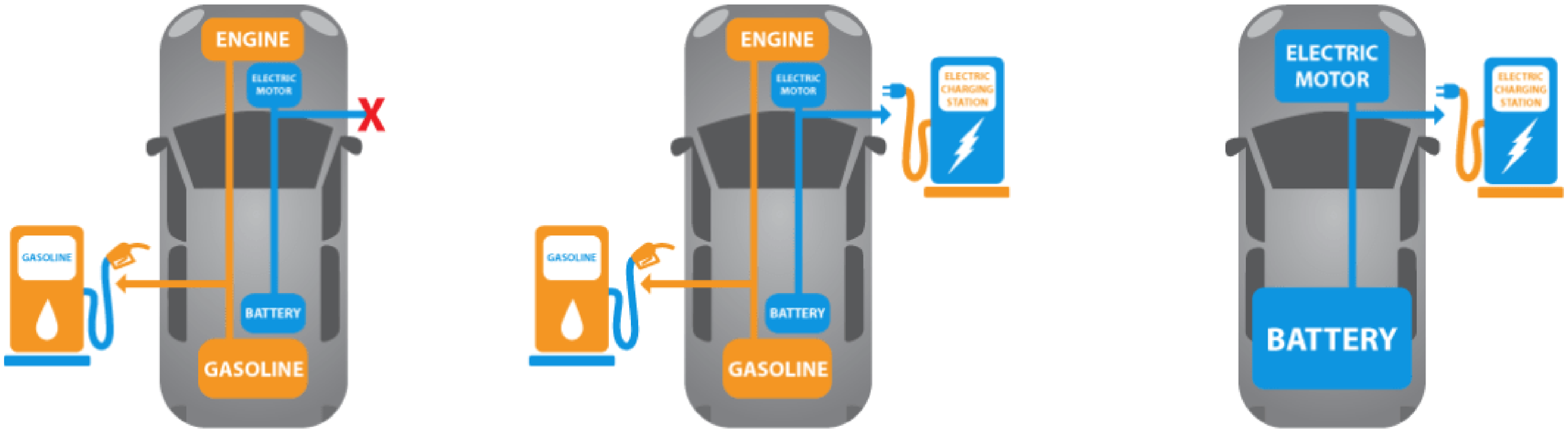






The price of a lithium-ion battery pack has plunged 89% in the last decade (from $1,100 per kWh to $137 per kWh).
DNV expects the cost of batteries to be reduced by 56% by 2025.

What are the 3 Main Types of Electric Vehicles?



HEV
(Hybrid Electric Vehicle)

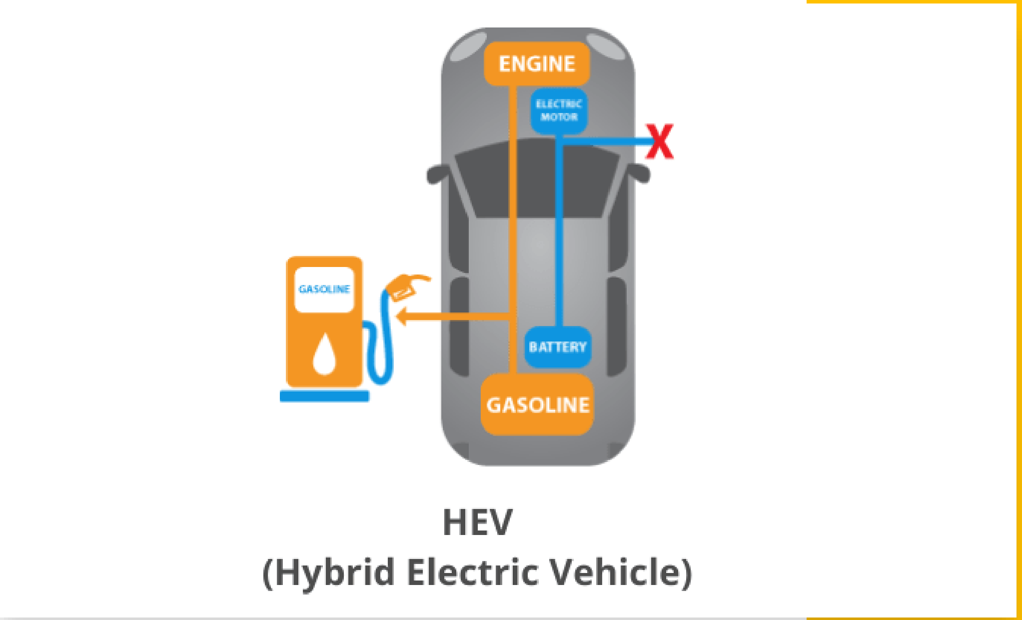
PHEV
(Plug-In Hybrid Electric Vehicle)

