National Aeronautics and Space Administration

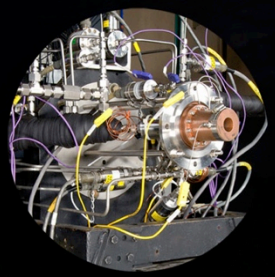
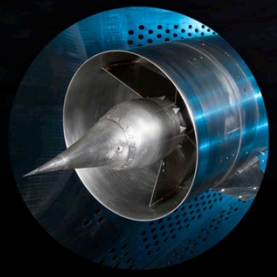
NASA Glenn Research Center

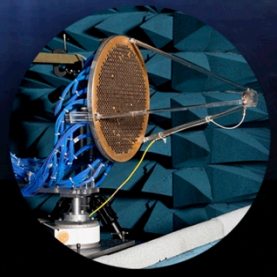
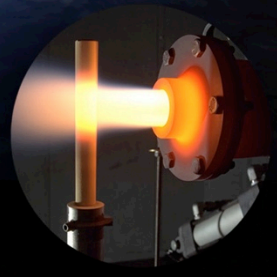
R&E

RESEARCH AND ENGINEERING DIRECTORATE

NASA Glenn Hydrogen Research & Technology Efforts

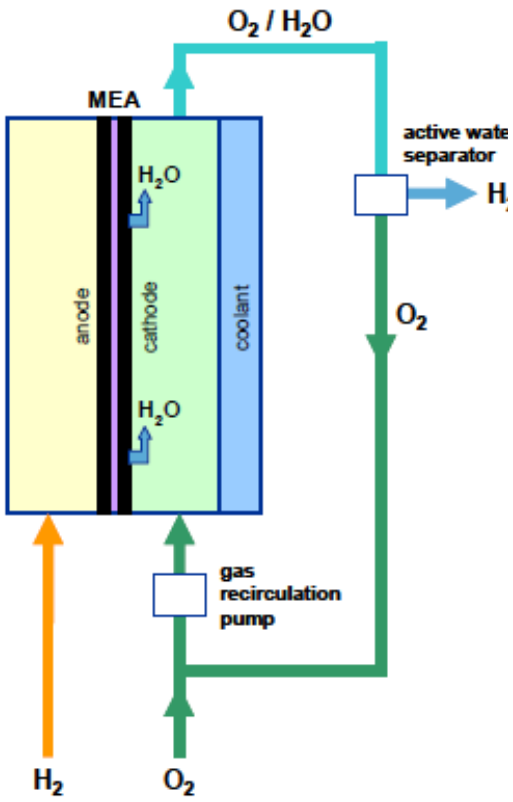
Dr. Rickey J. Shyne

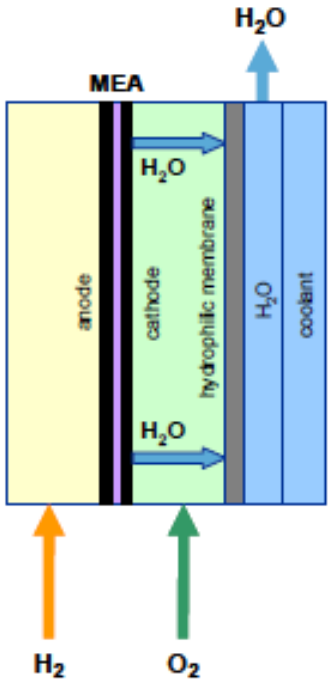



Non Flow-Through Proton Exchange Membrane (PEM) Fuel Cell

Flow-Through PEM Fuel Cell



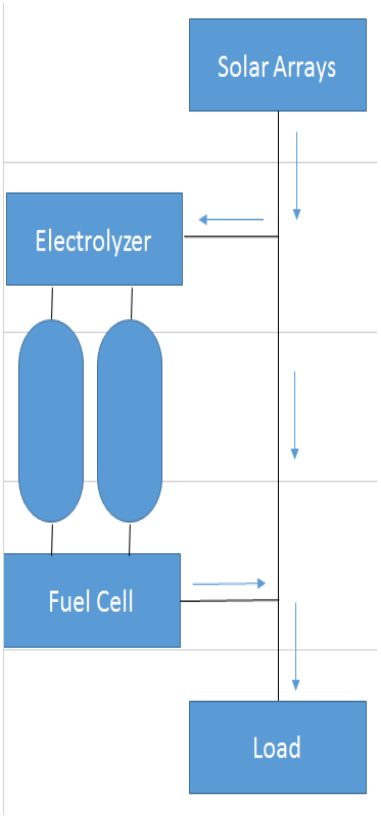
Non Flow-Through PEM Fuel Cell



Reduced complexity

Successful demonstration of 1 kW power, non flow-through Proton Exchange Membrane (PEM) fuel cell in Scarab rover field demonstration

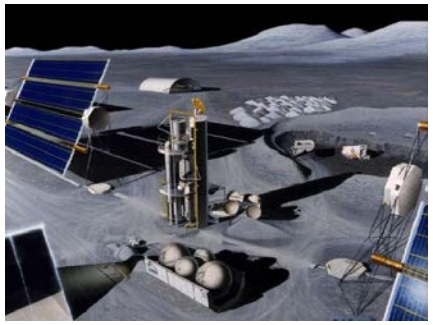
Regenerative Fuel Cell (RFC) for Surface Power



