Components of Electric Vehicles; Chassis /Battery/Charger/etc.

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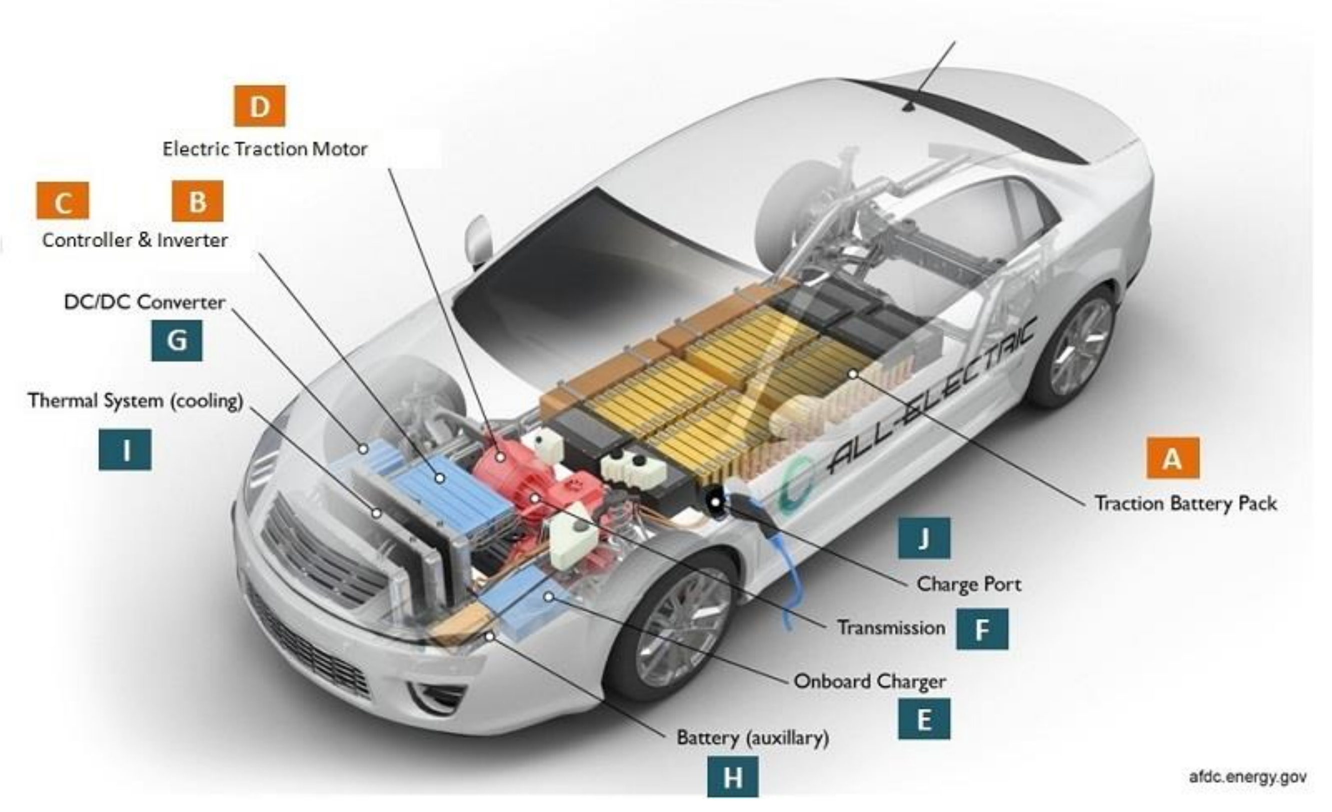
This ppt. will discuss various common main electric car components or parts or elements and their function such as traction batteries, inverters (DC-DC converters), traction motors, on-board chargers and controllers. The different types of electric car components determines how the car works. Electric cars (vehicles) components and functions can be explained by means of picture .

Why Electric Vehicles?