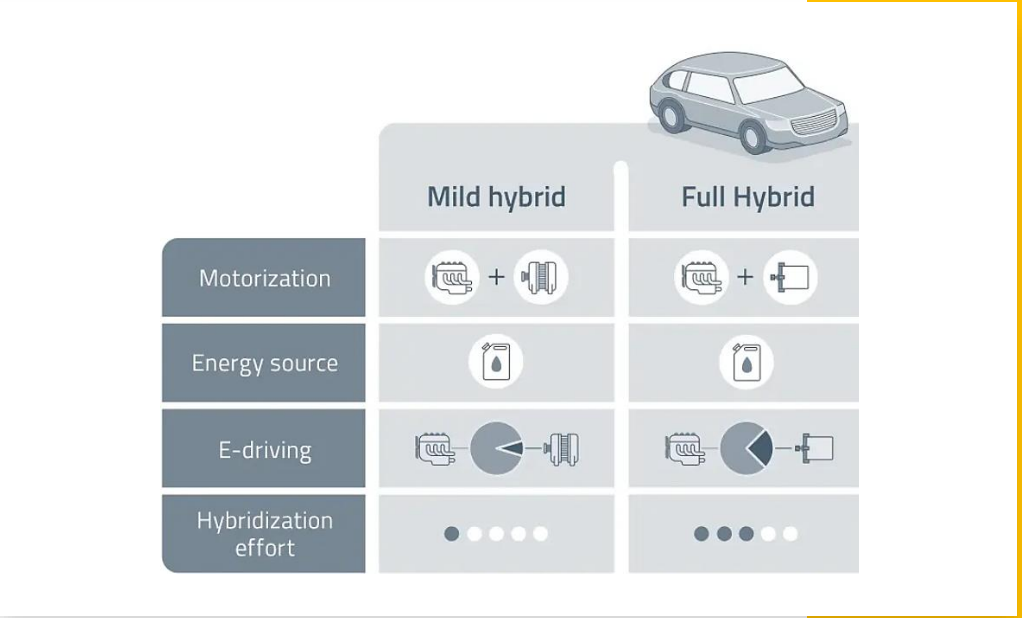
BEV
(Battery Electric Vehicle)

Hybrid EV

- ❑ Have both an internal combustion engine and an electric battery
- ❑ Charge their battery pack with the IC engine or using regenerative braking. It cannot be plugged in for charging.
- ❑ Use both power sources to optimize fuel efficiency and reduce emissions.