Regenerative Fuel Cell

Technology Gaps:

- Critical lack of PEM life/durability data to extrapolate system performance over projected mission duration
- RFC system-level development and demonstration required
- Supporting component development required
- Improved freeze tolerant membranes improve system durability for PEM stacks



Surface Power RFC for Lunar Outposts

Surface Power RFC for Martian Outposts

Goals:

- Power level of 10 kW
- 12 years operational life, > 60,000 hr for fuel cell and > 46,000 hr for electrolyte
- > 100 W/kg for fuel cell and > 30W/kg for regenerative fuel cell

Fuel Cells for Electrified Aircraft

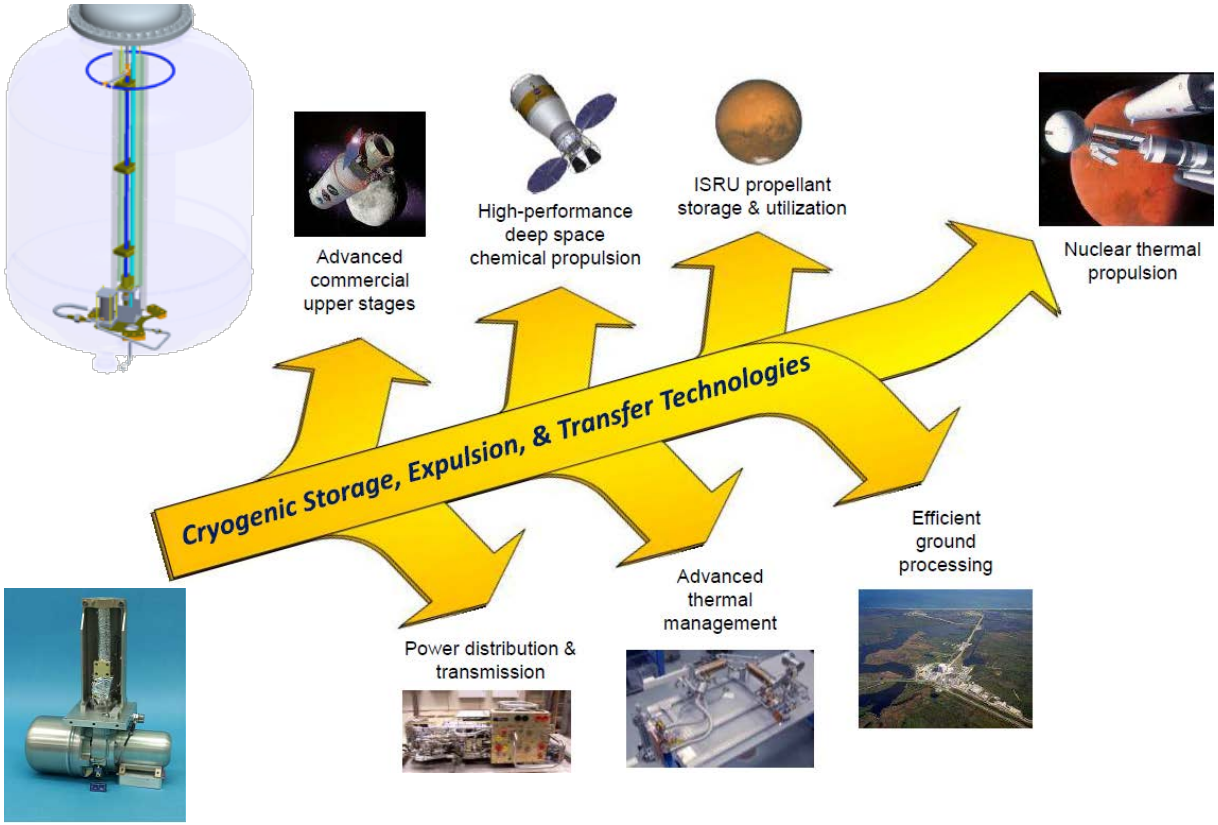
4-seater hydrogen fuel cell (PEM) flight test in 2016 (DLR Germany

Boeing, 2-seater hydrogen fuel cell (PEM) flight test in 2008

China, light airplane, hydrogen fuel cell (PEM) flight test in 2017(Ruixiang - RX1E)

- Energy density of fuel cell, on the order of 600 – 800 Wh/kg is attractive for electrified aircraft
- Low power density of SOA fuel cell system (~0.5 kW/kg) limits application of fuel cell to small aircraft
- 3-5X increase in power density required for larger airplanes

Cryogenic Fluid Management



The Cryogenic Fluid Management (CFM):

Develop storage, transfer, and handling technologies for cryogens that will support the enabling of high performance cryogenic propulsion systems, lunar surface systems and economical ground operations. Such technologies can significantly reduce propellant launch mass and required on-orbit margins, reduce or even eliminate propellant tank fluid boil-off losses for long term missions, and simplify vehicle operations.