TECHNOLOGY READINESS LEVEL (TRL) - 2023

IEA Technology Collaboration Programme
Advanced Fuel Cells

TECHNOLOGY DETAILS

Technology: **Hydrogen fuel cell electric vehicle**
Sub-technology: **Light commercial vehicle**

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

TRL 2023: 9

According to IEA criteria, the TRL of this technology in 2021 was: **9**
In China, the fuel cell dominant LDV is at the stage of verification in the actual environment.

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).

PROTOTYPE OR DEMONSTRATION PLANS, DEDICATED INVESTMENTS, LEADING INITIATIVES

At the end of 2020, there were only about 50 fuel cell light commercial vehicles worldwide (GEVO 2021).

Isuzu, Toyota, Hino and Commercial Japan Partnership Technologies Corporation (CJPT) announced they would jointly plan and develop light-duty fuel cell electric trucks for the mass-market. Demonstration project has begun in January 2023. Approx. 300 HDV and LDV will be introduced for demonstration project (January 2023 to the end of FY 2029 (planned)).

DEPLOYMENT TARGETS

By 2030:

* 95,000 fuel cell trucks on European roads (2% of total stock).

* An order of magnitude of 10,000 new fuel cell truck sales per annum (c. 7% of annual sales)

* 5 million light-duty FCEVs operating by 2030 (1.5% of total stock)

* 750,000 new fuel cell LDV sales per annum (c. 5% of annual sales)

http://www.hydrogeneurope.eu/sites/default/files/2018-10/Public_HE%20Tech%20Roadmaps_full%20pack_0.pdf

KEY COUNTRIES

United States, China, Japan, Europe.

COST REDUCTION TARGETS

- In the US:
  USD 30/kW for passenger cars
  USD 60/kW for medium- and heavy-duty trucks
  (US DOE, 2019: http://www.energy.gov/sites/prod/files/2019/06/f63/fcto-satyapal-overview-for-ecs-meeting-2019-05-27.pdf), with revision for durability emerging from the DOE's latest end-of-year review:
  http://www.energy.gov/sites/prod/files/2019/06/f63/fcto-satyapal-overview-for-ecs-meeting-2019-05-27.pdf (slides 28-30)
- In Europe:
  EUR 45/kW for passenger cars
  < EUR 40,000 for complete system (fuel cell + tank) for buses
  http://www.hydrogeneurope.eu/sites/default/files/2018-10/Public_HE%20Tech%20Roadmaps_full%20pack_0.pdf
- Japan (2030 target) Fuel Cell system (Stack + BOP)
  JPY 4,000/kW for Passenger Vehicle
  JPY 9,000/kW for Heavy Duty Vehicle
  (NEDO, 2022 https://www.nedo.go.jp/content/100956710.pdf (Japanese only))

RELEVANT PARAMETERS

Energy density	01 kW/kg system; 0,6 kW/L
Fuel cell efficiency (%)	60%
Cost (€)	60€/kW
Platinum loading	0.19 kg / kW
Durability	50,000 h

Based on expert input:

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