Unit 3: Retrofitting fuel-based vehicles to EV

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreement No. 101037141. This material reflect only the views of the Consortium, and the EC cannot be held responsible for any use that may be made of the information in it.

In this lesson:

- General Vehicle retrofitting definition
- Fuel-based Vehicle to EV Retrofitting Considerations
- Sizing of the main components
- EV main components selection
- Step by step conversion procedure

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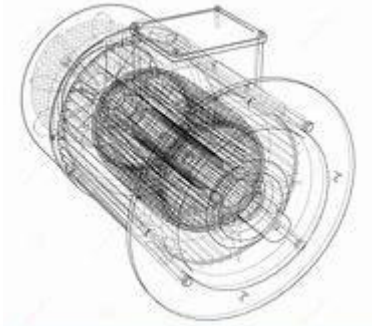
General Vehicle Retrofitting Definition

Vehicle retrofitting is the process of upgrading or modifying existing vehicles to enhance their performance, functionality, or environmental sustainability.

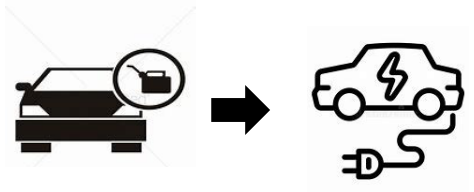
It involves incorporating new technologies, components, or systems into the vehicle's existing structure, thereby transforming it to meet changing standards, regulations, or user requirements.



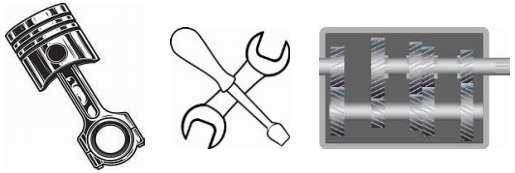
Can include various aspects such as improving fuel efficiency, advanced safety features, upgrading communication systems, or converting vehicles to alternative energy sources.

Fuel-based Vehicle to EV Retrofitting Considerations

Transformation of a traditional gasoline-powered vehicle into an electric vehicle (EV) by replacing its internal combustion engine and related components with an electric powertrain.



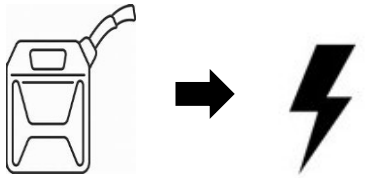
Involves removing the gasoline engine, fuel tank, and exhaust system, and installing an electric motor, batteries, a power control unit, and other components.



Some conversion use the same gearbox from the conventional vehicle, depending on the different user requirements.

May include integrating regenerative braking systems, charging infrastructure, and updated electronic controls to ensure proper functionality and safety.

The objective is to enable the vehicle to operate solely on electricity, reducing reliance on fossil fuels and contributing to a more sustainable transportation system.



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Sizing of the main components

The main components to be sized are:

- Electric Motor => Is the machine that moves the vehicle
- Battery Pack => Is the device that storages the energy for the movement.
- Power Electronics => Inverters, converters, and controllers that manage the electric power.
- Onboard Charger (OBC) => Converts external AC power into DC power to charge the battery pack.
- Vehicle Control Unit (VCU) => Controls all the systems and subsystems.
- Charging port => Port where the EV is connected to a charging station.