Note: The working principle above is for battery electric vehicle (BEV) type.

How Does An Electric Car Work?

When the car pedal is pressed, then:

- Controller [**C**] takes and regulates electrical energy from batteries [**A**] and inverters [**B**]
- With the controller set, the inverter then sends a certain amount of electrical energy to the motor (according to the depth of pressure on the pedal)
- Electric motor [**D**] converts electrical energy into mechanical energy (rotation)
- Rotation of the motor rotor rotates the transmission so the wheels turn and then the car moves.

Electric Vehicle Components

Basic Main Components of Electrical Vehicle

The basic main elements of electric cars installed in almost all types of electric cars are as follows:

Traction Battery Pack (A)

The function of the battery in an electric car is as an electrical energy storage system in the form of direct-current electricity (DC). If it gets a signal from the controller, the battery will flow DC electrical energy to the inverter to then be used to drive the motor. The type of battery used is a rechargeable battery that is arranged in such a way as to form what is called a *traction*

Electric Vehicle Components

There are various types of electric car batteries. The most widely used is the type of lithium-ion batteries.

Power Inverter (B)

The inverter functions to change the direct current (DC) on the battery into an alternating current (AC) and then this alternating current is used by an electric motor. In addition, the inverter on an electric car also has a function to change the AC current when regenerative braking to DC current and then used to recharge the battery. The type of inverter used in some electric car models is the bi-directional inverter category.

Electric Vehicle Components

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Controller (C)

The main function of the controller is as a regulator of electrical energy from batteries and inverters that will be distributed to electric motors. While the controller itself gets the main input from the car pedal (which is set by the driver). This pedal setting will determine the frequency variation or voltage variation that will enter the motor, and at the same time determine the car's speed.

In brief, this unit manages the flow of electrical energy delivered by the traction battery, controlling the speed of the electric traction motor and the torque it produces. This component will determine how electric car work.

The control system is responsible for governing the operation of the electric vehicle.

The control system receives inputs from the operator, Controller feedback signals from the motor controller and motor and also feedback signals from other systems within the EV.

The speed at which the control system must receive data from other systems, process the data in an algorithm and output a response to the given conditions must be accomplished in milliseconds. This requires the control system to have a microprocessor, just like a computer, to accomplish its tasks. Though no two control systems are identical, most of the feedback signals are similar.

The table below lists common components of a control system and the feedback signals that are sent to the microprocessor.

Controller

A motor controller.

Component	Feedback Signal
Electric Motor(s)	Winding temperature
	Rotor Speed (RPM)
Battery	Voltage
	Output Current
	Temperature
Motor Controller	Current (and direction of current)
	Voltage
	Temperature
	Leakage Current
Accelerator Pedal	Voltage as a function of pedal position
Shift Selector	FWD/REV
	Range Selection

The control system must continuously monitor the feedback signals listed above.

For instance, if the temperature of the windings in the motor gets too hot, the magnetic properties of that motor can be permanently altered or the windings may melt. By feeding a signal back to the microprocessor, the control system can limit the output of the motor if it senses a temperature rise.

The same limiting or shutdown of any system can take place if an undesirable condition is or has occurred.

Other feedback signals give information to the microprocessor to control the speed of the vehicle. The accelerator pedal functions in much the same way as conventional vehicles. As the pedal is depressed, an increasing signal voltage(not traction battery voltage) is sent to the microprocessor which instructs the motor controller to increase the amount of current in the motor windings, causing the motor to spin faster. As the signal voltage from the accelerator pedal is decreased, the motor spins slower.

Advanced Control Systems

In some advanced control systems, it is possible to limit the amount of current that flows to the motor, based on a switch selection. This allows the operator to adjust to a driving style that fits a particular situation.

