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Environmental Science and Technology

Exploring the Evolution, Components, and Types of Electric cars

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**Partnership for Promotion and Popularization of Electrical Mobility through
Transformation and Modernization of WB HEIs Study Programs/PELMOB**

Call: ERASMUS-EDU-2022-CBHE-STRAND-2

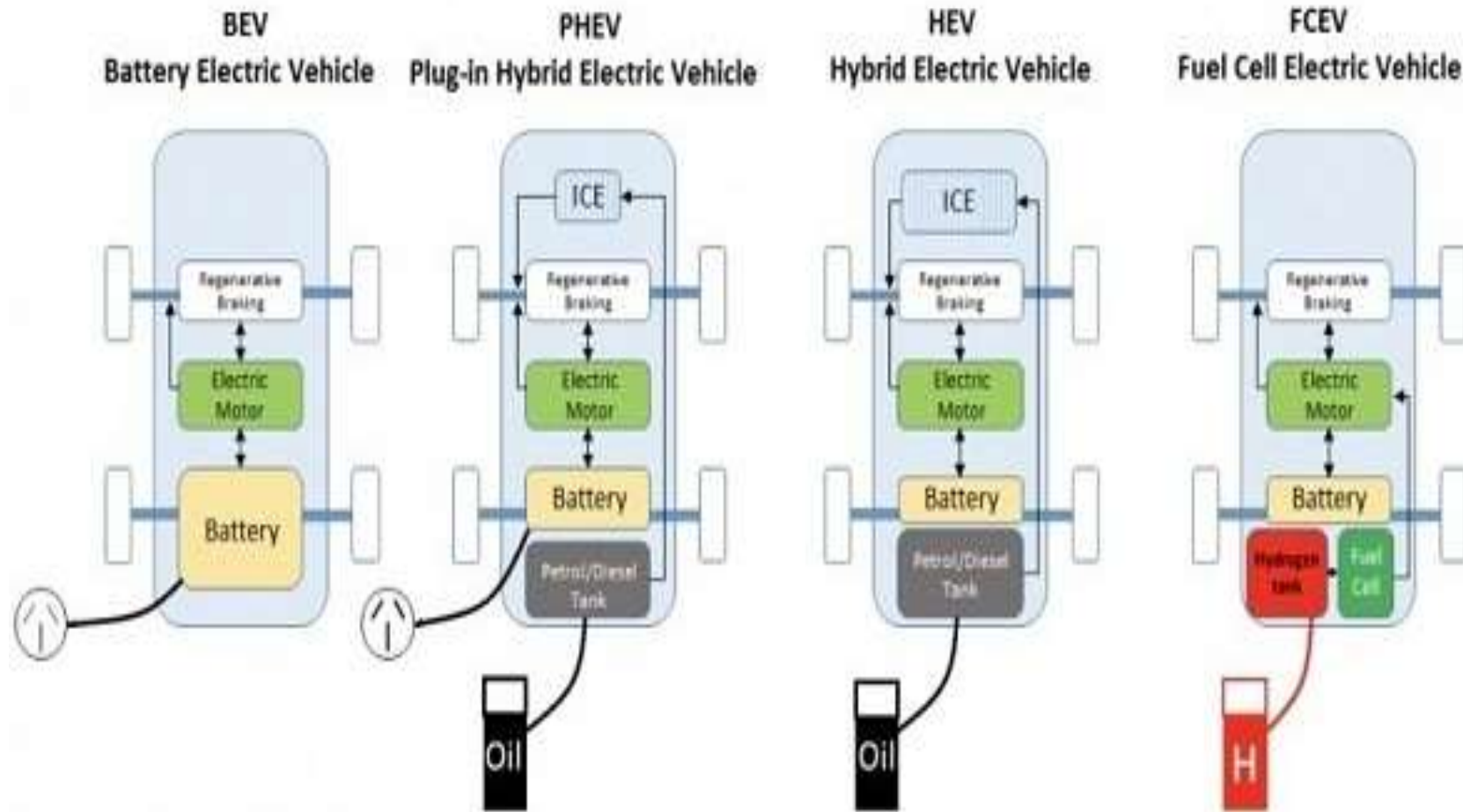
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- **EV Overview**
 - Electric vehicles (EVs) are powered by electricity, either from batteries or fuel cells, offering a cleaner alternative to traditional gasoline-powered vehicles.
 - They come in various forms, including battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).
- **Significance**
 - EVs play a crucial role in reducing greenhouse gas emissions and combating climate change.
 - They contribute to improved air quality in urban areas, leading to better public health outcomes.
- **Transition**
 - The automotive industry is undergoing a significant transition from internal combustion engines to electric drivetrains.
 - Government policies and consumer demand are driving this shift, with many countries setting ambitious targets for EV adoption.