Toyota Prius, Toyota Camry Hybrid, and the Honda Civic Hybrid

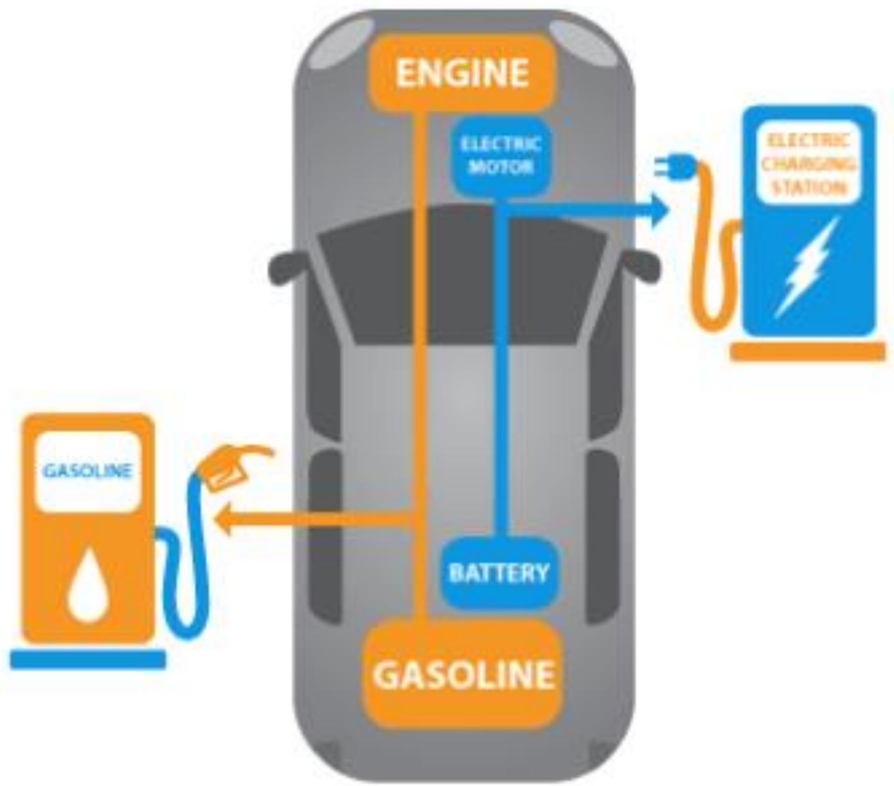




Hybrid Plug in

- ❑ Can be charged with an external power source by the IC engine or regenerative braking
- ❑ Can run on two modes: an all-electric mode and a hybrid mode
- ❑ Have a smaller IC engine and larger battery pack when compared to the hybrid EV
- ❑ Run for longer ranges and is preferred by consumers for this very reason

Chevy Volt, Porsche Cayenne SE hybrid, and Mercedes s550e



PHEV
(Plug-In Hybrid Electric Vehicle)

BEV (Lithium –Ion Battery)

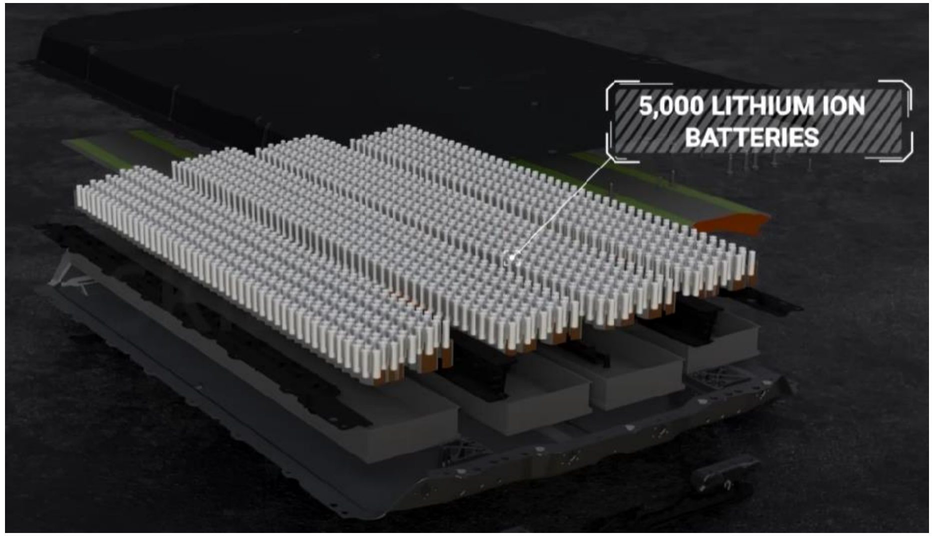
❑ Run solely on electric power stored in high-capacity batteries

