TECHNOLOGY READINESS LEVEL (TRL) - 2023

IEA Technology Collaboration Programme
Advanced Fuel Cells

TECHNOLOGY DETAILS

Technology: **Molten Carbonates Fuel Cell (MCFC)**
Sub-technology: **High-Temperature Fuel Cell**

Value chain: Generation
Sub-sector or technology: Hydrogen, Power
Sector: Energy transformation
Demand/Supply/Infrastructure: Supply

TRL 2023: 9

According to IEA criteria, the TRL of this technology in 2022 was: 7-9
TRL 9 with demonstrated commercial operation in relevant environment at MW-scale for stationary applications.

TECHNOLOGY DESCRIPTION

Fuel cells are a further option to convert hydrogen into electricity and heat, producing only water and no direct emissions. Fuel cells can achieve high electric efficiencies of over 60% (above 80% overall efficiency when also including the heat output) and reveal a higher efficiency in part load than full load, which makes them particularly attractive for systems that run for extended periods of time without frequent start and stop cycles and flexible operations such as load balancing. Molten carbonate fuel cells (MCFCs) and solid oxide fuel cells (SOFCs) operate with 600°C and 800 - 1 000°C, respectively, at higher temperatures, which allows them to run on different hydrocarbon fuels, without the need for an external reformer to produce hydrogen first. MCFCs are used in the MW scale for power generation (due their low power density, resulting in a relatively large size). The produced heat can be used for heating or cooling purposes in buildings and industrial applications. SOFCs have similar application areas but are used at smaller scale in the kW range, such as micro-CHP units or for off-grid power supply. The high-temperature systems can also be utilized in tri-generation mode to produce electrical power, heat, and hydrogen. For MCFCs, R&D would further limit electrolyte loss and prevent microstructural changes in the electrolyte support that lead to early stack failure. R&D would also benefit the development of more robust cathode materials.

KEY COUNTRIES

Korea, USA

PROTOTYPE OR DEMONSTRATION PLANS, DEDICATED INVESTMENTS, LEADING INITIATIVES

Capacity additions in 2020 (largely natural gas fired fuel cell systems): 9 MW globally.

Companies: FuelCell Energy. Is the main US company driving MCFC technology development, demonstration and deployment.

DEPLOYMENT TARGETS

Korea:

- 1.5 GW by 2022 and 8 GW (and 7 GW more for exports) by 2040 for district grid systems (1-30 MW)
- 50 MW by 2020 for small to medium systems (up to 400 kW)

COST REDUCTION TARGETS

State-of-the-art costs and future cost targets of the FCH 2 JU for large-scale fuel cells systems (0.4-30 MW) for converting hydrogen or renewable methane into electricity:

2017: USD 3 390-3 955/kW
2020: USD 2 260-3 390/kW
2024: USD 1 695-2 825/kW
2030: USD 1 356-1 977/kW

US 2030 targets for fuel cell system cost:

2030: USD 1 000/KW

RELEVANT PARAMETERS

Temperature (ºC)	600 – 700 ºC
Efficiency (kWh/kg)	~50% (LHV) electrical
System cost (€/MW)	USD 2,4 – 5,5 (installed)
Cell lifetime (h)	50.000
Temperature resistance materials	corrosion resistant at Temp up to 700C

Based on expert input:

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