HYBRID ELECTRICAL VEHICLES

Elective Course

By

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EE113

HYBRID ELECTRICAL VEHICLES

Instruction: 3 periods per week
hours
CIE: 40 marks
Credits: 3

Duration of SEE: 3

SEE: 60 marks

Course Objectives

- To understand the basics of electric and hybrid electric vehicles and their working
- To understand the basics of batteries and their role for electric/hybrid vehicle applications
- To obtain the knowledge of various types of electric/hybrid vehicles
- To understand the real time challenges in the implementation of this technology

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand basics of electric and hybrid electric vehicles both conceptually and mathematically so that clear understanding from basics physics is achieved.
2. Have the knowledge of battery behavior for electric vehicle application.
3. Understand different types of Electric/Hybrid vehicles technologies available and their applications.
4. Analyze challenges in implementing electric/hybrid vehicle technology by looking into various charging topologies and their impact on distribution systems.
5. Analyze various electric drives suitable for hybrid electric vehicles.

UNIT I

Introduction to Electric Vehicles: Sustainable Transportation - EV System – EV Advantages - Vehicle Mechanics - Performance of EVs - Electric Vehicle drivetrain - EV Transmission Configurations and components-Tractive Effort in Normal Driving - Energy Consumption - EV Market - Types of Electric Vehicle in Use Today – Electric Vehicles for the Future.

UNIT I

- **Introduction to Electric Vehicles**:
  -Sustainable Transportation
  -EV System –EV -Advantages
- **Vehicle Mechanics**
  –Performance of EVs
  –Electric Vehicle drive train
  –EV Transmission Configurations and Components
  –Tractive Effort in Normal Driving
  –Energy Consumption
- **EV Market**
  –Types of Electric Vehicle in Use Today
  –Electric Vehicles for the Future

Importance of sustainable transportation

- Sustainable transportation plays a vital role in addressing environmental and social challenges. According to the World Bank, transportation is the fastest-growing source of carbon emissions from energy use. It also accounts for a significant portion of urban air pollution—between 12% and 70% depending on the location.
- Sustainable transportation also offers practical advantages in industries and workplaces, such as lowering fuel consumption by reducing reliance on trucks, minimising waste, cutting down waiting times for loading operations, improving energy control by moving some activities indoors, and enhancing workplace safety by reducing forklift usage.

Impact of sustainable transportation

- The benefits of sustainable transportation include reducing greenhouse gas emissions, which lowers our carbon footprint. It also makes transportation safer and helps reduce traffic congestion in cities. By encouraging walking, cycling, and the use of public transit, it promotes better health and well-being. Additionally, it helps close social gaps by providing more equitable access to jobs, education, and services, creating opportunities for all members of society.
- Overall, adopting sustainable transportation contributes to cleaner air, safer roads, decreased congestion, healthier communities, and a more inclusive society with better access to essential opportunities