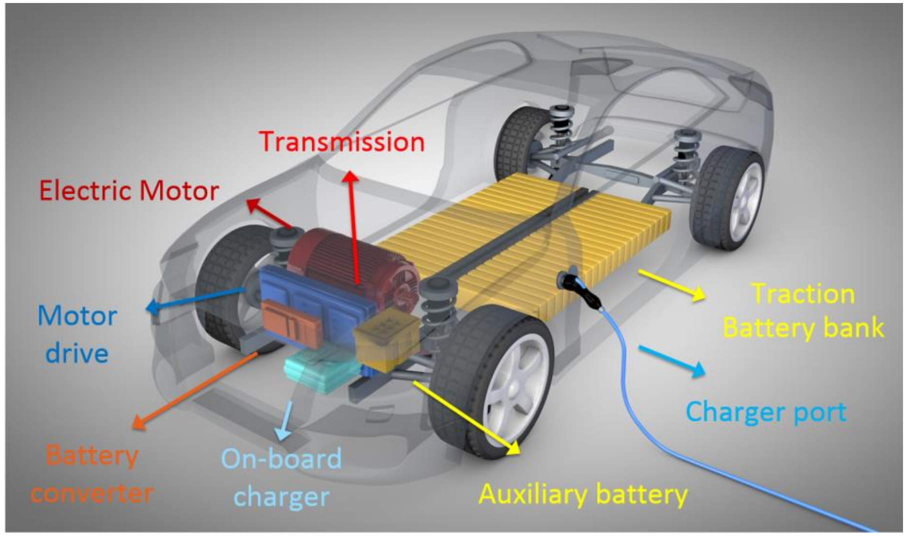
❑ Produce zero tailpipe emissions

❑ Mostly are lithium-ion batteries due to:

- High power density
- Fast charging potential
- High-temperature performance
- long lifespan

Tesla Model 3, Chevy bolt, and the Nissan Leaf



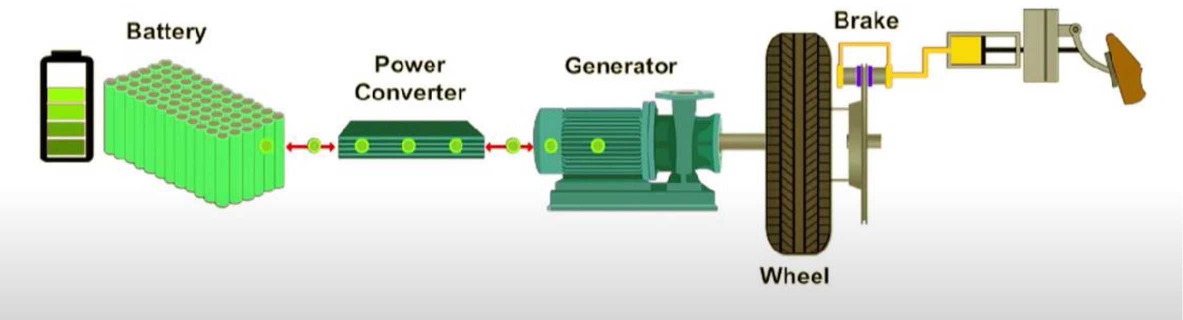


ICE VS EV

Feature	Electric Vehicles (EVs)	Internal Combustion Engine (Gas Cars)
Power Source	100% Electric Battery	100% Internal Combustion Engine
Fuel Type	100% Electricity (longer charging time)	100% Gasoline (Can not have gas station in house)
Emissions	0% Emissions (at tailpipe)	Emissions (CO2, pollutants)
Range	Varies, typically increasing	Dependent on gas tank capacity
Charging	100% Plug-in (Electricity)	100% Refueling (Gas Stations)
Number of Components	Fewer (e.g., electric motor, battery, power electronics) 30	More (e.g., engine, transmission, exhaust system) 3000
Maintenance	Generally Lower - Accident repair results in the replacement of entire parts such as body shell, motor, and battery assemblies. - The amount of manpower required yet is not skilled. - No oil change	Regular Maintenance Required - The spare parts of the vehicle in the market and results in replacement of the only the damaged part. - Skilled manpower is available. - Need oil change
Complexity	Simpler	More Complex
Cost of Fuel	Generally Lower	Subject to Fluctuating Gas Prices
Noise Level	Quieter	Engine Noise
Acceleration	Instant Torque	Gradual Acceleration
Environmental Impact	Depends on Energy Source	Emissions during Combustion

Regenerative braking system

- Converts kinetic energy generated by the movement of the car into electrical energy that can be stored in the battery
- Reduces wear on brake parts
- 16 to 70 percent of the kinetic energy can be captured and stored as electrical energy that depends on:
  - How the driver operates the vehicle
  - Speed
  - Frequently of using brakes



