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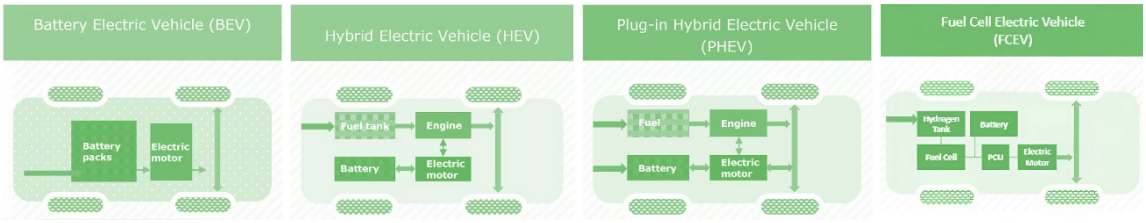
DEFINITIONS & TERMINOLOGY

TYPES OF ELECTRIC VEHICLES

There are four types of electric vehicles available:

- **Battery Electric Vehicle (BEV):** Fully powered by electricity. These are more efficient compared to hybrid and plug-in hybrids.
- **Hybrid Electric Vehicle:**
  - **Hybrid Electric Vehicle (HEV):** The vehicle uses both the internal combustion (usually petrol) engine and the battery-powered motor powertrain. The petrol engine is used both to drive and charge when the battery is empty. These vehicles are not as efficient as fully electric or plug-in hybrid vehicles.
  - **Plug-in Hybrid Electric Vehicle (PHEV):** Uses both an internal combustion engine and a battery charged from an external socket (they have a plug). This means the vehicle's battery can be charged with electricity rather than the engine. PHEVs are more efficient than HEVs but less efficient than BEVs.
- **Fuel Cell Electric Vehicle (FCEV):** Electric energy is produced from chemical energy. For example, a hydrogen FCEV.

System Architecture of 4 types of electric cars is as follows:



Battery Electric Vehicles (BEVs)

BEVs are also known as All-Electric Vehicles (AEV). Electric Vehicles using BEV technology run entirely on a battery-powered electric drivetrain. The electricity used to drive the vehicle is stored in a large battery pack which can be charged by plugging into the electricity grid. The charged battery pack then provides power to one or more electric motors to run the electric car. To find out more about BEVs, click below.

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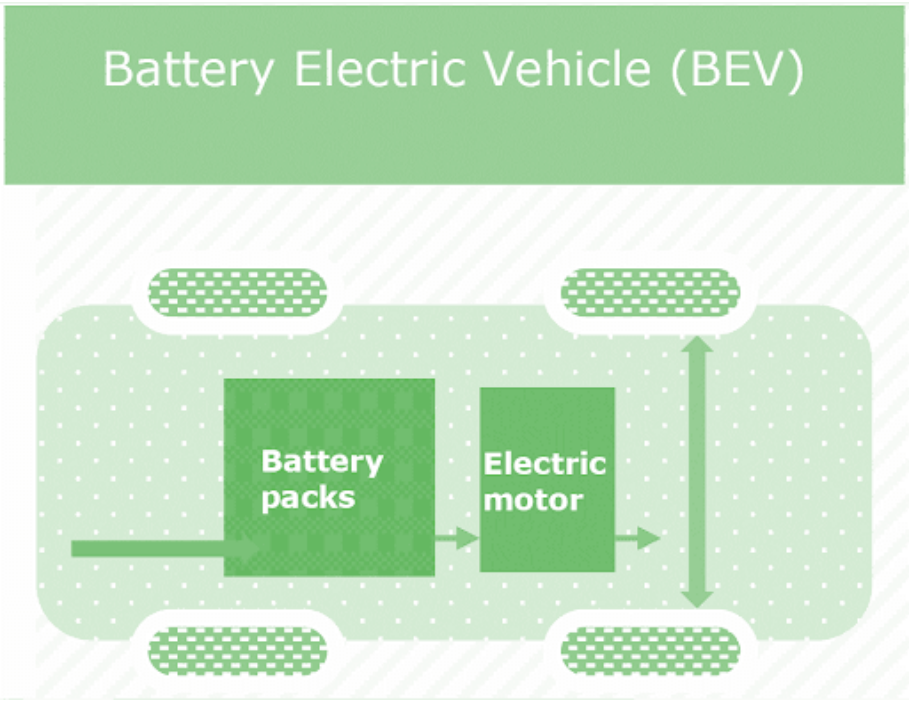
Main Components of BEV:

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

Working Principles of BEV:

The power for the electric motor is converted from the DC Battery to AC. As the accelerator is pressed, a signal is sent to the controller. The controller adjusts the speed of the vehicle by changing the frequency of the AC power from the inverter to the motor. The motor then connects and leads to the turning of wheels through a cog. If 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



Hybrid Electric Vehicle (HEV):

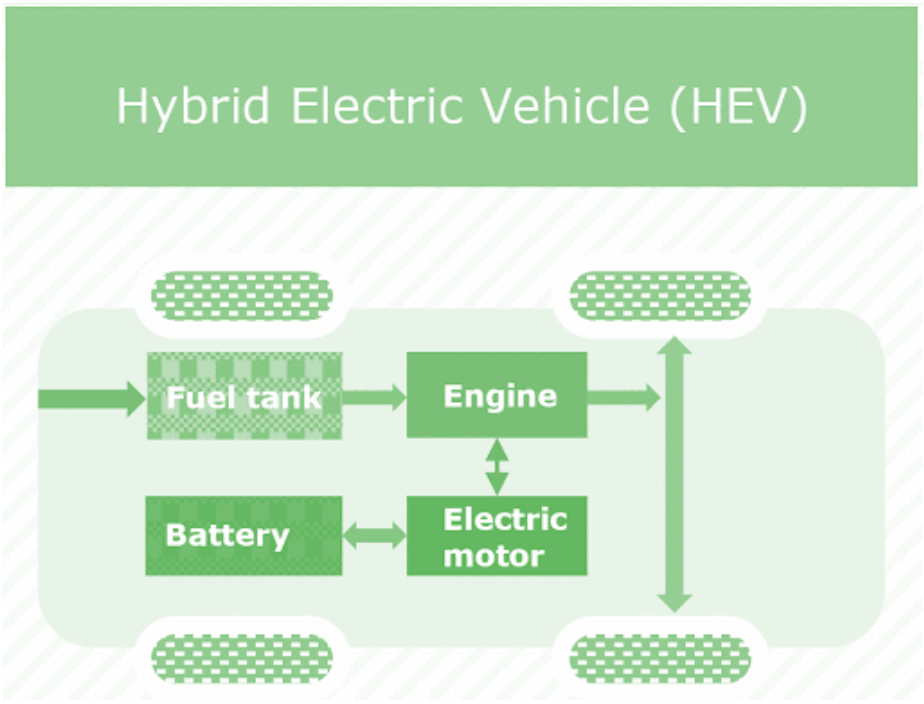
HEVs are also known as series hybrid or parallel hybrid. HEVs have both engine and electric motor. The engine gets energy from fuel, and the motor gets electricity from batteries. The transmission is rotated simultaneously by both engine and electric motor. This then drives the wheels. To find out more about HEVs, click below.

Main Components of HEV:

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

Working Principles of HEV:

The fuel tank supplies energy to the engine like a regular car. The batteries run on an electric motor. Both the engine and electric motor can turn the transmission at the same time.



Plug-in Hybrid Electric Vehicle (PHEV):

The PHEVs are also known as series hybrids. They have both engine and a motor. You can choose among the fuels, conventional fuel (such as petrol) or alternative fuel (such as bio-diesel). It can also be powered by a rechargeable battery pack. The battery can be charged externally. To find out more about PHEVs, click below.

PHEVs can run in at least 2 modes:

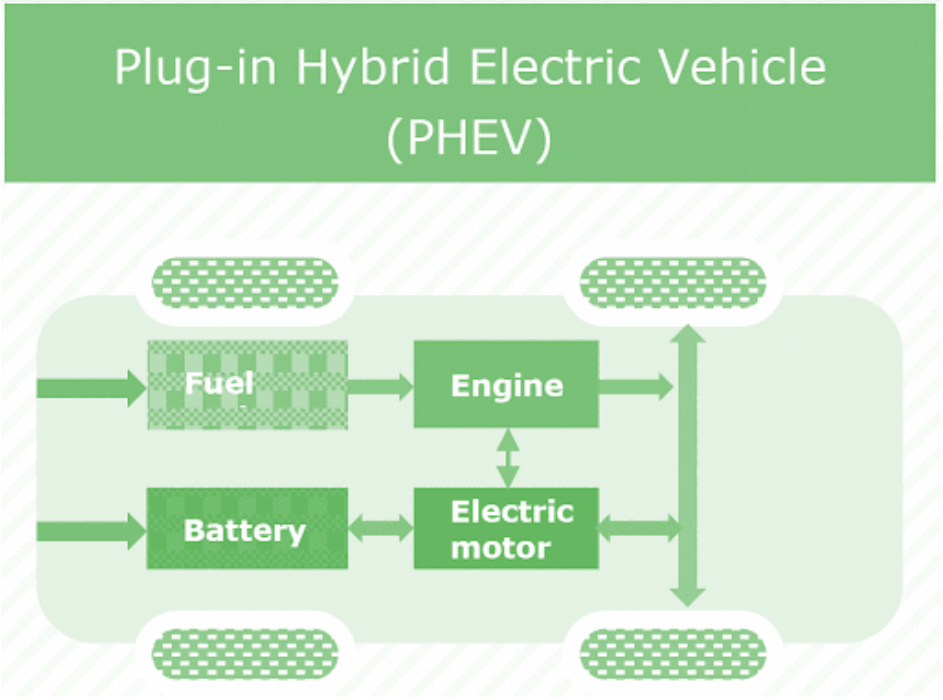
- All-electric Mode, in which the motor and battery provide all the car's energy
- Hybrid Mode, in which both electricity and petrol/diesel are employed