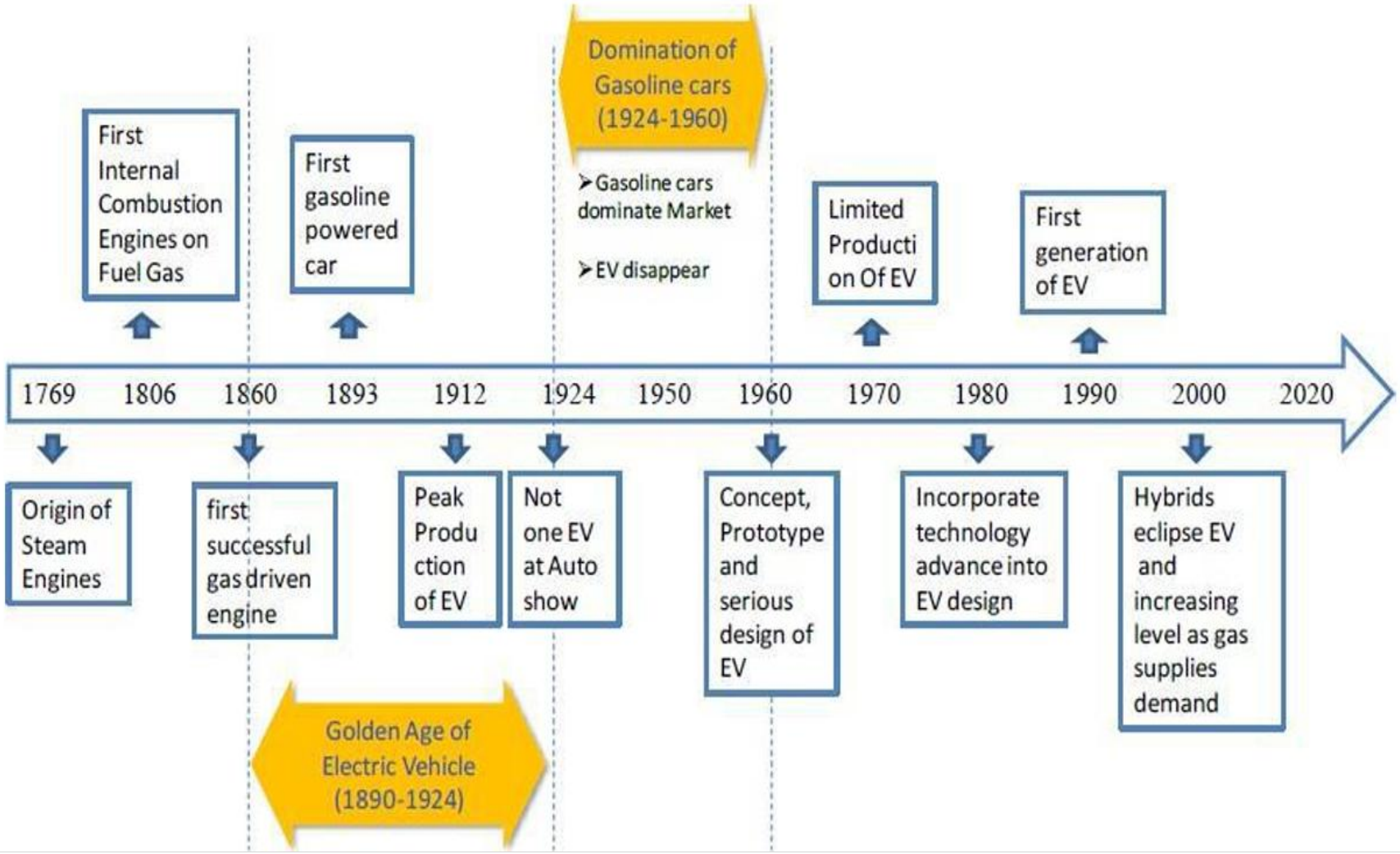
EVs for sustainable transportation

- Electric vehicles themselves, which eliminate exhaust emissions and improve air quality.
- Expansion of charging infrastructure powered by clean energy such as solar or wind.
- Urban planning that supports EV adoption and minimizes dependence on fossil fuel vehicles.
- Circular economy approaches for EV batteries, including recycling and reuse, to reduce environmental impact.

What are EVs?

- Electric Vehicle (EVs) or Electrically Chargeable Vehicles (ECVs) usually refers to any vehicle that is powered, partially or fully, by a battery that can be directly plugged into the mains.