Types of Electric Cars

There are 4 (four) types of electric cars –

- ❖ Fuel Cell Electric Vehicle (FCEV)
- ❖ Battery Electric Vehicle (BEV)
- ❖ Hybrid
 1. Hybrid Electric Vehicle (HEV)
 2. Plug-in Hybrid Electric Vehicle (PHEV)

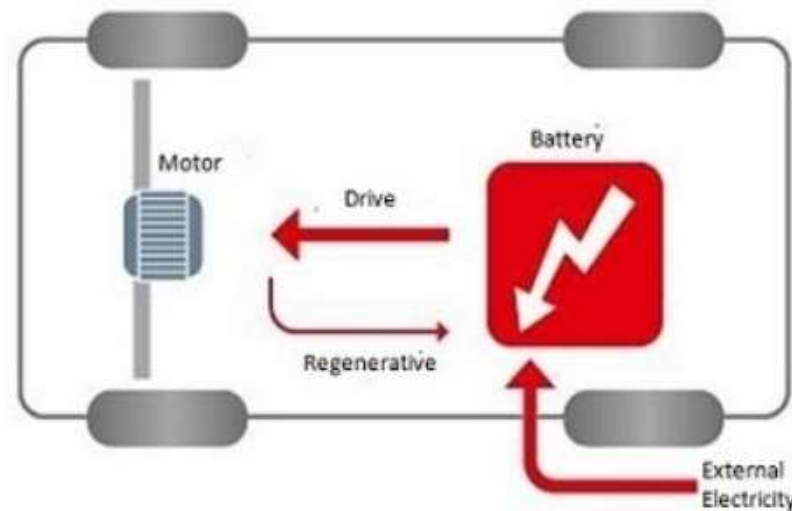


Battery Electric Vehicle (BEV)

A Battery Electric Vehicle (BEV), also called All-Electric Vehicle (AEV), runs entirely on a battery and electric drive train. This types of electric cars do not have an ICE. Electricity is stored in a large battery pack that is charged by plugging into the electricity grid. The battery pack, in turn, provides power to one or more electric motors to run the electric car.



Architecture and Main Components of BEV



Components of BEV

- Electric motor
- Inverter
- Battery
- Control Module
- Drive train

Working Principles of BEV

- Power is converted from the DC battery to AC for the electric motor
- The accelerator pedal sends a signal to the controller which adjusts the vehicle's speed by changing the frequency of the AC power from the inverter to the motor
- The motor connects and turns the wheels through a cog
- When the brakes are pressed or the electric car is decelerating, the motor becomes an alternator and produces power, which is sent back to the battery

