THE ROAD TO ELECTRIFICATION

Society is demanding cleaner and quieter alternatives to gasoline and diesel-powered engines, and the transportation industry is responding. For years, scientists and engineers have been developing cleaner ways to run cars and trucks. Alternative fuels such as ethanol, biodiesel, natural gas, hydrogen, and propane have been developed and used to move people and goods from place to place. And although it will not be the sole form of clean fuel, the future of transportation will undoubtedly include electric propulsion. From a curiosity, to a rarity, to a reality, electric vehicles (EVs) are clearly on a path to becoming a necessity.

VEHICLE ELECTRICATION

PROS

CLEANER.
Reduced/zero tailpipe emissions. Noise reduction/quiet operation.

GREENER.
CO_2 methane, and other greenhouse gas reduction. Fossil fuel consumption reduction. Wind and solar generating the electricity.

LEANER.
Total cost reduction (over time). Vehicle and battery costs are rapidly decreasing. Lower maintenance costs. No oil changes. Fewer moving parts means reduced wear and tear. In the short-term, incentives are available.

MEANER.
Improved performance and comfort. Instant torque available. Low center of gravity for improved ride and handling. Regenerative braking. Quiet operation. Low vibration. Direct drive – no gears to shift.

CONCERNS

RANGE ANXIETY AND POWER ACCESS.
Concern over access to fast, reliable and available charging points. Is the energy grid globally ready to handle all the anticipated demand? Can vehicles be easily upgraded to handle more power as battery technology improves?

BATTERY LIFE AND SUSTAINABILITY.
Although technology is advancing rapidly, how long will batteries last and what do we do with them after their useful life?

ELECTRICITY CAN BE DANGEROUS.
Concerns over shock/electrocution. In an accident, am I safe? Is it safe to charge the vehicle in the rain or if the cable is wet?

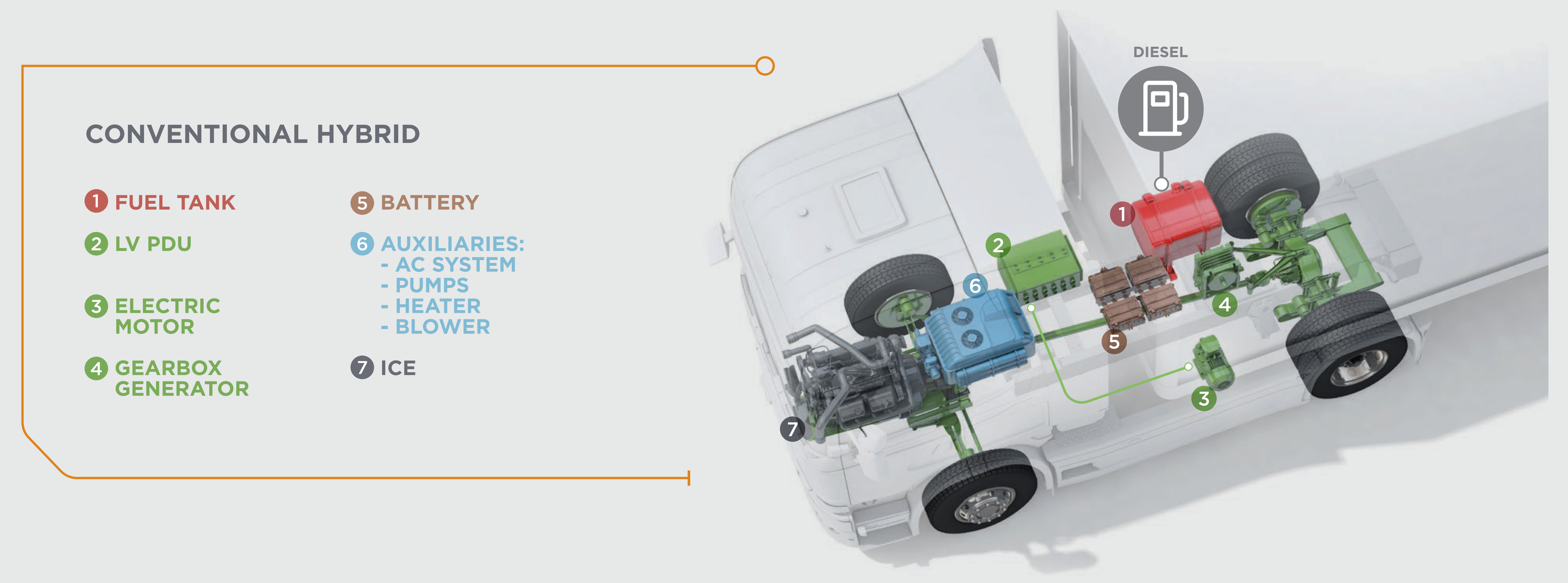
UPFRONT COSTS.
Even if the lifetime cost of electrification proves to be less expensive to operate, the cost of entry may prove to be higher than status quo.