History
Development of
Electric Vehicles



How are EVs different from ICEs

Aspect	Electric Vehicle (EV)	Internal Combustion Engine (ICE) Vehicle
Powertrain	Uses electric motor and batteries	Powered by internal combustion engine and transmission
Interior	More interior space due to no transmission tunnel	Transmission tunnel may impact the interior layout
Braking system	Regenerative braking recaptures energy, reducing wear on mechanical brakes	Traditional hydraulic braking system without energy recovery
Refueling infrastructure	Needs charging stations, which are less widespread	Gasoline and diesel stations are widely available
Weight distribution	Batteries placed at the vehicle's base ensure a low center of gravity	Engine and transmission are positioned higher, resulting in a higher center of gravity
Fueling system	Equipped with a charging port for electricity	Includes fuel tank and cap for gasoline or diesel
Exhaust system	No tailpipe or exhaust system	Tailpipe and emissions control components present
Transmission	Usually single-speed, enabled by broad torque range	Multi-speed transmission supports varying engine speeds
Cooling system	Simpler systems designed for electric motors and batteries	Complex systems needed to control engine temperature
Noise insulation	Reduces road and wind noise for enhanced driving experience	Reduces engine noise and vibration

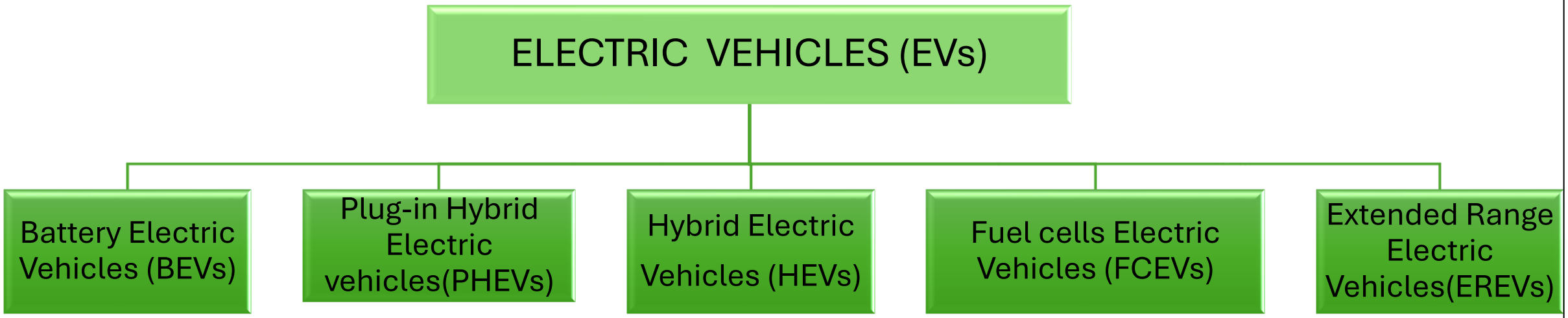
Advantages of EVs

- **Environmental Benefits**
  Zero direct emissions, reduced carbon footprint, and improved air quality in urban areas

- **Economic Savings**
  Lower fuel costs, reduced maintenance expenses, and government incentives