Main Components of PHEV:

Electric motor, Engine, Inverter, Battery, Fuel tank, Control module, Battery Charger (if onboard model)

Working Principles of PHEV:

PHEVs start-up in all-electric mode and make use of electricity until their battery pack is depleted. Once the battery gets drained, the engine takes over, and the vehicle operates as a conventional, non-plug-in hybrid. PHEVs can be charged by plugging into an outside electric power source, engine, or regenerative braking. When brakes are applied, the electric motor acts as a generator, using the energy to charge the battery. The engine's power is supplemented by the electric motor; as a result, smaller engines can be used, increasing the car's fuel efficiency without compromising performance.



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Fuel Cell Electric Vehicle(FCEV):

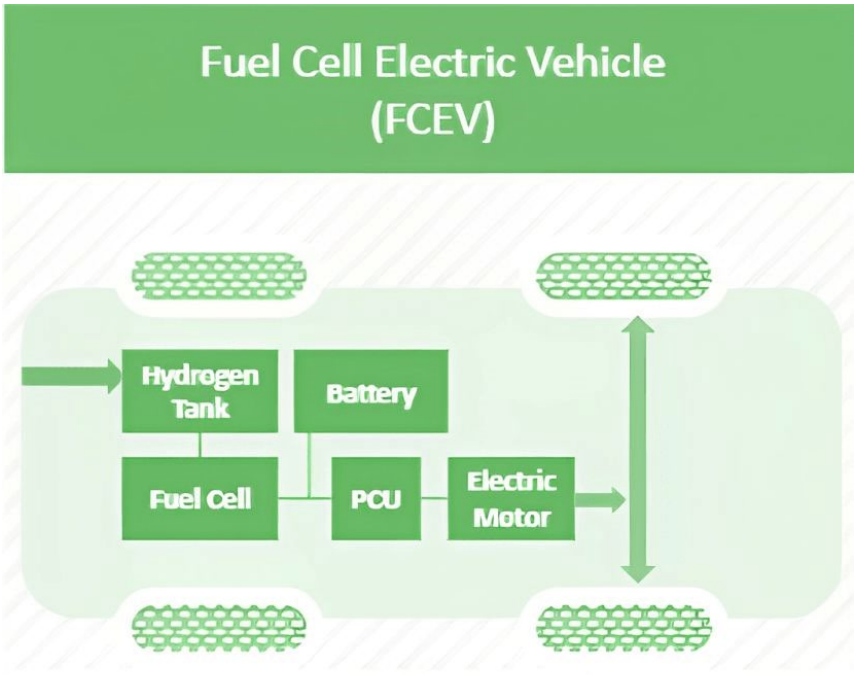
FCEVs are also known as Zero-Emission Vehicles. They employ 'fuel cell technology' to generate the electricity required to run the vehicle. The chemical energy of the fuel is converted directly into electric energy. To find out more about FCEVs, click below.

Main Components of FCEV:

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

Working Principles of FCEV:

The FCEV generates the electricity required to run this vehicle on the vehicle itself.