VARIOUS ARCHITECTURES

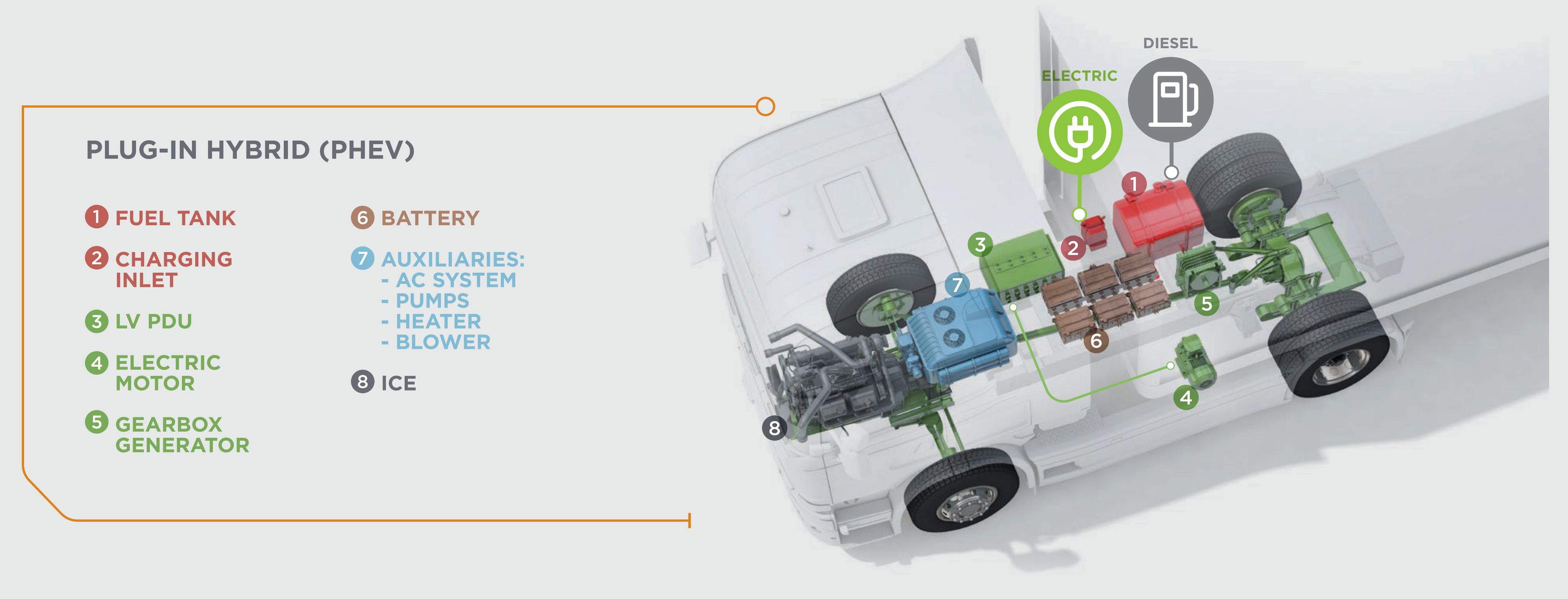
LV – Low Voltage. HV – High Voltage. PDU – Power Distribution Unit.