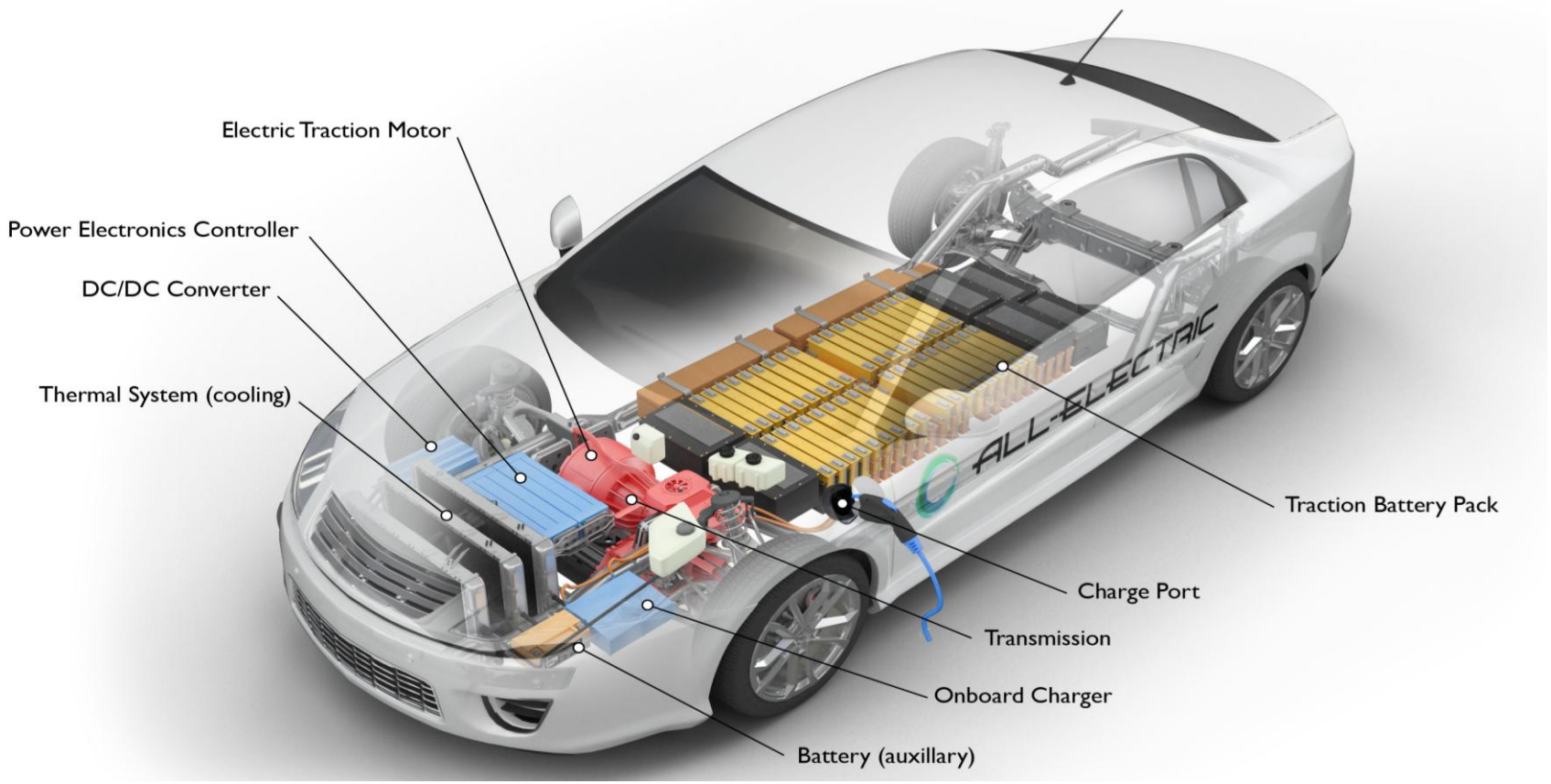
- **Performance Advantages**
  Instant torque delivery, quiet operation, and smooth acceleration

- **Energy Security**
  Reduced dependence on fossil fuels and integration with renewable energy


ELECTRIC VEHICLES (EVs)
Battery Electric Vehicles (BEVs)
Plug-in Hybrid Electric vehicles(PHEVs)
Hybrid Electric Vehicles (HEVs)
Fuel cells Electric Vehicles (FCEVs)
Extended Range Electric Vehicles(EREVs)

