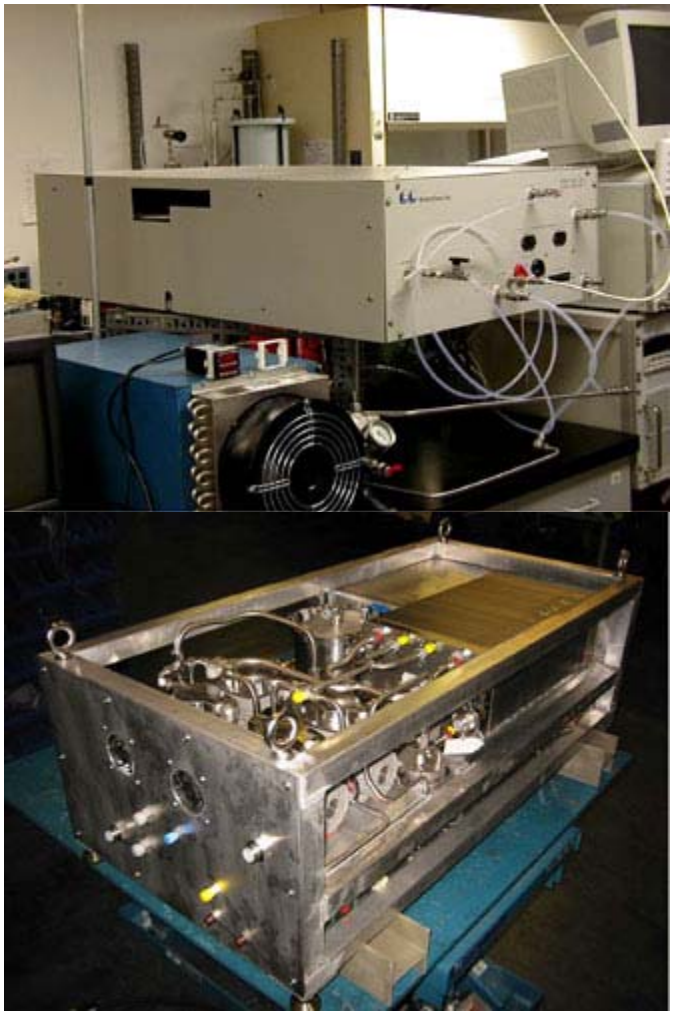
Proton-Exchange-Membrane Fuel Cell Powerplants Developed and Tested for Exploration Missions

Proton-exchange-membrane fuel cell (PEMFC) technology has received major attention for terrestrial applications, such as the automotive and residential markets, for the past 20 years. This attention has significantly advanced the maturity of the technology, resulting in ever more compact, efficient, reliable, and inexpensive PEMFC designs. In comparison to the terrestrial operating environment, the space operating environment is much more demanding. Microgravity to high-gravity loads and the need to use pure oxygen (rather than air) as the fuel cell oxidizer place more stringent demands on PEMFC technology. NASA and its partners from industry are leveraging terrestrial PEMFC advancements by conducting parallel space technology development for future exploration missions.



Left: ElectroChem breadboard. Right: Teledyne breadboard.

A team from the NASA Glenn Research Center, NASA Johnson Space Center, and NASA Kennedy Space Center recently completed the first phase of a PEMFC powerplant development effort for exploration missions. The industry partners for this phase of the development effort were ElectroChem, Inc., and Teledyne Energy Systems, Inc. Under contract to Glenn, both of these industry partners successfully designed, fabricated, and tested a breadboard PEMFC powerplant in the 1- to 5-kW power range (see the photographs). These powerplants were based on existing company-proprietary fuel cell stack designs, combined with off-the-shelf components, which formed the balance of the powerplant design. Subsequent to the contractor development efforts, both powerplants were independently tested at Johnson to verify operational and performance characteristics, and to determine suitability for further technology development in the second phase of the NASA-led effort. Following the independent NASA testing, Teledyne Energy Systems, Inc., was selected to develop an engineering model PEMFC powerplant.

COMPARISON OF BREADBOARD PEMFC POWERPLANT CHARACTERISTICS

Vendor	ElectroChem	Teledyne
Nominal power, kW	1.0	5.0
Number of cells	45	82
Cell active area, cm^2	232	302
Nominal current density, mA/cm^2	110	270
Peak power capability (peak/nominal)	6:1	>6:1
Reactant recirculation approach	Passive (ejectors)	Active (pumps)

This effort was initiated by the 2nd Generation Reusable Launch Vehicle (RLV) Program Office in 2001; it transitioned to the Next Generation Launch Technologies (NGLT) Program Office in 2003. The effort is now being funded by the Exploration Program Office. We plan to summarize the results from the ongoing engineering model PEMFC powerplant development in a future Research & Technology article.

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