Bi-furcated Reversible Alkaline Cell for Energy Storage (BRACES) – TP

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Project Overview

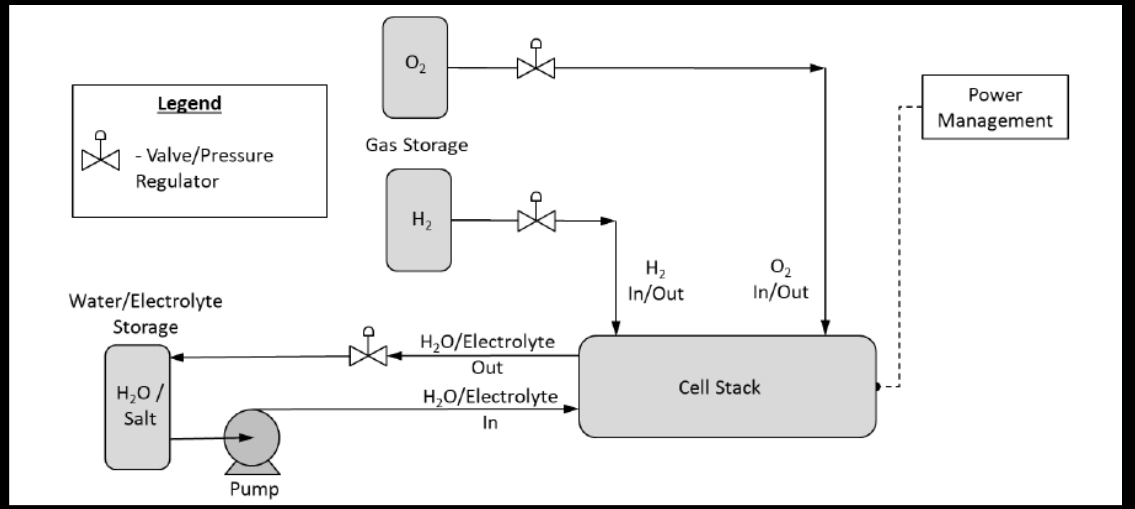
NASA needs energy storage for lunar applications where night lasts up to 354 hours. Batteries have relatively low energy density for large long-duration systems. Reversible fuel cell systems are potentially well-suited for long-duration storage but must have high reliability to last the 4-year maintenance cycle. Moving parts (compressors and blowers) are the primary limitation for high reliability fuel cell systems.

Technical Approach (3 years)

The project is developing a unitized reversible fuel cell system based on a unique cell design. The mostly passive system will have no moving parts except for an electrolyte circulation pump. This project will increase the technology to TRL 6 and demonstrate a brassboard prototype system in a NASA TVAC chamber under simulated lunar conditions, and in shock and vibe testing.

Results/Summary

Initial cell target performance has been demonstrated. High pressure test stand and cell sealing has been designed. Water contaminant specifications are being developed. Improved membrane formulations were synthesized.



Simplified process diagram

Value	NASA RFC Goal	SOA Discrete PEM System (AIRS)[4]	Proposed URFC Approach
Nominal Current Density (mA/cm^2)	N/A	200 (each stack)	**160**
Round-Trip Efficiency (RTE)	54% [4]	~55%	**55%**
Specific Energy (kWh/kg)	Highest Possible	360-850	**>1,000***
Water Purity Required**	TBD	Deionized	**>ppm**
Mode Change Speed	Seconds [4]	Minutes	**<5 s**
Number of Cell Cycles	>79***	30,000	**>1,000**
Reliability / # of Moving Parts****	No Failure for >5 yrs	Blowers (2), Pump	**Pump (1)**
Other Functionalities	As many as possible	None	**ISRU**

** Without thermal system and assuming locally sourced water (the proposed URFC would be 850 Wh/kg if water mass is included)*
*** PEM systems require D.I. water free of metal ions; proposed approach was demonstrated with ppm metal ion impurities (Ca, Mg, Fe, and Ni)*
**** Based on 5-years between maintenance, 700-hour cycles*
***** System reliability is poor for system with blowers and/or compressors*

Table of key properties

Key Performance Parameters (in Draft)

- Projected system energy density >850 Wh/kg for 354 hours of lunar energy storage at 10-kW scale
- >50% Round-Trip Efficiency (RTE) at 160 mA/cm^2 defined as voltage out over voltage into the cell-stack
- 250-bar pressure operation of the cell stack and storage tanks with target electrochemical performance

Contributing Partners

- Sister AARC-ACO project to develop water specifications for ISRU
- NASA Glenn Research Center
- NASA Johnson Space Center
- Bettergy Corp.
- Power to Hydrogen, LLC
- Shell GameChanger

Infusion and Transition Plan

- Space flight test opportunities to achieve TRL 7
- Lunar surface energy storage missions
- Commercial hydrogen / energy storage customers

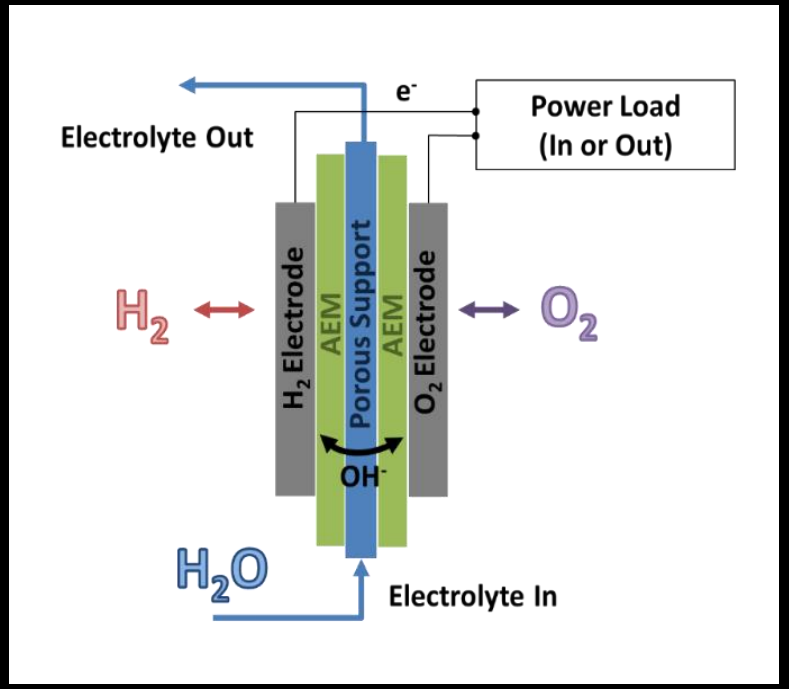
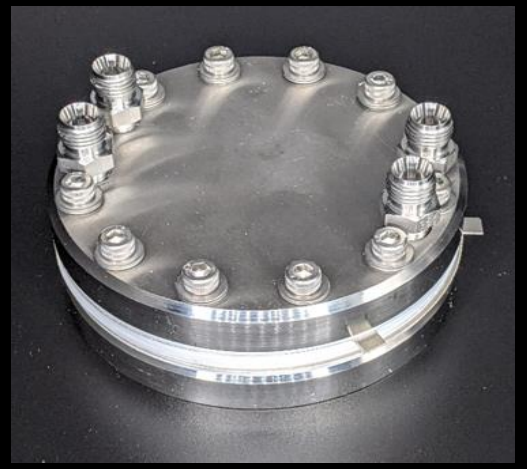


Diagram of cell design



Photograph of test cell