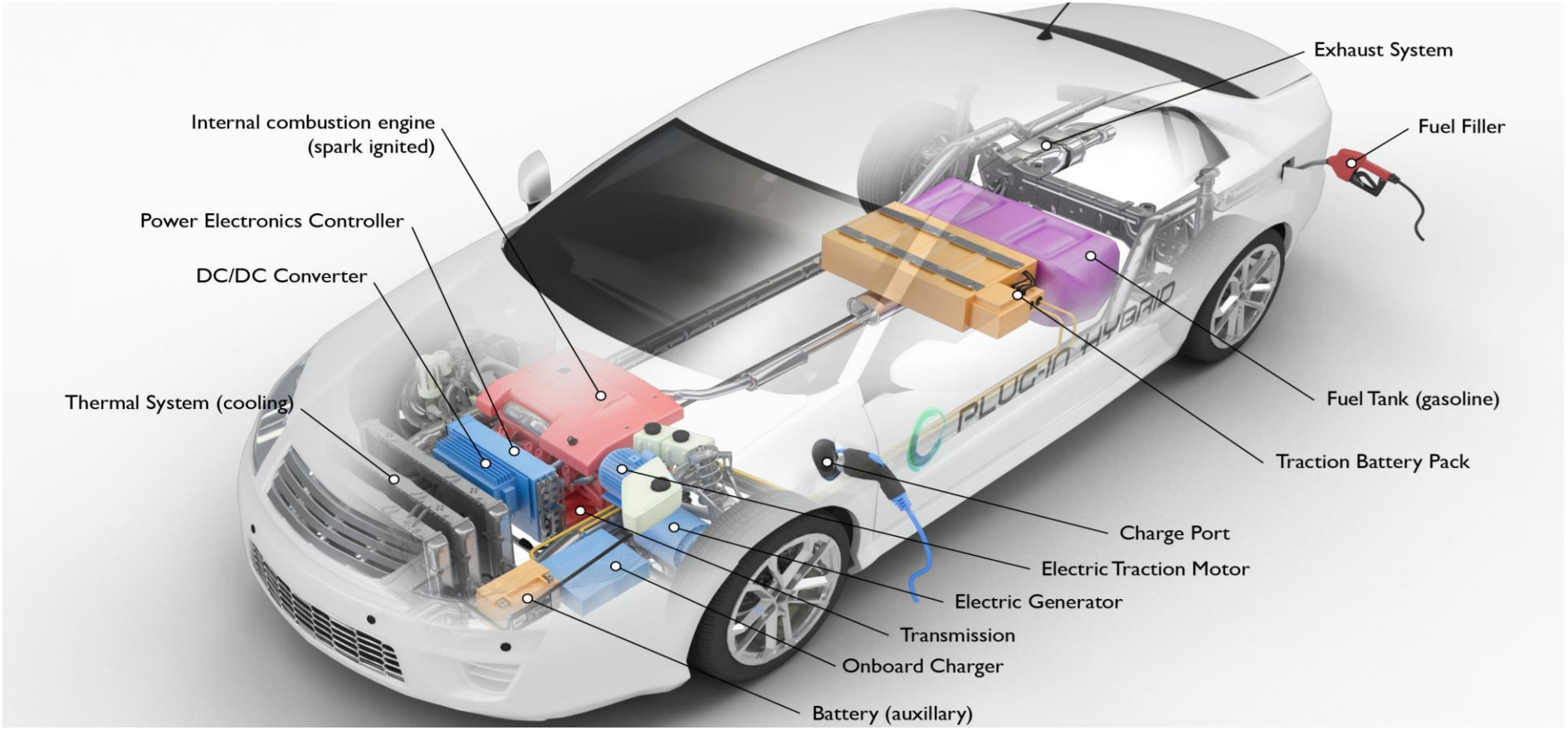
Battery Electric Vehicles (BEVs):

BEVs run solely on electric power stored in large battery packs. They do not have an internal combustion engine or fuel tank. BEVs are charged by plugging into an electric power source and produce zero emissions during operation.