For instance, if a driver needs a certain range(in miles) from a single charge, the range selection can be set so that the microprocessor will limit the amount of output current from the motor controllers to a preset limit. If the preset limit is 100 amps, the microprocessor will not allow any current above this limit to flow to the motors. In this mode, acceleration ability is sacrificed for range.

If the driver is in an area where the vehicle must climb steep grades, the range selector can be set so that the maximum current capability of the motor controller and motor can be used. The range selection feature is a valuable feature that adds to the efficiency of the motor controller.

The ultimate goal of a control system is to maximize the energy stored within the traction battery and to prevent unsafe conditions from occurring within the electric vehicle.

Electric Traction Motor (D)

Because the controller provides electrical power from the traction battery, the electric traction motors will work turning the transmission and wheels. Some hybrid electric cars use a type of generator-motor that performs the functions of propulsion and regeneration.

Other Electric Car Components

Charger (E) is a battery charging device. Chargers get electricity from outside sources, such as the utility grid or solar power plants.AC electricity is converted into DC electricity and then stored in the battery.
There are 2 types of electric car chargers:

- On-board charger: the charger is located and installed in the car
- Off-board charger: the charger is not located or not installed in the car.

Transmission (F): The transmission transfers mechanical power from the electric traction motor to drive the wheels.

DC/DC Converter (G): This one of electric car parts that to converts higher-voltage DC power from the traction battery pack to the lower-voltage DC power needed to run vehicle accessories and recharge the auxiliary battery.

Battery (H): In an electric drive vehicle, the auxiliary battery provides electricity to power vehicle accessories.

Thermal System – Cooling (I): This system maintains a proper operating temperature range of the engine, electric motor, power electronics, and other components.

DO IT NOW !!

- Battery rating and capacity in Hero Electric Optima E5 (48 V, 28Ah (double battery)), TATA TIGOR EV (21.5 KW).
- MOTORS RATING used in Hero Electric Optima E5 (550-1200 W), TATA TIGOR EV (72 V, 3-phase AC Induction).
- Charging time (6 A; 5 hours) for Hero Electric Optima and TATA TIGOR EV (11. 5 hours).

Charging

- **Types of Charging**

There are a number of different types of battery chargers based on the way they control the charging rate.

- ***Constant Voltage***

A constant voltage is applied and the current flows into the battery (the highest current occurs when the battery has been fully discharged and steps down to a low current when the battery is nearly charged.) Electronics on constant voltage charges is relatively simple, therefore, these types of chargers tend to be less expensive.

Charging

- ***Combination Constant Current/Constant Voltage***

The charge cycle starts with a high constant current until the voltage reaches a set value, then changes to a constant voltage control. This is the most sophisticated of the basic types of battery chargers and generally increases the life of a battery by reducing heat during the charging process. These chargers also tend to increase battery performance.

Charging

- ***Pulse Charging***

One of the advanced charging methods currently being evaluated eliminates the practice of requiring constant current and/or constant voltage by "pulsing" voltage. A series of very high current and voltage pulses are applied until the battery voltage reaches a set value.

Boost charging

The major advantage of a pulse charger is the significant reduction in heat which allows the charger to operate at a high voltage rate even when the battery is almost full. Additionally, the reduction in heat results in a reduction in "lost" energy. Thus, pulse charging can significantly reduce charging time and are more energy efficient.

- **Charger Location/Coupling Options**

Electric vehicle battery chargers may be onboard (in the electric vehicle) or offboard (at a fixed location). As with many options, there are advantages and disadvantages with both types.

If the battery charger is onboard, the batteries can be recharged anywhere there is an electric outlet. The drawback with onboard chargers is the limitation in their power output because of size and weight restrictions dictated by the vehicle design.

Offboard charges are limited in their power output only by the ability of the batteries to accept the charge. While the EV owner can shorten the time it takes to recharge the batteries with a high-power, offboard charger, the flexibility to charge at different locations is restricted.