Sizing of the main components

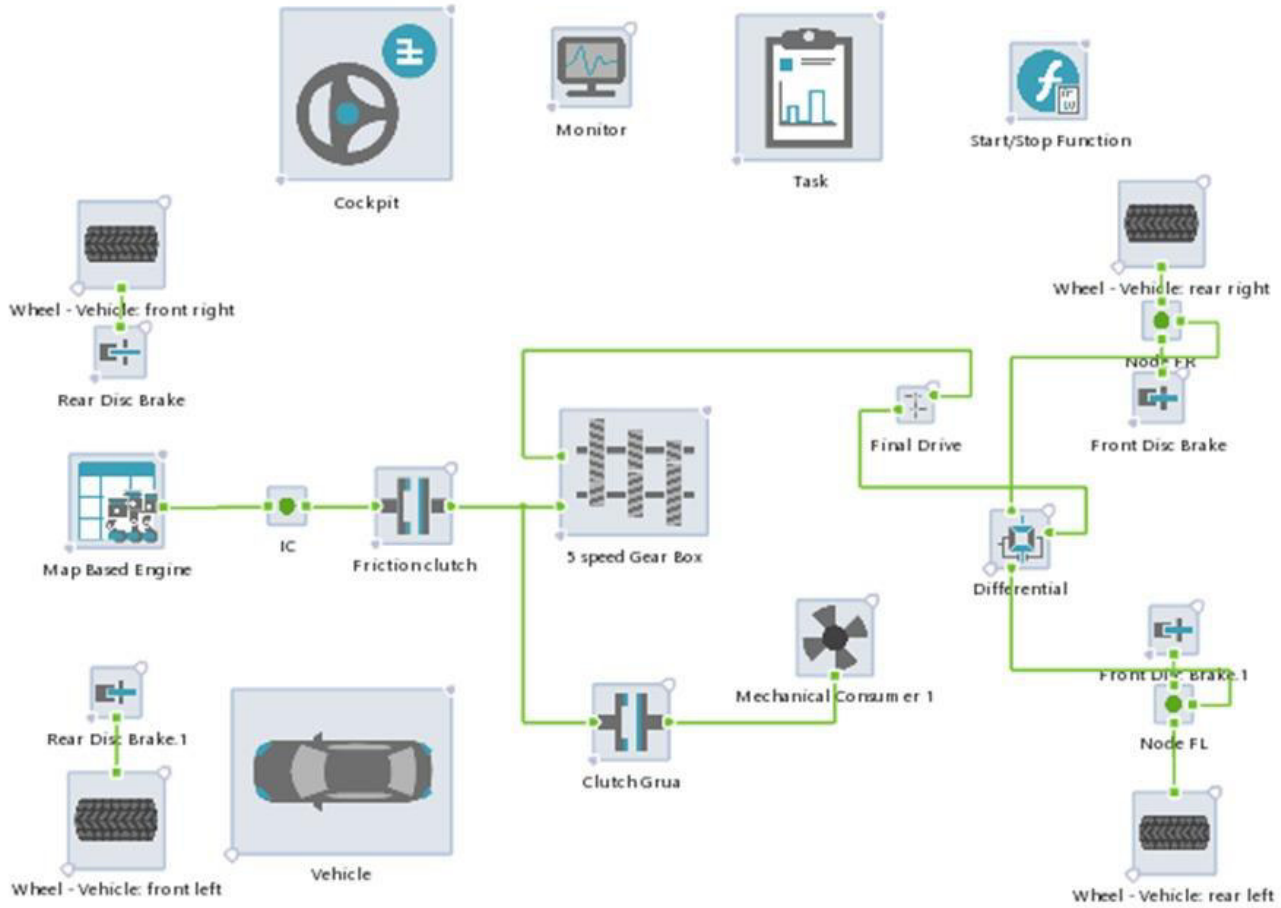
How to size the components:

1. Modelling the vehicle in a proper software (i.e. GT-Suite® / AVL® / others)
2. By using equations considering the main vehicle variables and performance requirements

Sizing of the main components

Modelling by software.

1. A proper Software is required
2. Medium-high level of engineering
3. Must be applied for medium-big projects



AVL ® software diagram print screen.