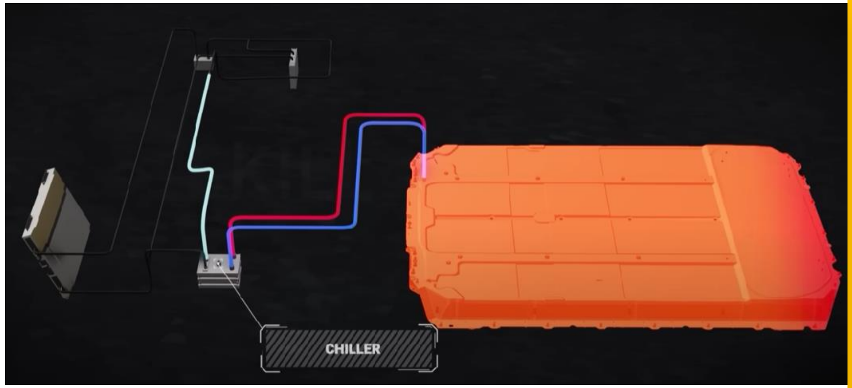
Battery Thermal Management System

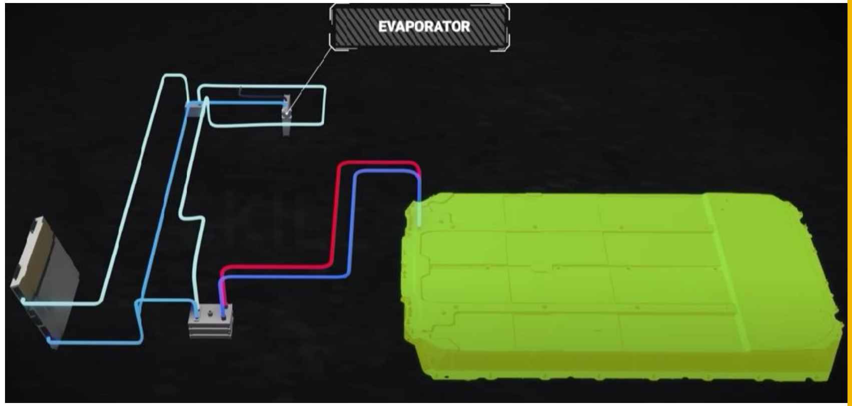
The regular charging and discharging of these batteries generate a lot of heat, so the battery motor and controller May overheat due to peak loads of current and outside temperatures