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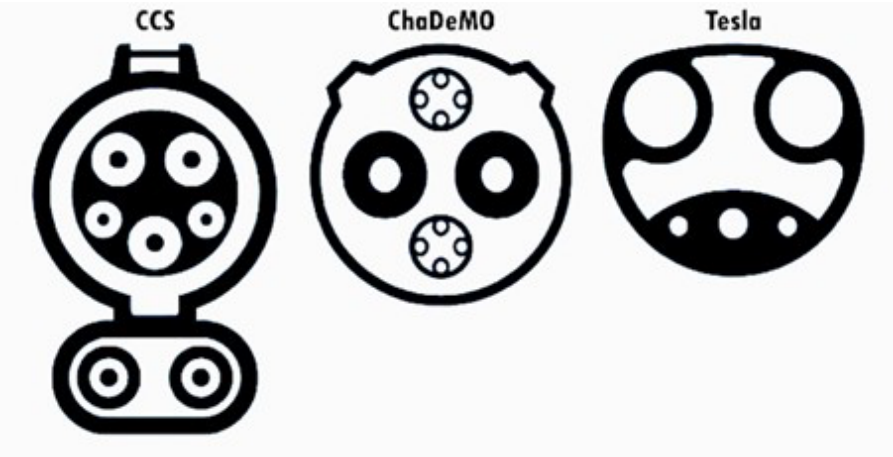
BEV: Battery Electric Vehicles (BEVs) operate exclusively on electricity stored in batteries and only have an electric motor (e.g., Nissan LEAF, Ford Focus EV, Tesla Models, Chevy Bolt, etc.).

Direct Current Fast Charging (DCFC): Requires a 480V/3-Phase Alternating Current (AC) electricity connection (with the DCFC equipment converting AC to DC) and is the fastest charging EVSE type which is especially useful for applications such as highway charging. Note that this high-speed charging comes at a high cost for the equipment and the investment in electrical supply.

Electrical Connectors for DCFC: Unlike Level 1 and 2 charging, there are currently three different types of DCFC connectors (plugs) in use in the United States: CHAdeMO, SAE Combined Charging System (CCS), and Tesla.

- CHAdeMO is used by Japanese automakers Nissan and Mitsubishi. Older Kia, Honda, and Hyundai models also use CHAdeMO.
- All other automakers in the U.S market, except Tesla, use the CCS connector. Except for Tesla stations, many new DCFC stations come equipped with both CCS and CHAdeMO plugs.
- The proprietary Tesla connector can currently only be used by Tesla vehicles, but Tesla announced in July 2021 that it would eventually allow its charging network to be used by other EVs.



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Electric Vehicle (EV): Any vehicle that is licensed and registered for operation on public and private highways, roads, and streets; and operates either partially or exclusively using an electric motor powered by an externally charged on-board battery.

Electric Vehicle Energy Management System (EVEMS): A means used to control electric vehicle supply equipment loads through the process of connecting, disconnecting, increasing, or reducing electric power to the loads and consisting of any of the following: a monitor(s), communications equipment, a controller(s), a timer(s), and other applicable device(s).

Electric Vehicle Supply/Service Equipment or (EVSE): The equipment, including the cables, cords, conductors, connectors, couplers, enclosures, attachment plugs, power outlets, power electronics, transformer, switchgear, switches and controls, network interfaces, point of sale equipment, and associated apparatus designed and used for the purpose of transferring energy from the electric supply system to a plug-in electric vehicle. "EVSE" may deliver either alternating current or, consistent with fast charging equipment standards, direct current electricity. “EVSE” is synonymous with “electric vehicle charging station”.

Level 1 (L1): Charging requires 120V with 1-Phase AC (equivalent to powering a space heater). While this charging method has a relative slow charging rate, adding 3 - 5 miles of range per hour of charge, there are still opportunities for L1 use such as workplace or home charging, where vehicles may be parking for many hours. This is somewhat dependent on how far the vehicle is typically driven. Level 1 may be particularly appropriate for plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs) with small batteries, workplace charging for employees, as well as long-term parking at airports, transit lots and shared community parking.

Level 2 (L2): Charging requires 208V or 240V with 1-Phase AC (outlet equivalent to an electric range or electric dryer). Level 2 charging provides charging at a rate of 12-30 miles of range per hour of charge. Many people find L2 charging provides the best solution for at home or at work charging. Level 2 charging may also be appropriate for other locations where people park vehicles for several hours at a time (e.g., fleet vehicles, retail establishments, destination locations, etc.).

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EV Charging Station Comparison

	AC Level 1	AC Level 2	DC Fast Charger
Voltage	120V 1-Phase AC	208V or 240V 1-Phase AC	480V 3-Phase AC
Suitable for Installation	Single-family Multi-family	Single-family, Multi-family, Commercial, Municipal/Private Fleet	Municipal/Private Fleet Public Metro Areas
Amps	12-16 Amps	12-90 Amps (Typical 32 Amps)	<125 Amps (Typical 60 Amps)
Charging Loads	1.4 - 1.9 kW	2.5 - 19.2 kW (Typical 7 kW)	<90 kW (Typical 50 kW)
Charge Duration	3-5 miles of range per hour	10-20 miles of range per hour	80% charge in 20-30 minutes
Best for	6+ hour or overnight charge	2-6 hour dwell times	High turn over
Station Hardware Cost	$500 - $1,000 per port	$600 - $5,000 per port	$7,000 - $50,000 per port