Electric and hybrid vehicles equipment complex and diverse, so are the possible vehicle architectures being developed to enable cleaner transportation. Today's vehicles whether industrial, commercial or consumer, are typically powered by internal combustion engines driving two or more wheels through a transmission.

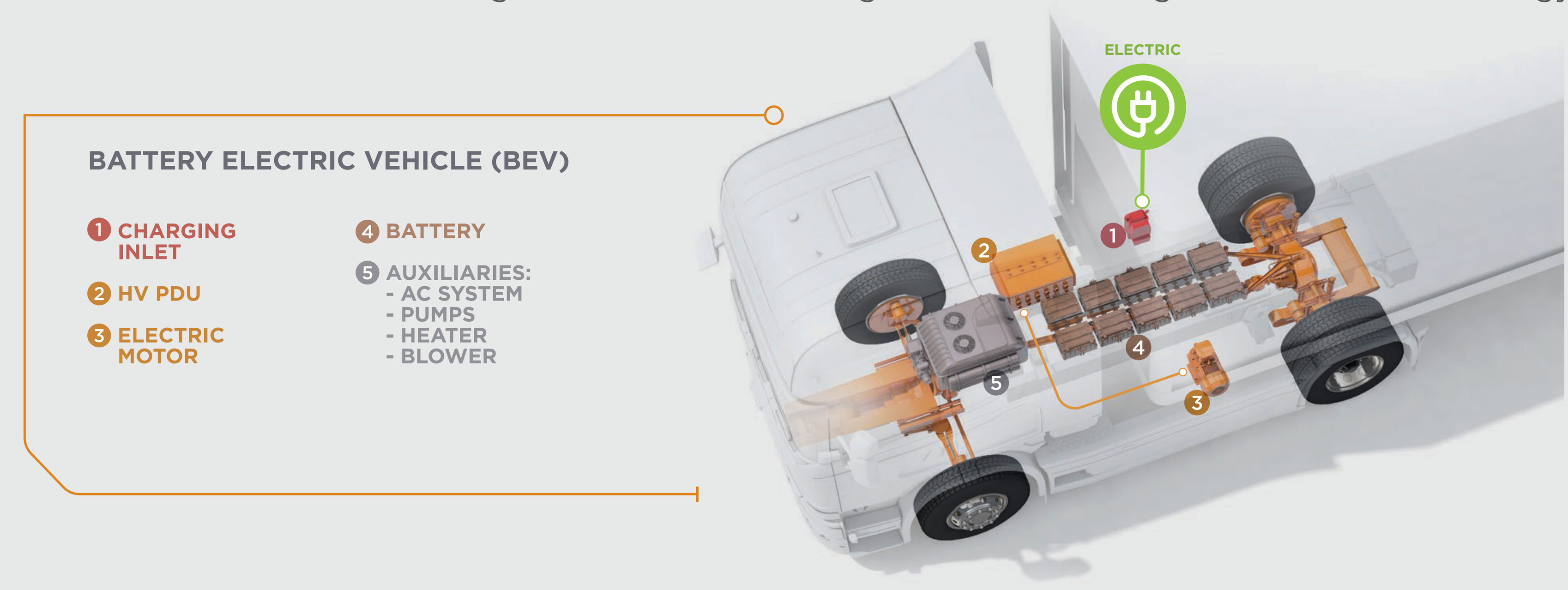
CONVENTIONAL HYBRIDS These hybrid architectures have conventional engines and electric motors and batteries, but cannot be plugged in. They derive their power from gasoline and diesel and thus are not categorized as electric vehicles. A mild hybrid typically utilizes a small electric motor and 48V battery combined with an ICE, allowing for assisted acceleration and regenerative braking. A strong, or parallel hybrid, will generally consist of a larger electric motor and battery combined with a downsized ICE utilizing regenerative braking and electric motor drive.



