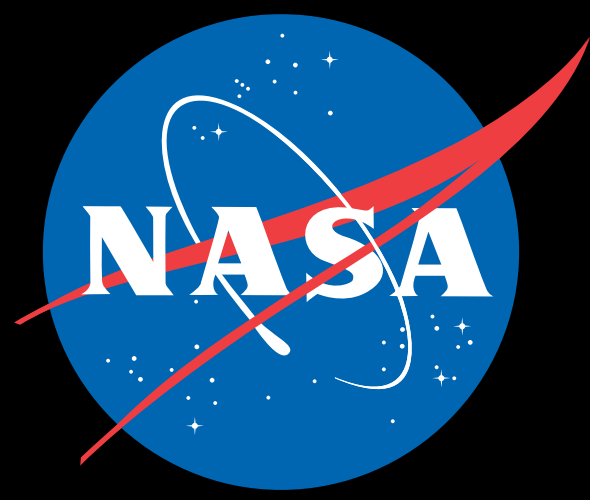


Technology Readiness Assessment Framework for Fuel Cell and Electrolyzer Systems

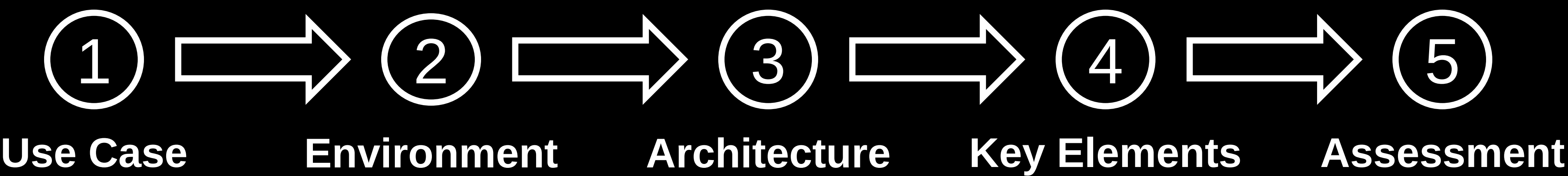
National Aeronautics and
Space Administration



Background

As electrolyzer (EZ), primary fuel cell (PFC), and regenerative fuel cell (RFC) technologies advance for space applications, technology readiness assessments are imperative for identifying and characterizing the challenges for systems to become flight-ready. A standardized framework applicable to developmental EZ, PFC, and RFC systems is presented here that provides a common foundation to accurately compare systems across the technology landscape.

Framework



1. Use Case

Define the mission case, or target application, for the evaluated system.

2. Environment

Define the operational and non-operational environments (OE and NOE, respectively) to determine the relevant environments (REs).

OE: Environment the system will be operated.

NOE: Environment the system is exposed to and expected to survive, but not operate.

RE: Representative subset of the OE and NOE required to demonstrate system performance for technology maturation.

3. Architecture

Identify internal and external interfaces where energy, mass, or force transfer to define where the technology resides in reference to the mission architecture.

4. Key Elements

Identify the key system elements (i.e., components, subsystems, etc.) that are crucial to the system technically maturing.

5. Assessment

Evaluate the readiness level (RL) and advancement degree of difficulty (AD²) with justification for each key element. These assessments can and should be utilized for technology, manufacturing, software, and modeling RLs (MRL, SRL, MoRL, respectively).

RFC Project Case Study

The NASA RFC Project is developing and demonstrating an RFC system for lunar surface applications and is used as a case study following the framework provided here:

1. The RFC system would interface with a lunar habitat to send/receive communication, power, and thermal loads.
2. OE: Lunar surface conditions over an entire day/night cycle at the habitat location.
NOE: Conditions during transit to lunar surface location (e.g., shock and vibration during launch and/or landing or temperatures exposed to during transit more extreme than the OE temperatures)
REs: Temperature, pressure, radiation, dust, 1/6th gravity, and electromagnetic interference/compatibility for an operational demonstration; non-operational shock, vibration, and temperature demonstration.
3. Major subsystems: Fuel cell, electrolysis, fluid conditioning, reactant compression and storage, avionics, power management and distribution, and thermal management.
4. Key RFC elements are the overall RFC system, fuel cell subsystem, electrolysis subsystem, reactant compression, and water quality.
5. RFC System: TRL 3
Fuel cell subsystem TRL: 4
Electrolysis subsystem TRL: 4
Reactant compression TRL: 4
Water quality TRL: 2