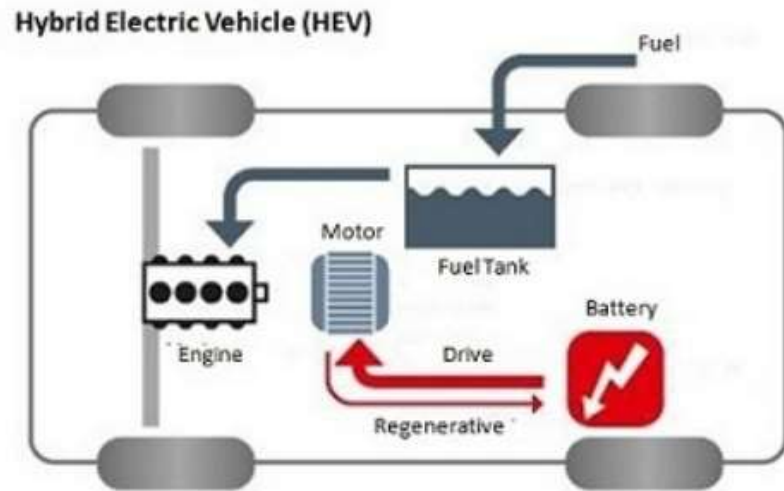
Examples of BEV

Volkswagen e-Golf, Tesla Model 3, BMW i3, Chevy Bolt, Chevy Spark, Nissan LEAF, Ford Focus Electric, Hyundai Ioniq, Karma Revera, Kia Soul,
Mitsubishi i-MiEV, Tesla X, Toyota Rav4.

Hybrid Electric Vehicle (HEV)

- This type of hybrid cars is often called as standard hybrid or paralel hybrid. HEV has both an ICE and an electric motor. In this types of electric cars, internal combustion engine gets energy from fuel (gasoline and others type of fuels), while the motor gets electricity from batteries. The gasoline engine and electric motor simultaneously rotate the transmission, which drives the wheels.
- The difference between HEV compared to BEV and PHEV is where the batteries in HEV can only charged by the ICE, the motion of the wheels or a combination of both. There is no charging port, so that the battery cannot be recharged from outside of the system, for example from the electricity grid.

Architecture and Main Components of HEV



Components of HEV

- Engine
- Electric motor
- Battery pack with controller & inverter
- Fuel tank
- Control module

Working Principles of HEV

- Has a fuel tank that supplies gas to the engine like a regular car
- It also has a set of batteries that run an electric motor
- Both the engine and electric motor can turn the transmission at the same time

Examples of HEV

Honda Civic Hybrid, Toyota Prius Hybrid, Honda Civic Hybrid, Toyota Camry Hybrid.

Plug-in Hybrid Electric Vehicle (PHEV)

- PHEV is a type of hybrid vehicle that both an ICE and a motor, often called as series hybrid. This types of electric cars offers a choice of fuels. This type of electric cars is powered by a conventional fuel (such as gasoline) or an alternative fuel (such bio-diesel) and by a rechargeable battery pack. The battery can be charged up with electricity by plugging into an electrical outlet or electric vehicle charging station (EVCS).
- PHEV typically can run in at least two modes:
- All-electric Mode, in which the motor and battery provide all the car's energy
- Hybrid Mode, in which both electricity and gasoline are employed.
- Some PHEVs can travel more than 70 miles on electricity alone.

Working Principles of PHEV

- PHEVs typically start up in all-electric mode and operate on electricity until their battery pack is depleted. Some models shift to hybrid mode when they reach highway cruising speed, generally above 60 or 70 miles per hour. Once the battery is empty, the engine takes over and the vehicle operates as a conventional, non-plug-in hybrid.

Examples of PHEV

Porsche Cayenne S E-Hybrid , Chevy Volt, Chrysler Pacifica, Ford C-Max Energi, Ford Fusion Energi, Mercedes C350e, Mercedes S550e, Mercedes GLE550e, Mini Cooper SE Countryman, Audi A3 E-Tron, BMW 330e, BMW i8, BMW X5 xdrive40e, Fiat 500e, Hyundai Sonata, Kia Optima, Porsche Panamera S E-hybrid, Volvo XC90 T8.

Fuel Cell Electric Vehicle (FCEV)

Fuel Cell Electric Vehicles (FCEVs), also known as fuel cell vehicles (FCVs) or Zero Emission Vehicle, are types of electric cars that employ 'fuel cell technology' to generate the electricity required to run the vehicle. In this type of vehicles, the chemical energy of the fuel is converted directly into electric energy.