Charging Methods

- Coupling methods

There are two basic coupling methods used to complete the connection between the utility power grid, the battery charger, and the vehicle connector. The first is the traditional plug (called conductive coupling). With this connection, the EV operator plugs his vehicle into the appropriate outlet (i.e. 110 or 220 volts) to begin charging. This type of coupling can be used with the charger in the car (onboard) or out of the car (offboard).

The second type of coupling is called inductive coupling. This type of coupling uses a paddle which fits into a socket on the car. Rather than transferring the power by a direct wire connection, power is transferred by induction, which is a magnetic coupling between the windings of two separate coils, one in the paddle, the other mounted in the vehicle.

Charging Methods

- Inductive Charging

The inductive charger has no direct electrical connection to the vehicle. A weatherproof paddle transfers power to the vehicle’s charge port via magnetic field . The Delco off-vehicle chargers provides a safe and easy-to-use system for EV charging. Inserting the charge coupler is all that is required to initiate charging. Charging can be terminated at any time by removing the coupler. Bi-directional communication and built-in diagnostics ensure a safe connection and prevent the vehicle from being driven while connected.

Charging Methods

Charge Levels

Chargers are also classified by the level of power they can provide to the battery pack:

Level 1 - Common household type of circuit, rated to 120 volts/AC and rated to 15 amps.

Level one chargers use the standard household 3-prong connection and they are usually considered portable equipment.

Level 2 - Permanently wired electric vehicle supply equipment used specially for electric vehicle charging and it is rated up to 240 volts/AC, up to 60 amps, and up to 14.4 kilowatts.

Level 3 - Permanently wired electric vehicle supply equipment used specially for electric vehicle charging and it is rated greater than 14.4 kilowatts. Fast chargers are rated as Level 3 chargers. However, not all Level 3 chargers are considered as fast chargers. This depends on the size of the battery pack to be charged and how much time is required to charge the battery pack. A charger can be considered a fast charger if it is capable of charging an average electric vehicle battery pack in 30 minutes or less.

Battery Management

With so many differences in chargers and charging methods, there existed a need to monitor the status of the batteries being charged and discharged.

Battery Management Systems (BMS) have been developed which are microprocessor controlled allowing charge algorithms to be programmed into the system for virtually all the different battery types.

These systems monitor the energy consumed by the vehicle while being driven, as well as temperature, individual cell voltages and total pack voltage. The same process is monitored in reverse during charging creating a safety net in the event of problems with a single cell within the battery pack.

Battery Management

- With existing electric vehicles and battery chargers, it usually takes from several hours to overnight to recharge an electric vehicle battery pack. The time required to recharge electric vehicle batteries depends on the total amount of energy that can be stored in the battery pack, and the voltage and current (i.e., power) available from the battery charger.

- New developments in battery recharging decreases the time required to recharge electric vehicle batteries to as little as 10-15 minutes. For example, pulse battery chargers have demonstrated that the EV battery pack can be recharged in under 20 minutes without damaging it. When this technology is fully deployed, electric charging stations, similar to gas stations, will allow the electric vehicle operator to quickly recharge the battery pack.

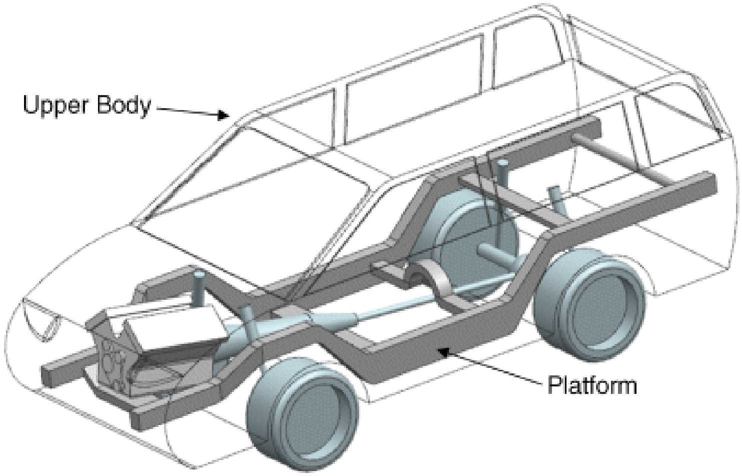
- This new charger technology, coupled with advanced batteries with a range of 200 miles between recharging, will allow the electric vehicle operator the same freedom of the road currently enjoyed by today's operators of gasoline-powered vehicles.