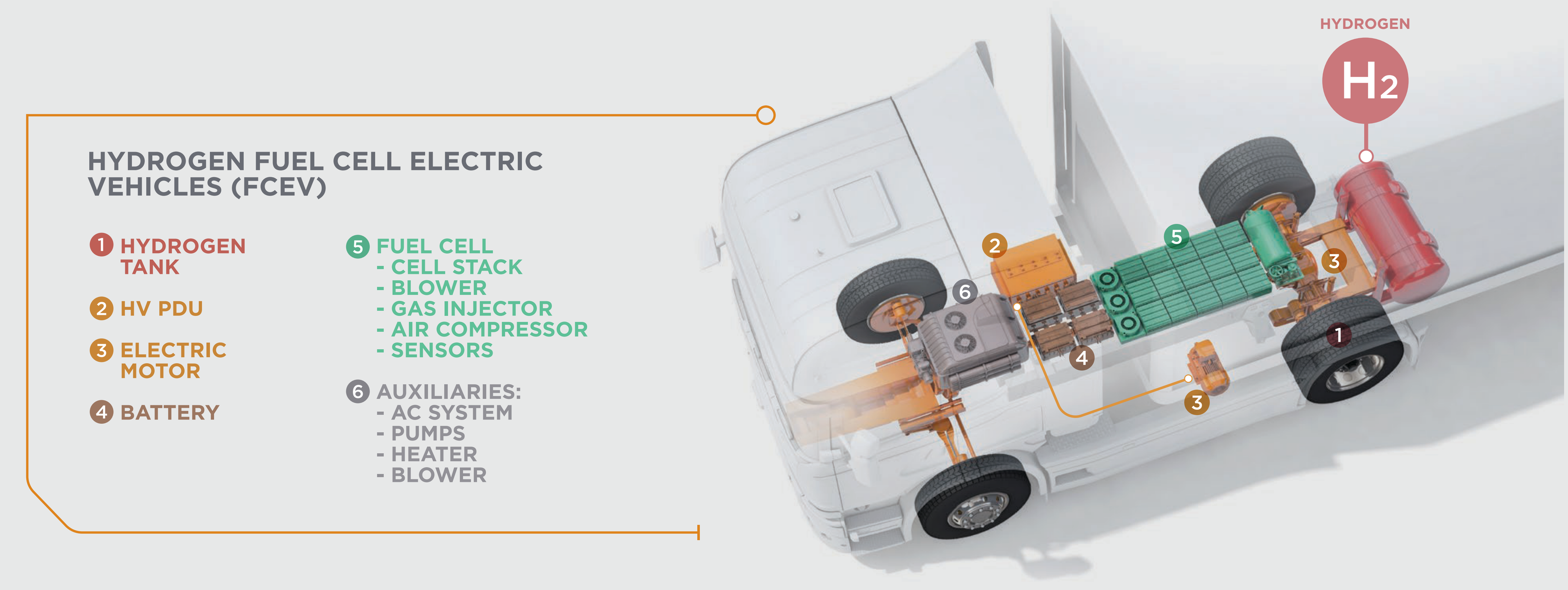
PLUG-IN HYBRIDS Plug-in hybrid electric vehicles (PHEVs) are similar to battery electric vehicles, typically with a smaller battery, but also have a conventional gasoline or diesel engine. Although not as clean as battery electric or fuel cell vehicles, plug-in hybrids produce significantly less pollution than their conventional counterparts. Series PHEVs are typically referred to as range extenders, with the ICE's primary purpose to charge the battery on the go.



BATTERY ELECTRIC VEHICLE (BEV) BEVs use stored energy in a battery to drive electric motors. The operating voltage can be as low as 48V and as high as 850V, depending upon the application. This offers them increased efficiency and, like fuel cell vehicles, allows them to drive emissions-free when the electricity comes from renewable sources. BEVs use existing infrastructure to recharge and are increasing the demand on the energy grid.