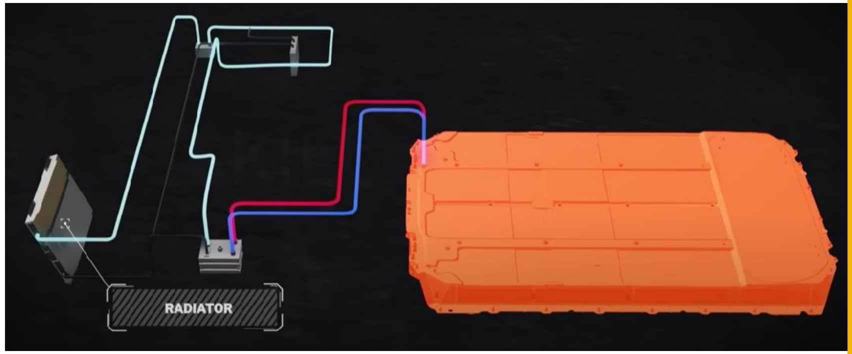
Battery thermal management system

Using a glycol coolant flows

Absorbs heat and releases it into the atmosphere





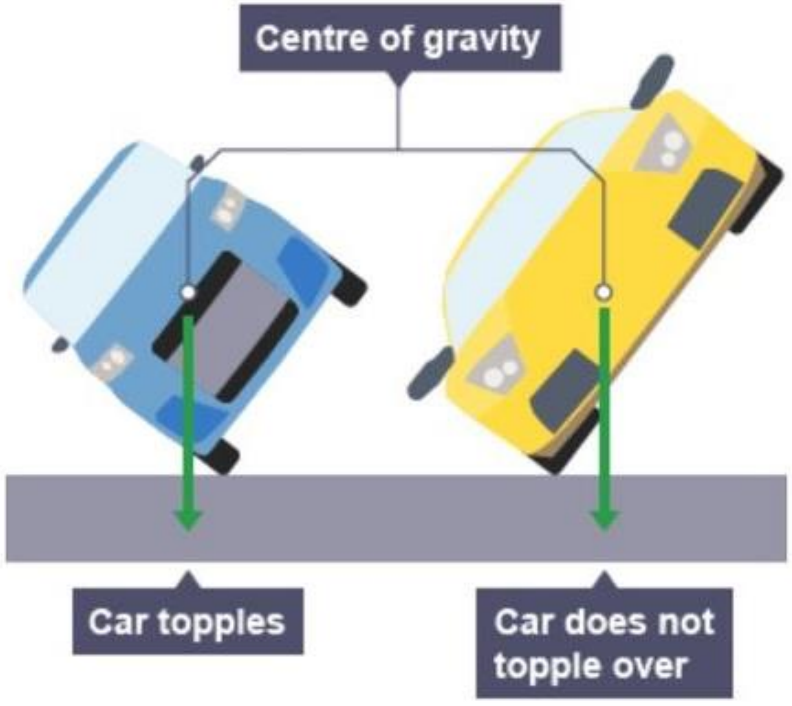


One Hidden Safety Point

Batteries are packed together and evenly distributed on the floor of the vehicle

The EV center of gravity is lower than that of an ordinary cars

Provides reinforced stability during collisions and makes the EV a tad safer



The wider car will not topple over because it has a lower centre of gravity, but the narrow car will

Toyota Strategy

Toyota intends to focus on hybrids instead of EVs because of three major barriers to EV adoption

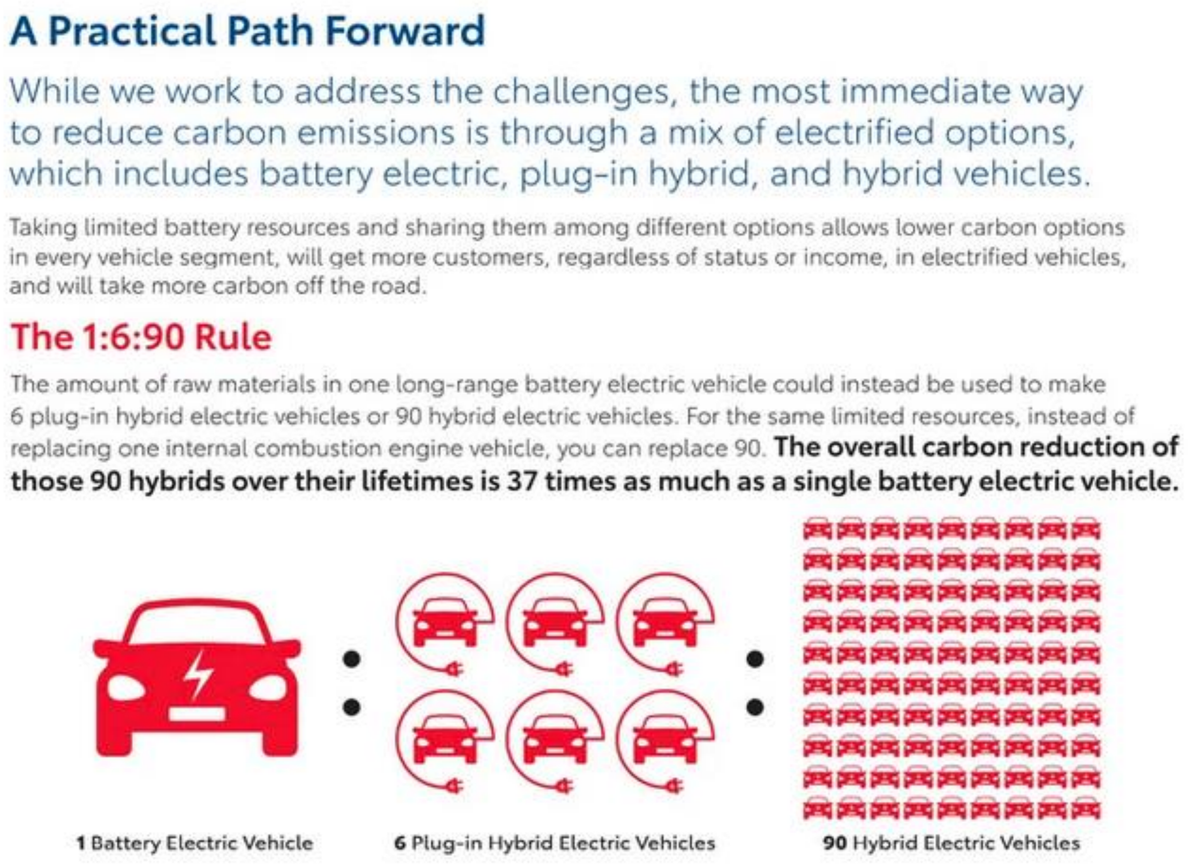
1. Critical mineral supply
   - 300 new mines are required to support battery demand by 2035

2. Charging infrastructure

3. Affordability

Toyota has a goal to "reduce carbon emissions as much as possible, as soon as possible" including a 35 percent reduction in emissions from their vehicles by 2030, and a 90 percent reduction in emissions from their entire fleet by 2050.