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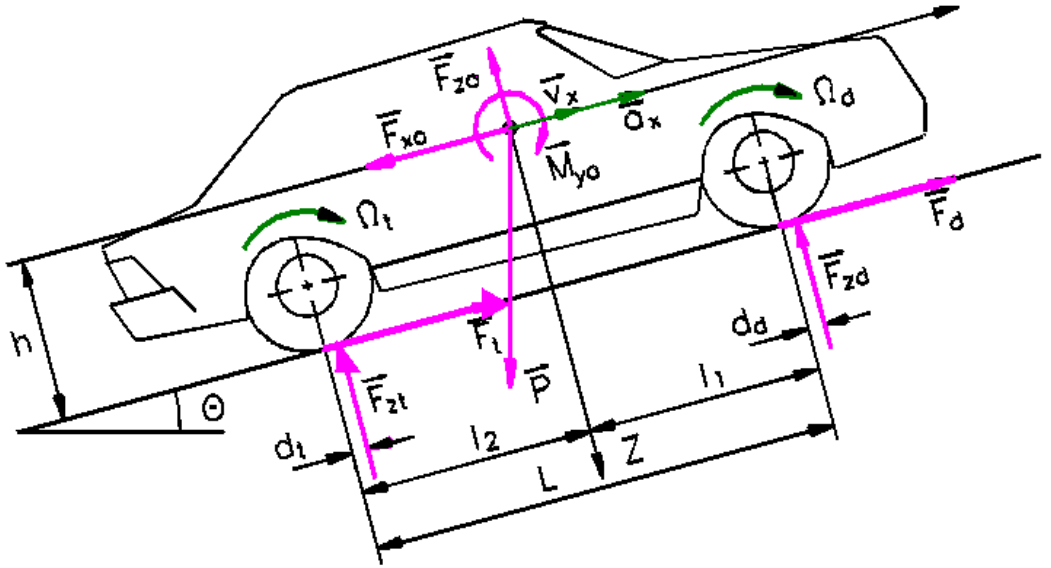
Sizing of the main components

Modelling by using equations

1. No Software is required
2. Most simple method
3. Used for small projects
4. Main vehicle characteristics are required
5. Max. acceleration, max. climbing capacity, max. speed.



Free body diagram, with the forces acting on the vehicle. (Source: www.digestiblenotes.com/physics)

Sizing of the main components

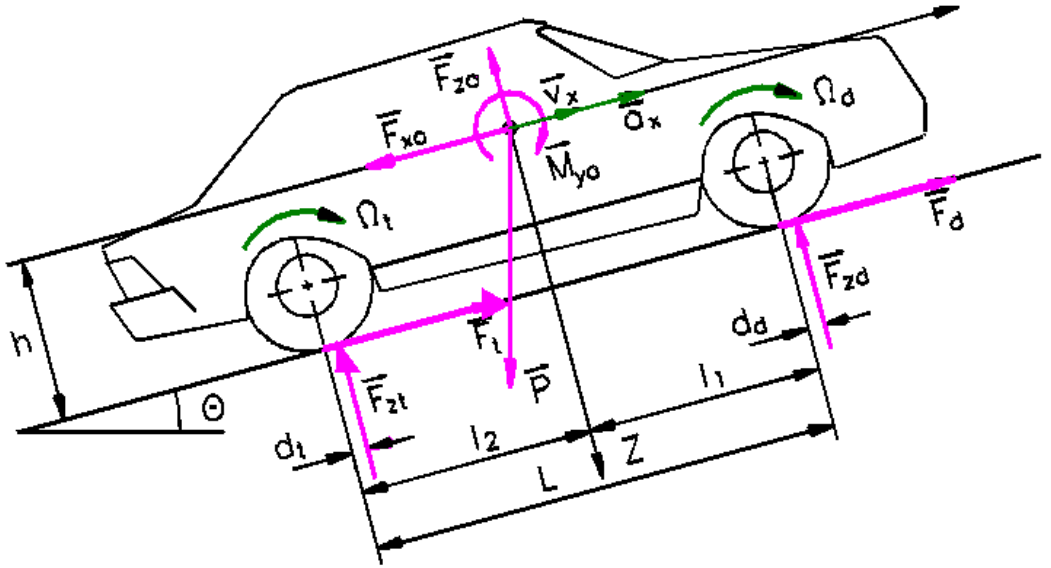
Traction power equation:

$$P_t = \frac{m\gamma_m}{2t_a}\left(V_f^2 + V_b^2\right) + \frac{2}{3}mgf_rV_f + \frac{1}{5}\rho_a C_X A_f V_f^3$$

