TECHNOLOGY READINESS LEVEL (TRL) - 2023

IEA Technology Collaboration Programme
Advanced Fuel Cells

TECHNOLOGY DETAILS

Technology: **Hydrogen fuel cell electric vehicle**
Sub-technology: **Polymer electrolyte membrane fuel cell as range-extender**

Value chain: Road
Sub-sector or technology: Vehicle/aircraft/vessel and components
Sector: Transport
Demand/Supply/Infrastructure: Demand

TRL 2023: 8

According to IEA criteria, the TRL of this technology in 2021 was: **7**
Numerous OEM has announced of light commercial vehicles and mass production powerplant

TECHNOLOGY DESCRIPTION

A hydrogen fuel cell system generates electric power from hydrogen. Fuel cell electric vehicles (FCEV) have much smaller batteries than battery electric vehicles (at least by a factor of 10), as the energy is stored in the hydrogen. By exploiting the higher gravimetric energy density of hydrogen, FCEVs can offer a higher range than BEVs. However, their continuing deployment faces multiple technical and economic challenges, including safety of hydrogen handling (refuelling, residual leakage), on-board hydrogen storage (see the dedicated entry below) and the high cost of the fuel cell stack (the electrochemical reaction inside the stack requires a proton exchange membrane (PEM) coated with a platinum-based catalyst, a costly material) and system. Costs of the fuel cell stack and system are expected to decline significantly with economies of scale.

For FCEVs to be competitive with other powertrain technologies, hydrogen must be delivered to hydrogen refuelling stations at prices that bring per kilometre costs into the same range as conventional ICEs, or of battery electric vehicles powered by grid electricity. This will require further cost reductions in technologies for low- and zero-carbon hydrogen production technologies (e.g. SMR with CCS, renewable electricity generation such as wind and solar coupled to electrolysers), as well as in hydrogen transmission and distribution networks and in hydrogen refueling stations (HRS). PEM fuel cell as range-extender is sized to only provide range extension to the battery electric powertrain.

KEY COUNTRIES

Japan, Korea, North America, France, Germany

PROTOTYPE OR DEMONSTRATION PLANS, DEDICATED INVESTMENTS, LEADING INITIATIVES

* Fuel cell manufacturers: Ballard, Symbio (joint venture between Michelin and Faurecia), among others

DEPLOYMENT TARGETS

More targets here: https://www.iea.org/reports/global-hydrogen-review-2021

By 2030:

* 1% Fuel cell truck sales in Europe

https://www.fch.europa.eu/sites/default/files/Hydrogen%20Roadmap%20Europe_Report.pdf

COST REDUCTION TARGETS

In the US, USD 30/kW for passenger cars USD 60/kW for medium- and heavy-duty trucks. In Europe, EUR 40/kW for passenger cars and EUR 600 / kW for buses.

RELEVANT PARAMETERS

Hydrogen purity	99.999%
Energy density	0.5 kWh/kg
Fuel cell efficiency (%)	65 %
Cost (€)	60 Euros/kW
Platinum loading	0.3 g/kW
Durability	15 000 hours

Based on expert input:

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