Chassis

One of the main challenges during design of Chassis is optimizing energy consumption for EVs and HEVs, which have limited on-board energy.

As such, constructing lightweight body, chassis, and chassis systems should be a primary focus of the design process.

Likewise, accommodating a heavy and oversized battery pack into the chassis and body design is another challenge. For these reasons, it is important to study the design and technology behind the body, chassis, and chassis systems.



A car can be divided into two main parts: the platform and the upper body.

The definition of a platform varies based on the car manufacturer, but it generally refers to the chassis structural members, chassis systems, and the powertrain.

The design and configuration of the platform includes the most significant technological, functional, and costly components of the vehicle. These components help determine the vehicle's general size, strength, and performance.

In some vehicles (mainly commercial and heavy-duty vehicles), the chassis is an independent ladder frame on which the body, chassis systems, and powertrain are directly mounted. This configuration is known as body-on-frame; and it allows the vehicle platform to be physically separated from the vehicle body as an independent system.

In contrast, the unibody construction of most passenger cars consists of a chassis structure integrated into the body floor. This configuration does not allow separation of the platform and body as two independent systems.

Designing and producing a platform are significantly more challenging, costly, and time-consuming, than developing an upper body. As a result, car manufacturers try to keep platform designs unchanged between different generations of cars, and share these designs between different car models.

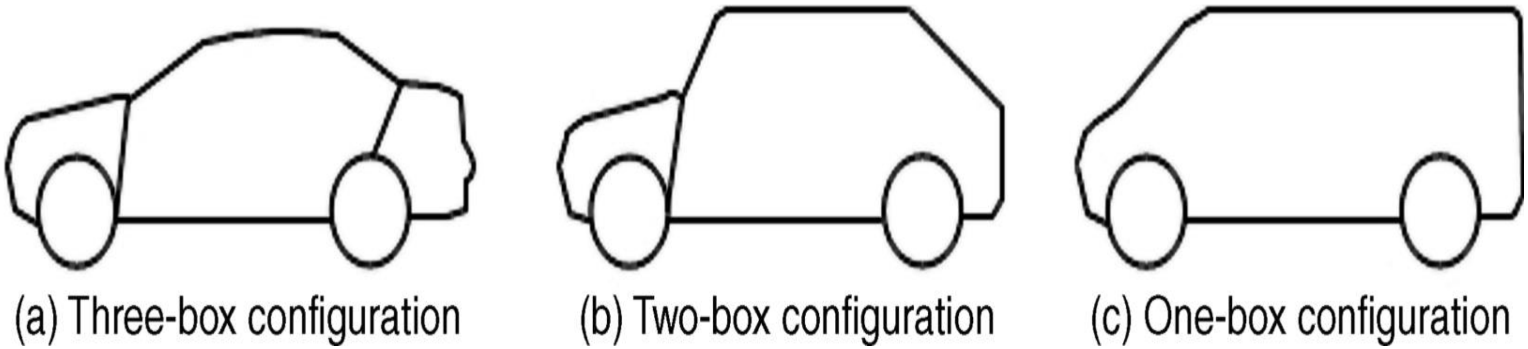
A modern car is often based on combining upper bodies of different styles and classes with a shared platform design. Platform consolidation significantly reduces the time and cost associated with vehicle development.