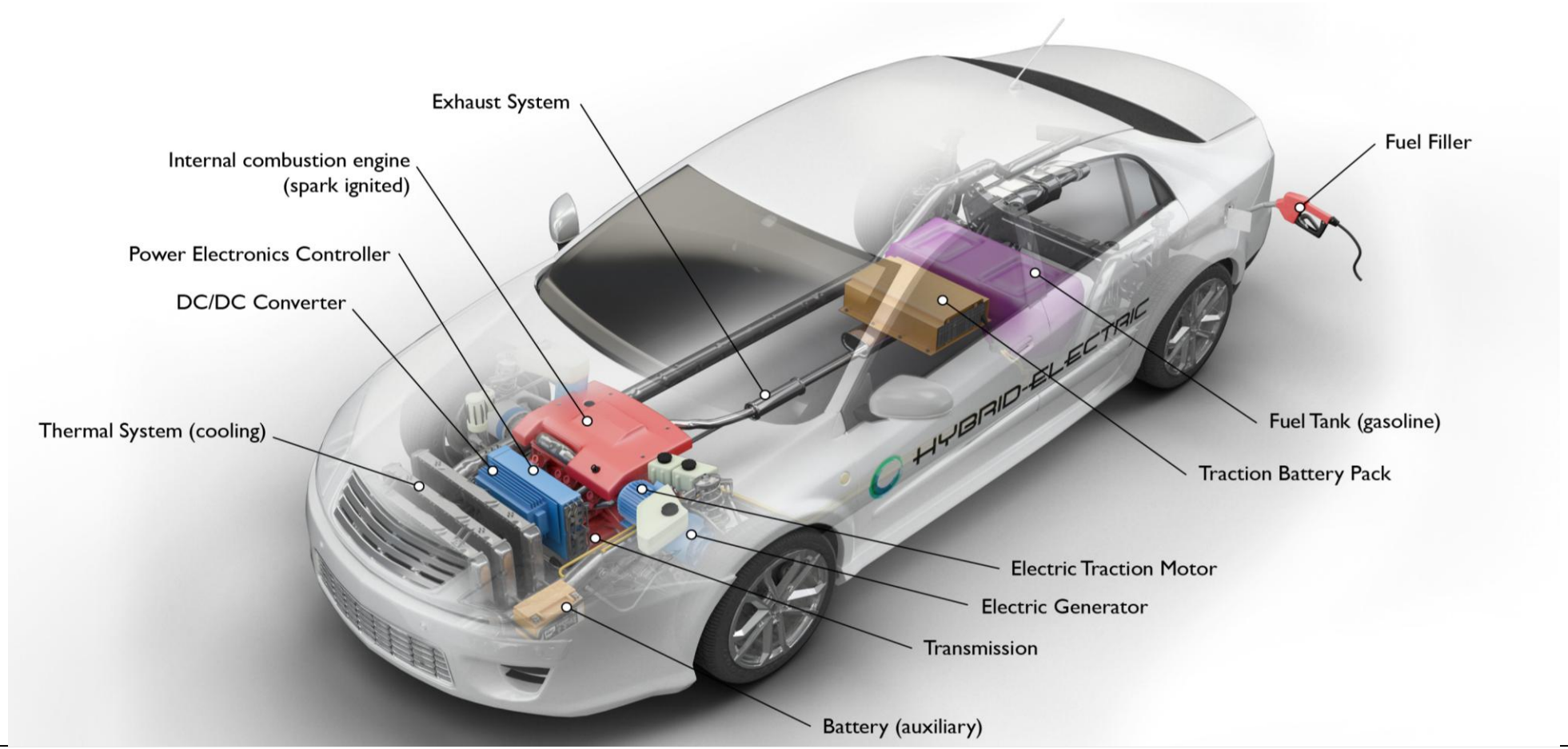
Plug-in Hybrid Electric Vehicles (PHEVs):

PHEVs combine a conventional internal combustion engine with an electric motor and rechargeable battery. They can run on electric power alone for a limited range and switch to gasoline or diesel as needed. PHEVs are plugged in to recharge the battery and offer flexibility between electric and fuel modes.