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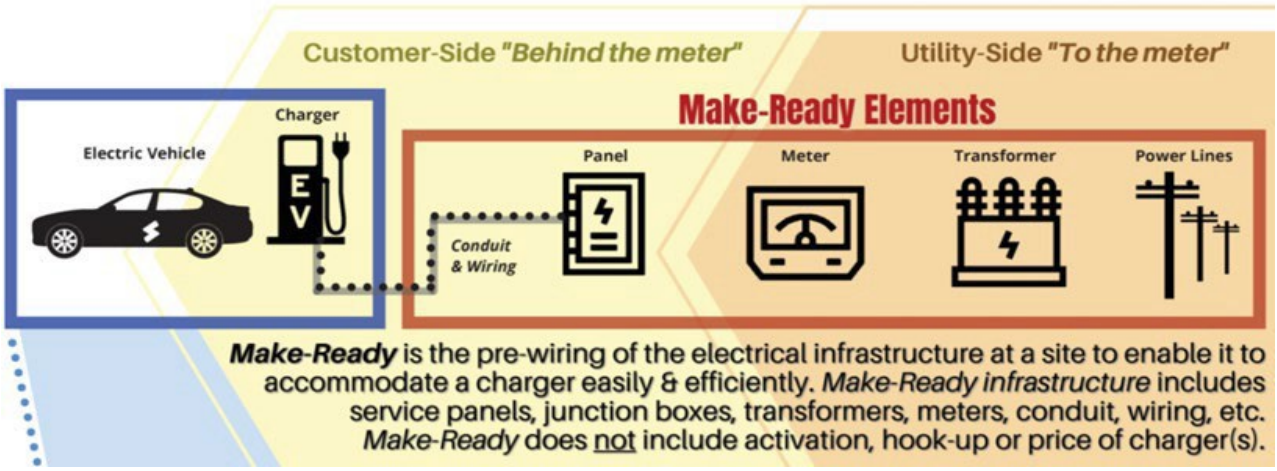
Make-Ready: Means the pre-wiring of electrical infrastructure at a parking space, or set of parking spaces, to facilitate easy and cost-efficient future installation of Electric Vehicle Supply Equipment or Electric Vehicle Service Equipment, including, but not limited to, Level Two EVSE and direct current fast chargers. Make Ready includes expenses related to service panels, junction boxes, conduit, wiring, and other components necessary to make a particular location able to accommodate Electric Vehicle Supply Equipment or Electric Vehicle Service Equipment on a "plug and play" basis. "Make-Ready" is synonymous with the term "charger ready," as used in P.L.2019, c.362 (C.48:25-1 et al.).



Multi-Unit Dwelling (MUD) refers to multi-family residences, including apartments, condominiums, and townhouses. There must be a minimum of 5 units.

PEV: A Plug-in Electric Vehicle (PEV) is a general term for any car that runs at least partially on battery power and is recharged by plugging in to the electricity grid. There are two different types of PEVs to choose from: pure battery electric and plug-in hybrid electric vehicles.

PHEV: Plug-in Hybrid Electric Vehicles (PHEVs) combines two propulsion systems in one vehicle; an electric motor that is battery-powered and can be plugged in and recharged, and an engine refueled with gasoline (e.g., Chevy Volt, Toyota Prius Plug-in, Ford C Max and Fusion Energi, etc.)

Port: One charging station connection to one vehicle, capable of supplying the full rated power of the charging station. In the case of Level 2 charging stations, a port is one SAE J1772 connector. In the case of DCFC stations, one port may include both a CHAdeMO and CCS connector if only one connector can be used at a time. In all cases, if a charging station has multiple connectors but reduces the power to each connector when multiple vehicles are plugged in, then this counts as only one port.

Private EVSE: Means EVSE that has restricted access to specific users (e.g., single and two-family homes, executive parking, fleet parking with no access to the general public).

Publicly accessible EVSE: Means EVSE that is publicly available (e.g., park & ride, public parking lots and garages, on-street parking, shopping center parking, non-reserved parking in multi-family parking lots, etc.).

SAE J1772 or J1772 is a North American standard connector for plugging into EVs, established by the SAE International. The standard includes physical, electrical, communication, and performance requirements. The J1772 connector is used for both Level 1 and Level 2 charging.

SAE J1772 CCS or "combo connector" is the protocol standard that adds pins to the J1772 connector to allow DC fast charging. This connector is most commonly supported by North American and European EVs equipped for fast charging.