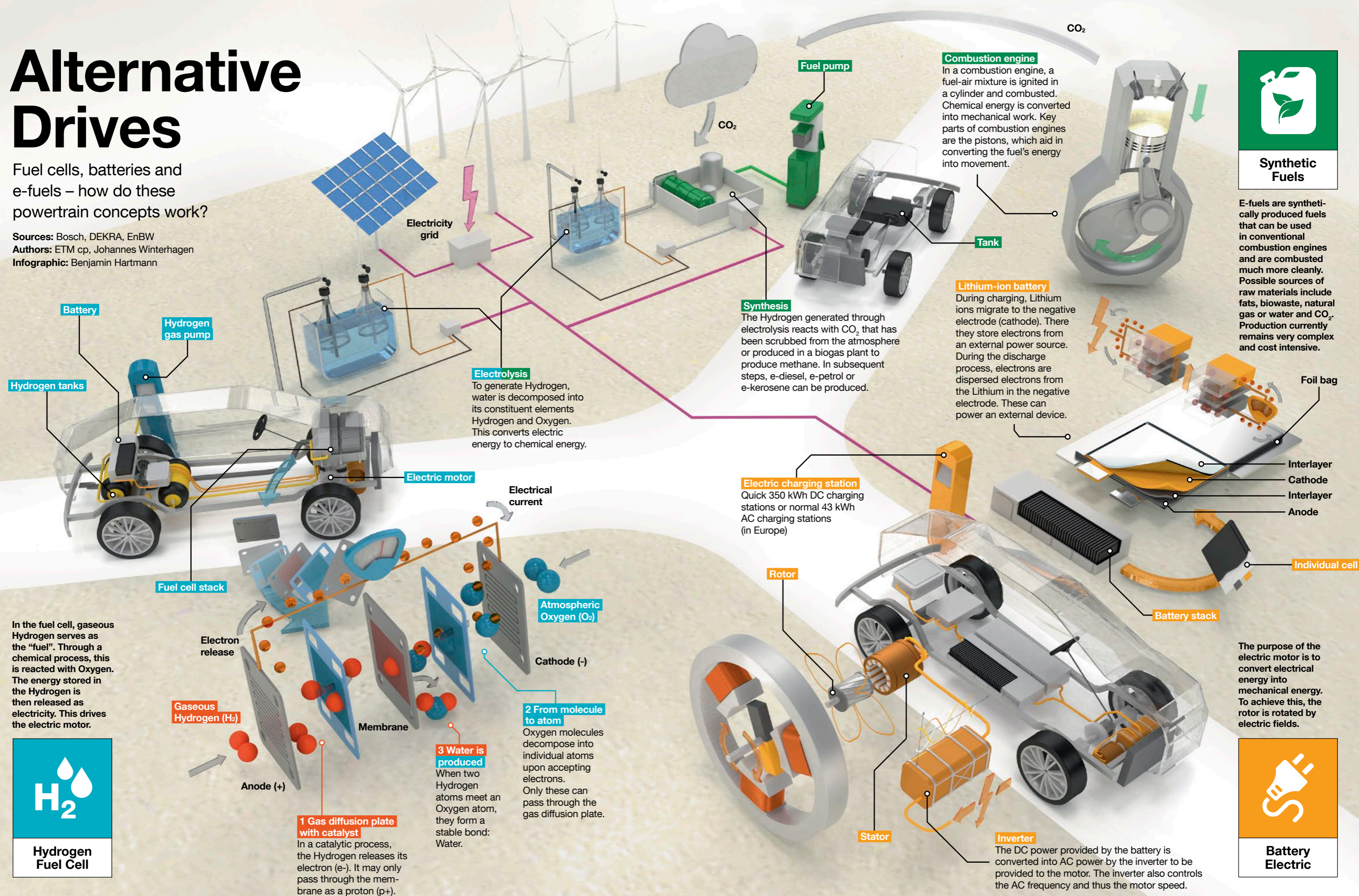


Alternative Drives

Fuel cells, batteries and e-fuels – how do these powertrain concepts work?

Sources: Bosch, DEKRA, EnBW
 Authors: ETM cp, Johannes Winterhagen
 Infographic: Benjamin Hartmann



Synthetic Fuels

E-fuels are synthetically produced fuels that can be used in conventional combustion engines and are combusted much more cleanly. Possible sources of raw materials include fats, biowaste, natural gas or water and CO₂. Production currently remains very complex and cost intensive.

Combustion engine
 In a combustion engine, a fuel-air mixture is ignited in a cylinder and combusted. Chemical energy is converted into mechanical work. Key parts of combustion engines are the pistons, which aid in converting the fuel's energy into movement.

Synthesis
 The Hydrogen generated through electrolysis reacts with CO₂ that has been scrubbed from the atmosphere or produced in a biogas plant to produce methane. In subsequent steps, e-diesel, e-petrol or e-kerosene can be produced.

Lithium-ion battery
 During charging, Lithium ions migrate to the negative electrode (cathode). There they store electrons from an external power source. During the discharge process, electrons are dispersed from the Lithium in the negative electrode. These can power an external device.

Electrolysis
 To generate Hydrogen, water is decomposed into its constituent elements Hydrogen and Oxygen. This converts electric energy to chemical energy.

Battery
Hydrogen gas pump
Hydrogen tanks

In the fuel cell, gaseous Hydrogen serves as the "fuel". Through a chemical process, this is reacted with Oxygen. The energy stored in the Hydrogen is then released as electricity. This drives the electric motor.

Hydrogen Fuel Cell

1 Gas diffusion plate with catalyst
 In a catalytic process, the Hydrogen releases its electron (e-). It may only pass through the membrane as a proton (p+).

2 From molecule to atom
 Oxygen molecules decompose into individual atoms upon accepting electrons. Only these can pass through the gas diffusion plate.

3 Water is produced
 When two Hydrogen atoms meet an Oxygen atom, they form a stable bond: Water.

Atmospheric Oxygen (O₂)
Cathode (-)
Membrane
Anode (+)
Gaseous Hydrogen (H₂)
Electron release

Electric charging station
 Quick 350 kWh DC charging stations or normal 43 kWh AC charging stations (in Europe)

Foil bag
Interlayer
Cathode
Interlayer
Anode
Individual cell
Battery stack

The purpose of the electric motor is to convert electrical energy into mechanical energy. To achieve this, the rotor is rotated by electric fields.

Battery Electric

Rotor
Stator
Inverter
 The DC power provided by the battery is converted into AC power by the inverter to be provided to the motor. The inverter also controls the AC frequency and thus the motor speed.