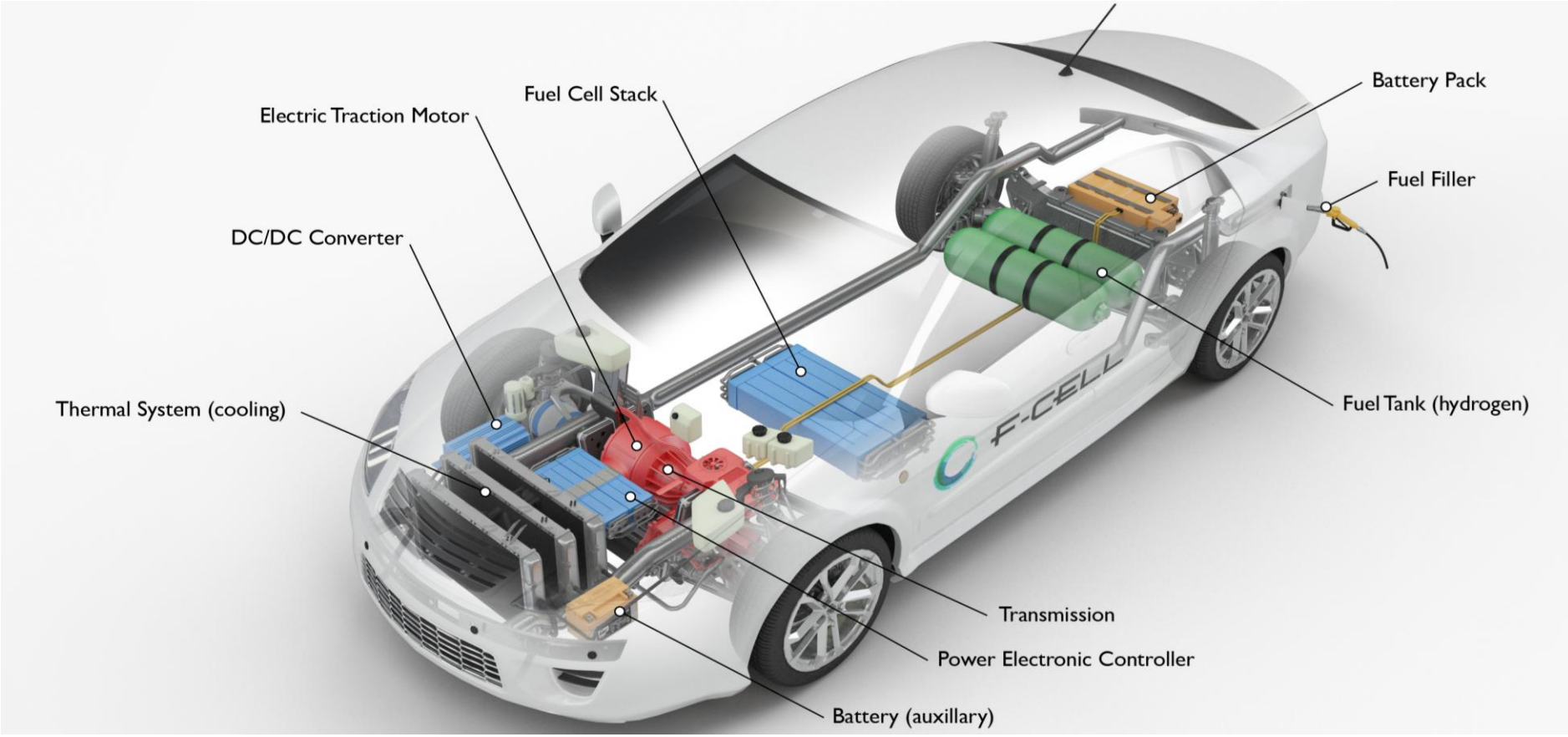
Hybrid Electric Vehicles (HEVs)

HEVs have both an internal combustion engine and electric motor, but their batteries are charged through regenerative braking and the engine, not by plugging in. They operate using a combination of electric power and fuel to improve efficiency and reduce emission.



Fuel Cell Electric Vehicles (FCEVs):

FCEVs generate electricity on board using hydrogen fuel cells, which combine hydrogen and oxygen to produce electricity and water vapour as the only emission. They refuel by hydrogen gas instead of charging batteries and provide longer driving ranges similar to conventional vehicles.



Extended Range Electric Vehicles (ER-EVs)

ER-EVs are primarily electric vehicles with an electric motor and battery for propulsion but have a small internal combustion engine that acts as a generator to recharge the battery when the charge is low. This extends the vehicle's driving range beyond what the battery alone can provide.