Toyota's solution: the 1:6:90 rule



EV’s Competitor

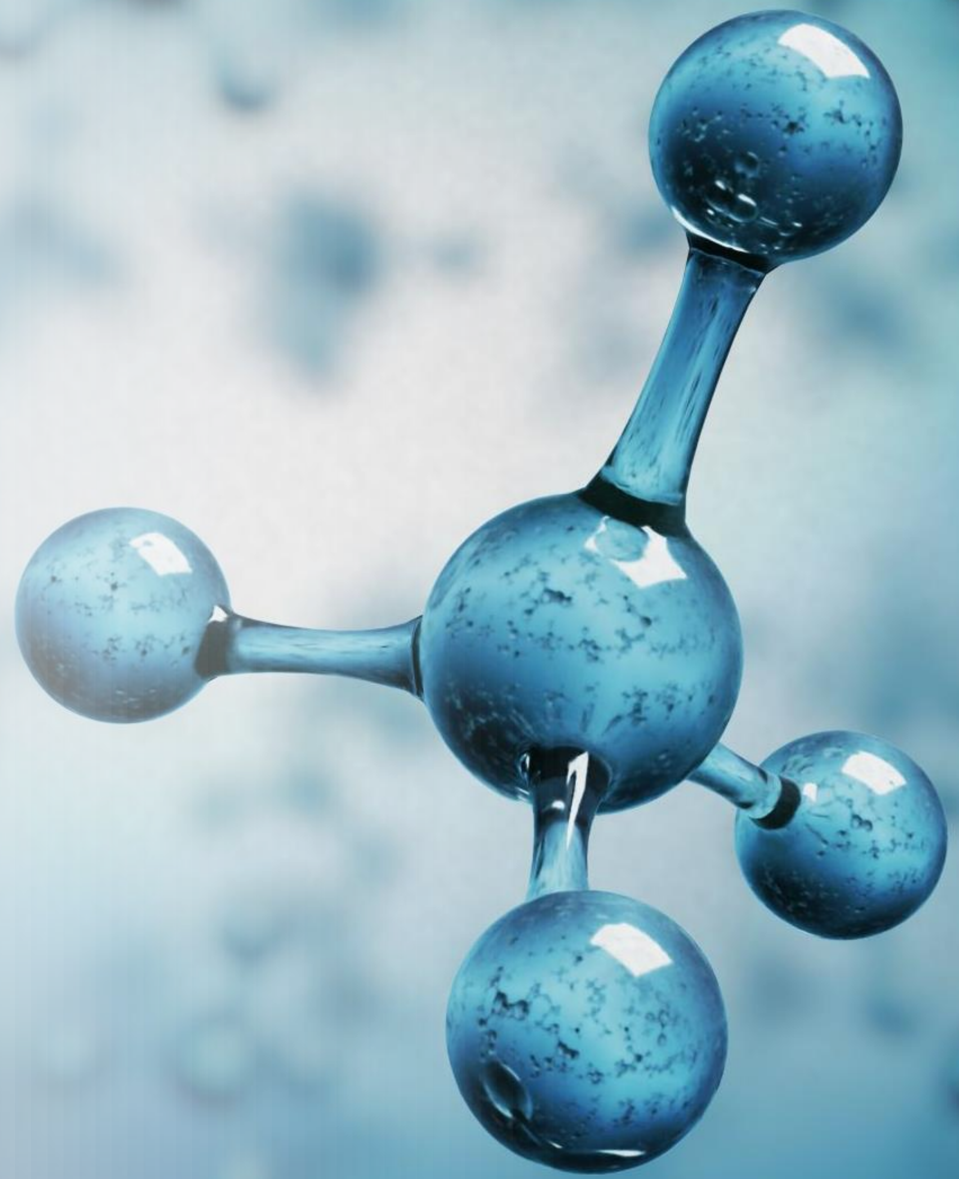
Hydrogen Fuel Cell Vehicles (HFCVs)

Pros:

- Zero-Emission Transportation (producing only water vapor as a byproduct)
- Longer Range and Faster Refueling

Cons:

- Infrastructure development
- Technological advancements



Thank You!