Max. Speed component

Max. Climbing capacity component

Max. Acceleration component



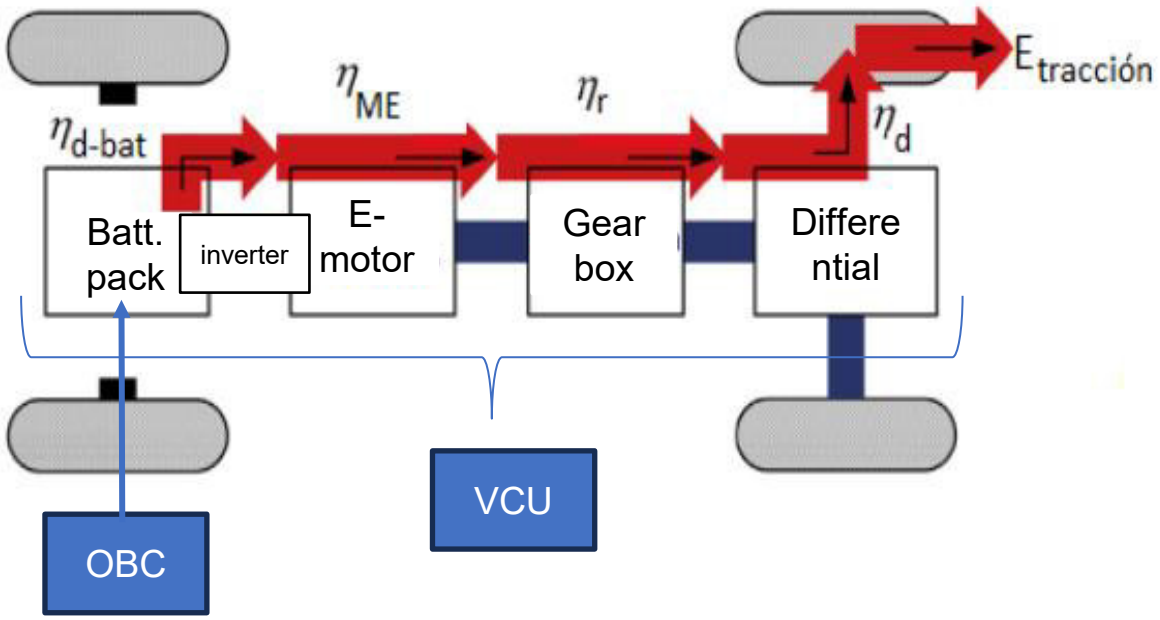
Free body diagram, with the forces acting on the vehicle. (Source: www.digestiblenotes.com/physics)

EV main components selection

1. Electric motor
2. Battery pack
3. Inverter
4. Vehicle control unit (VCU)
5. Onboard Charger (OBC)

Secondary components:

- DC-DC converter
- Peripherals

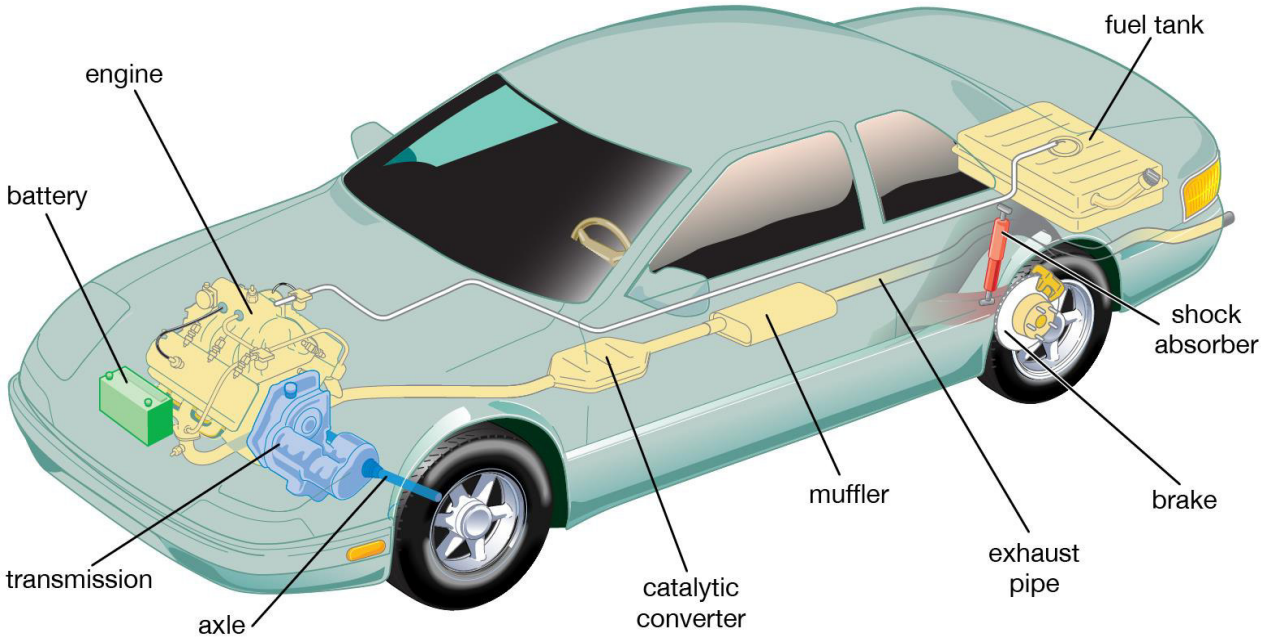


Electric vehicle main components and energy flow diagram.

Step-by-step conversion

Remove the internal combustion engine (ICE) and its related vehicle components:

1. ICE and its accessories
2. Fuel tank
3. Exhaust system
4. Cooling system
5. Other minor ICE related components

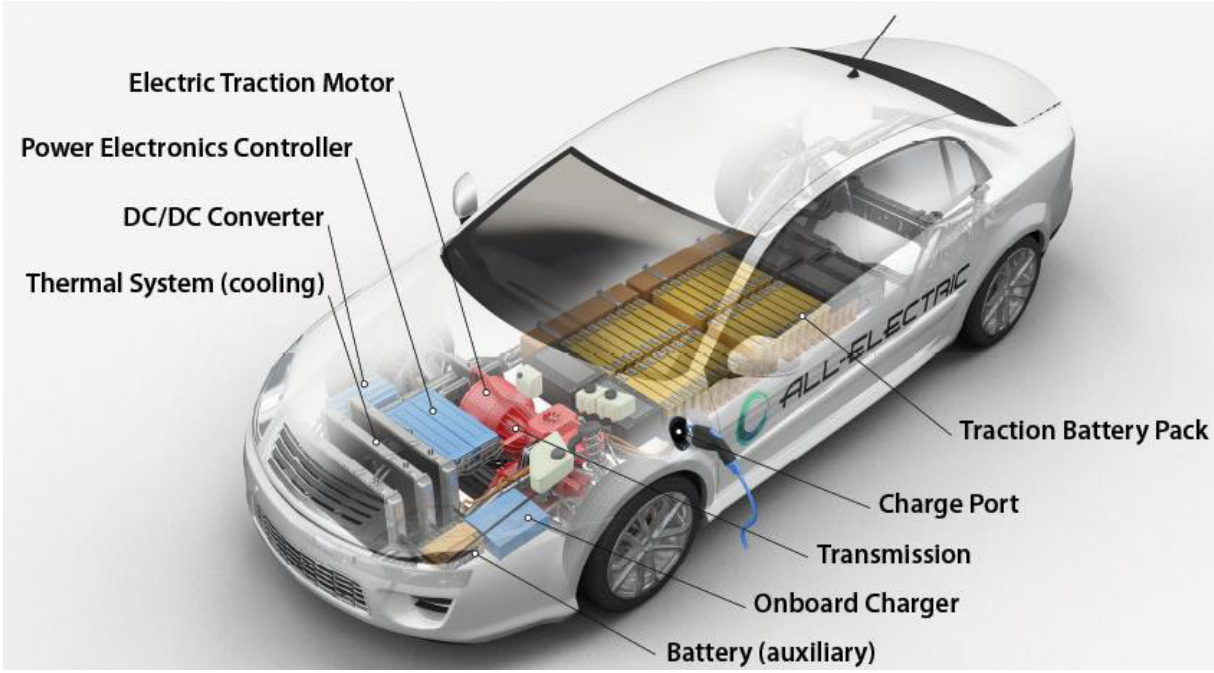


Conventional vehicle main powertrain components. (Source: www.britannica.com/technology/automobile)

Step-by-step conversion

EV assembly:

1. Electric Motor and Battery Installation
2. Power Electronics and Control Systems
3. Charging Infrastructure
4. Auxiliary Systems and Integration
5. Commissioning, Testing and Quality Assurance
6. Compliance and Certification / homologation
7. User Education and Support



Conventional vehicle main powertrain components. (Source: www.afdc.energy.gob)

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THANK YOU

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