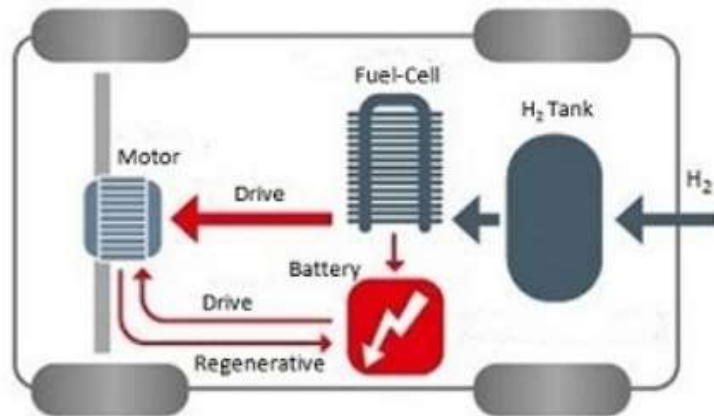


Architecture and Main Components of FCEV

Components of FCEV

- Electric motor
- Fuel-cell stack
- Hydrogen storage tank
- Battery with converter and controller

Fuel-Cell Electric Vehicle (FCEV)



Working Principles of FCEV

The working principle of a 'fuel cell' electric car is different compared to that of a 'plug-in' electric car. This types of electric cars is because the FCEV generates the electricity required to run this vehicle on the vehicle itself.

Examples of FCEV

Toyota Mirai, Hyundai Tucson FCEV, Riversimple Rasa,

Honda Clarity Fuel Cell, Hyundai Nexo.

Battery Technology

- Battery Types
 - Batteries can be classified into several types, including lead-acid, nickel-cadmium, lithium-ion, and solid-state. Each type has unique characteristics that make it suitable for specific applications, such as electric vehicles, portable electronics, and renewable energy storage.
- Operating Principles
 - Batteries operate on the principle of electrochemistry, where chemical energy is converted into electrical energy through redox reactions. In simple terms, during discharge, electrons flow from the anode to the cathode, generating electric current, while during charging, the process is reversed.
- Charging Cycles
 - Charging cycles refer to the process of charging and discharging a battery. A typical lithium-ion battery can undergo hundreds to thousands of cycles, but its capacity diminishes over time due to factors like temperature, charge levels, and usage patterns. Proper management of charging cycles is crucial for extending battery life.
- Recent Innovations
 - Recent advancements in battery technology include the development of faster charging methods, improved energy density, and the exploration of new materials like graphene and lithium-sulfur. These innovations aim to enhance performance, reduce costs, and make batteries more sustainable for future applications.

Power Electronics in EVs

- Inverters
 - Inverters convert direct current (DC) from the battery into alternating current (AC) for the electric motor.
 - They play a crucial role in controlling the speed and torque of the motor, enhancing vehicle performance.
- Converters
 - Converters manage the flow of electrical energy between the battery and other components, ensuring efficient power distribution.
 - They include DC-DC converters that step down voltage levels for auxiliary systems, improving overall energy management.
- Controllers
 - Controllers regulate the operation of the electric motor by adjusting the power supplied based on driver input and vehicle conditions.
 - They ensure optimal performance and efficiency, contributing to a smoother driving experience.
- Efficiency
 - Power electronics significantly enhance the efficiency of electric vehicles, reducing energy losses during conversion processes.
 - Higher efficiency translates to longer driving ranges and better overall performance, making EVs more competitive with traditional vehicles.



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Thermal Management Systems

- Performance Boost
 - Effective thermal management enhances the overall performance of electric vehicles by maintaining optimal operating temperatures.
 - This leads to improved battery life, increased range, and better acceleration.
- Cooling Techniques
 - Various cooling techniques, such as liquid cooling and phase change materials, are employed to dissipate heat efficiently.
 - These methods ensure that critical components like batteries and motors operate within safe temperature limits.
- Efficiency Gains
 - Proper thermal management systems contribute to energy efficiency by reducing energy losses due to overheating.
 - This results in lower energy consumption and extended vehicle range, making electric vehicles more sustainable.