Carlos Vallejo-Cervantes
carmaval@espol.edu.ec
FIMCP

Alfredo Iranzo-Paricio
airanzo@us.es
Energy Engineering Department

Mayken Espinoza-Andaluz
masespin@espol.edu.ec
FIMCP

Technical review of commercial LT-PEMFC technologies: Performance, applications and challenges

PROBLEM

LT-PEMFC technology has reached commercial deployment in transportation and stationary power generation. However, performance information is scattered across manufacturers and applications. The lack of standardized reporting complicates comparisons and assessments against international targets.

GENERAL OBJECTIVE

To perform a cross-sectoral benchmarking of commercial LT-PEMFC technologies and evaluate their alignment with DOE and CHJU performance targets for 2024 and 2030.

PROPOSAL

This study employed a structured review methodology focused on commercial LT-PEMFC technologies. Publicly available datasheets, technical reports, and manufacturer specifications were collected across transportation, stationary, and maritime sectors. The selected technologies included LD vehicles, buses, trains, HD trucks, stationary power units, and marine applications.

Technical parameters such as power output, efficiency, durability, hydrogen consumption, and operating conditions were systematically analyzed. Commercial systems were benchmarked against KPI established by the U.S. DOE and the CHJU. Missing parameters were reconstructed from reported specifications to enable consistent cross-sectoral comparisons.

Table 1. Integration of commercial LT-PEMFC modules/stacks into commercial FCEV applications.

Commercial module/stack LT- PEMFC	Commercial FCEVs launched
Ballard FCmove-MD	Q-Light FCEV – Quantron
Ballard FCmove-HD	Hydroliner FCEV – Wrightbus
Ballard FCmove-HD+	Xcelsior CHARGE FC - New Flyer Urbino 12 Hydrogen bus – Solaris Urbino 18 Hydrogen bus – Solaris
Ballard module (model not disclosed)	Mireo Plus H – Siemens
Bosch Stack based on Power Cell (model not disclosed)	Tre FCEV – Nikola
Toyota TFCM2s-B	Mirai
Toyota TFCM2s-F (flat type)	Sora Fuel Cell Bus eCitaro fuel cell - Mercedes-Benz
Toyota stack (model not disclosed)	H2.City Gold – Caetano
Hyundai commercial module (HTWO)	Tucson ix35 FCEV NEXO FCEV ELEC CITY Fuel Cell Bus XCIENT Fuel Cell
Symbio H2Motive StackPack 40	Vivaro/Movano-e Hydrogen – Opel e-Expert Hydrogen – Peugeot e-Jumpy Hydrogen – Citroen
Accelera stacks/modules (model not disclosed)	Coradia iLint – Alstom

RESULTS

The comparative analysis revealed that hydrogen consumption varies considerably across commercial LT-PEMFC applications. Several LD vehicles already satisfy or closely approach the CHJU 2024 and 2030 targets, while fuel cell buses generally exhibit higher consumption due to increased vehicle mass and operational requirements.

Electrical efficiency results indicate that current stationary PEMFC systems remain below the long-term CHJU target of 58%, although some technologies already surpass the 2024 benchmark. These findings highlight the technological maturity achieved in several sectors while emphasizing the need for continued improvements in efficiency, system integration, and performance standardization.

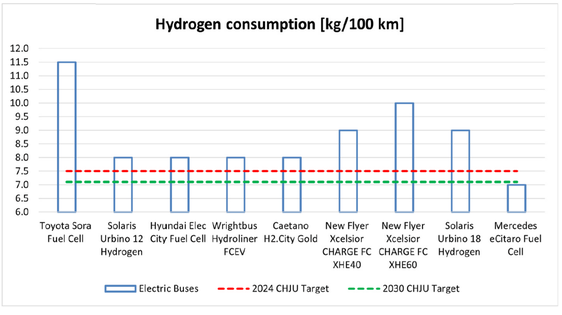

Figure 1. Comparison of hydrogen consumption in light-duty FCEVs against CHJU targets for 2024 and 2030.

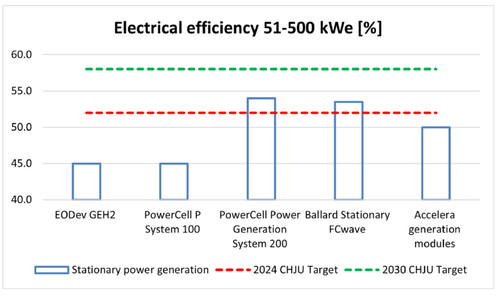

Figure 2. Comparison of electrical efficiency of stationary PEMFC systems (51–500 kWe) with CHJU targets for 2024 and 2030.

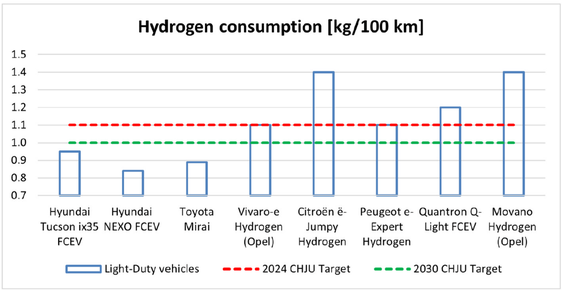

Figure 3. Comparison of hydrogen consumption in fuel cell buses relative to CHJU 2024 and 2030 benchmarks.

CONCLUSIONS

- LT-PEMFC technology has achieved commercial deployment across light-duty vehicles, buses, trains, heavy-duty trucks, stationary systems, and maritime applications.
- Several commercial platforms already meet or approach current DOE and CHJU performance targets, particularly in the transportation sector.
- Significant challenges remain in efficiency improvement, durability enhancement, and hydrogen consumption reduction for stationary and heavy-duty applications.
- Standardized reporting of technical parameters is essential to enable transparent benchmarking and accelerate progress toward 2030 hydrogen technology goals.