- As previously mentioned, the car platform includes the chassis structural parts and systems, as well as the vehicle powertrain. Whether the chassis is an independent ladder frame or an integrated unibody configuration, its structural members play an essential role in the strength, noise and vibration characteristics, and crashworthiness of the vehicle.

- Chassis systems are directly connected to the chassis. They include the suspension, steering, and brake systems, and significantly affect performance features such as comfort, handling, and safety. Cars exhibit either comfort or sporty characteristics based on the design and adjustment of the chassis systems.

- The powertrain produces and transfers driving power to the vehicle wheels; it also determines important factors such as vehicle acceleration, speed, gradeability, fuel consumption, and emission levels.

- Lastly, the upper body forms the exterior and interior styles of the vehicle. It functions as a protective barrier for vehicle occupants, and also houses trim parts and body systems.



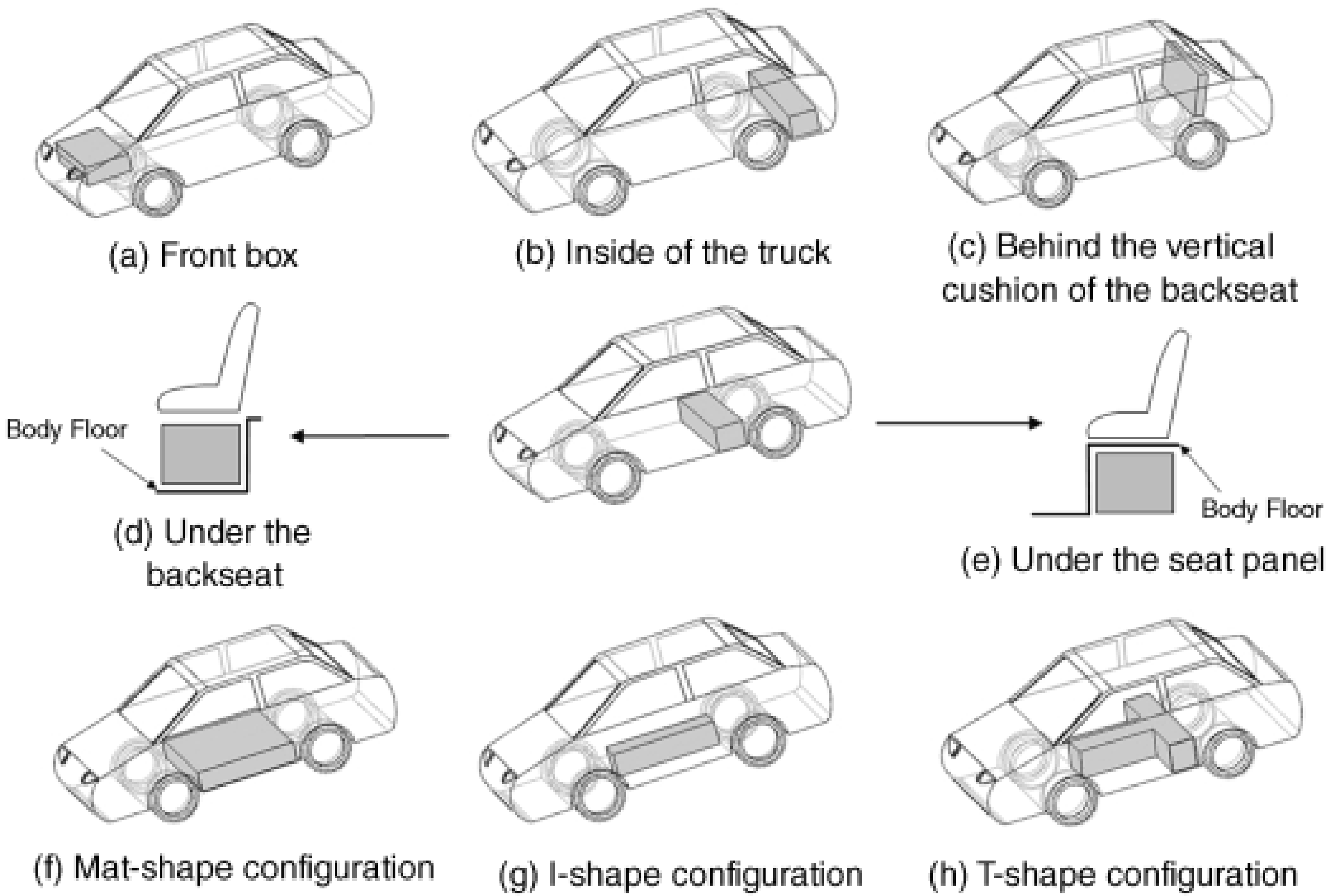
The three-box configuration is the most popular, and is typically used by sedan cars. As seen in Figure ,a three-box configuration vehicle consists of three individual boxes: the front box for powertrain and other mechanical components; the central box for passengers; and the rear box for luggage and cargo.