HYDROGEN FUEL CELL ELECTRIC VEHICLE (FCEV) The source of power is an on-board fuel cell that generates electricity from hydrogen, either to charge a battery or to drive the electric motors. FCEVs require a hydrogen fueling infrastructure which is not always emissions-free and not broadly available today.



Performance Materials:

An underlying solution to complex electrification design requirements

Heat Shrink Tubing - 6 Key Functionalities

PROTECTION
WHERE YOU NEED IT

Insulation
Protects and minimizes heat transfer for solid thermal and electrical insulation with operating temperatures ranging from -55°C to 150°C

Strain Relief
Allows for greater flexibility in areas where stress can cause failures such as connector pins and splices, enabling a reliable connection

Protection
Against the harshest environments with cut through, chemical, fluid, abrasion and anti-fungal resistance

Sealing
Keeps out moisture, water, bacteria, fuels, and fungus

Identification and Safety
Helps identify wires for grounding and color coding capabilities to reduce safety hazards

Why choose TE's Heat Shrink Tubing?

Versatility and Durability
Designed to keep out moisture, harsh chemicals, and protect from mechanical interface.

Safety
Thick-tubing to secure extra protection, many color options for easy identification, and various levels of flame retardancy to meet UL VW-1 flammability standards.

Easy and Quick Installation
When heated, heat shrink tubing conforms to the size and shape of the substrate beneath, enabling quick and easy installation. It provides shorter application time, improves yield, and provides higher operating temperature.

Reliable, Robust Cross-linking Technology
Cross-linking technology modifies the molecular structure of a polymer, allowing the tubing to withstand high temperatures without melting - a critical factor in harsh environments.

Sealing | Vibration | Temperature

Electromagnetic Compatibility & Performance Considerations

Electromagnetic Compatibility (EMC): The ability of a device, equipment, or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance to anything in that environment.

Here are some of the factors affecting electromagnetic compatibility:

Design for EMC: Consider EMC early in the design process, from careful layout of PCB's and components ensuring good signal integrity. Design with the accommodation of EMI gaskets for enclosure seams and covers, I/O connections, doors etc. Retrofit is expensive.

Mechanical: Closure forces of gaskets vary dependant on material, profile, and size. Enclosure panel rigidity will dictate the minimum number of fixings. Compression limits should be used to protect the gasket from damage caused by over compression/deflection.

RFI/EMI Shielding: The basis of RFI/EMI shielding to make a faraday cage of the enclosure and ensure good grounding, this can be at PCB level for discreet components, modular and the final enclosure. Enclosures can vary in size from small handheld devices up to large cabinets and architectural rooms/buildings.

Shielding Effectiveness: To ensure good shielding effectiveness, low contact resistance is required between the gasket and the mating surface of the enclosure. For optimum shielding it is best to ensure metal to metal contact by using gaskets in grooves or incorporate labyrinth designs.

Environmental: Dust and moisture sealing is often a requirement alongside the EMC needs. Electrically conductive elastomers (ECE) provide this up to IP66 and above if the design is to achieve this. ECE fluorosilicones will seal against fuels, oils etc. For very harsh environments non-conductive seals can be incorporated in the design.

Chemical or Galvanic Compatibility: Two dissimilar metals in the presence of an electrolyte e.g. salt fog will act as a battery and create a flow of electric current. This effect can cause corrosion of the less noble material and will increase contact resistance between the gasket and enclosure causing a reduction in shielding effectiveness.

Electromagnetic Fields: When shielding magnetic fields generally the requirement is 10 kHz and above, high permeability metal type gaskets are needed these gaskets have a high current carrying capacity and are suitable for EMP protection. High frequency electric field 1 GHz and above require highly conductive more noble materials such as conductive elastomers with silver plated particles.