Specific Considerations in Body and Chassis Design of Electric and Hybrid Electric Vehicles

- Packaging is a key challenge for chassis and body designers for EVs and HEVs. One of the major hurdles for engineers to overcome is the placement of a large battery pack(s). This issue is an even greater concern for pure electric vehicles, which need significantly larger battery packs.

- Similarly, car body designers face a different challenge for HEVs powered by two independent electric and internal combustion power sources. Instead of accommodating large battery packs, they must ensure there is adequate space for both power sources without affecting the passenger and cargo spaces.

- As a result, efficient packaging is essential for the body and chassis design of electric and hybrid electric vehicles. The next section further discusses the packaging problems described above.



Different feasible alternatives for battery pack location

(1) Battery Pack Packaging

Since the battery pack is fairly heavy and sensitive, determining its placement requires consideration of the following factors:

- *Structural factors:* The weight of the battery pack should be supported by the main longitudinal and lateral structural members of the chassis. Generally, the front and rear rails, sills, and central tunnel are capable of supporting the battery pack load. As such, the battery pack should be located as close to these elements as possible. Furthermore, designers need to ensure that redesigning or reworking the car body for battery pack placement does not adversely affect the overall bending and torsional performance of the car body structure.
- *Protection against crash impact:* The high sensitivity and cost of batteries make it important to protect them against crash impact. Designers should also consider the ability of batteries to harm passengers in the event of a collision. First, battery packs are capable of penetrating the passenger compartment area due to their concentrated heavy mass. Second, batteries may explode or catch fire during a crash. Thus, it is important to place the battery pack away from the front, rear, and side crash zones. While the central box is the ideal location to host the battery pack because of its safe location, it is sometimes impossible to place the battery pack there due to other design considerations.
- *Handling and stability:* To improve the vehicle handling and rollover threshold, the vehicle's center of gravity must be kept close to the road surface. This can be achieved by installing the battery pack as low as possible. Moreover, the location of the battery pack can also strongly affect the longitudinal and lateral position of the vehicle's center of gravity. As such, engineers must carefully determine the longitudinal and lateral position of the battery pack to maintain the appropriate balance between the normal force of the front/rear and left/right wheels.
- *Protection against the road effects:* The battery pack must be able to withstand road-splashing and denting. Moreover, the location of the battery pack must be as far above the road as possible, or shielded.

(2) **Powertrain Packaging**

In modern electric vehicles, one or more electric motors replace the internal combustion engine. The gearbox is either eliminated or relegated to a small fixed-ratio gearbox. Due to the specific torque-speed performance curve of electric motors, EVs do not usually need the multi-speed gearboxes of conventional cars.

An electric powertrain includes an electric motor, its incorporated controller, and a transmission system. Generally, a typical electric powertrain system occupies less space than a typical internal combustion engine powertrain. Smaller electric powertrain systems can provide additional space for other components such as batteries.

THANK YOU