Hydrogen - A Competitive Energy Storage Medium To Enable the Large Scale Integration of Renewable Energies

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H_2/Br_2 Flow Battery for Grid-Scale Energy Storage

Introduction

The aim of the project is to invent a flow battery that has high efficiency and low cost by rethinking the choice of chemistry and the design of the cell. The key is to start with a chemistry that has fast reaction kinetics and design a cell to maximize performance. The system chosen uses such a reversible redox couple (H_2/Br_2), which is comprised of inexpensive and earth-abundant chemicals and operates within the stability window of water. A team approach is utilized comprised of component manufacturers, system integrators and analyzers, and led by a US DOE National Laboratory (Lawrence Berkeley).

Unprecedented high power at high efficiency enables cost competitive grid-scale energy-storage solution

Objectives

The main objectives are to

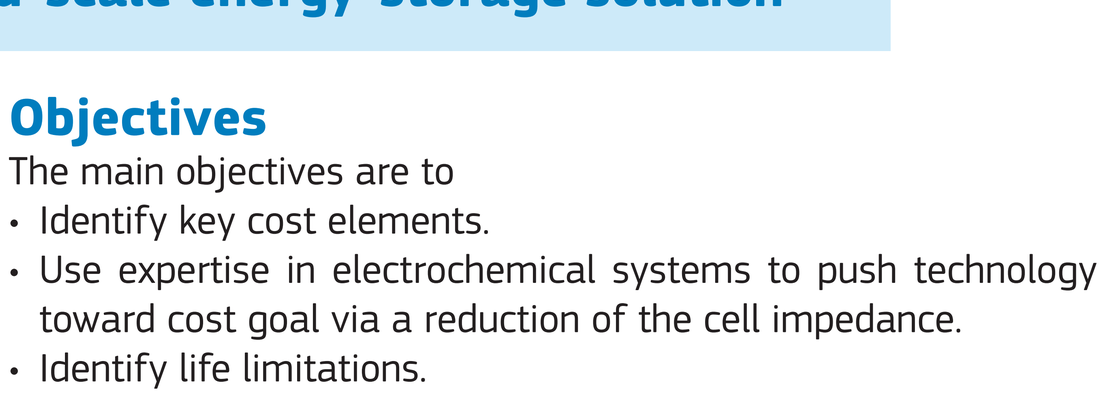
- Identify key cost elements.
- Use expertise in electrochemical systems to push technology toward cost goal via a reduction of the cell impedance.
- Identify life limitations.
- Identify suitable safety measures.

The main thrust so far has been to increase power without sacrificing efficiency to reach the ARPA-E GRIDS target of 100$/kWh for a 1 hour discharge at 80 % system efficiency.

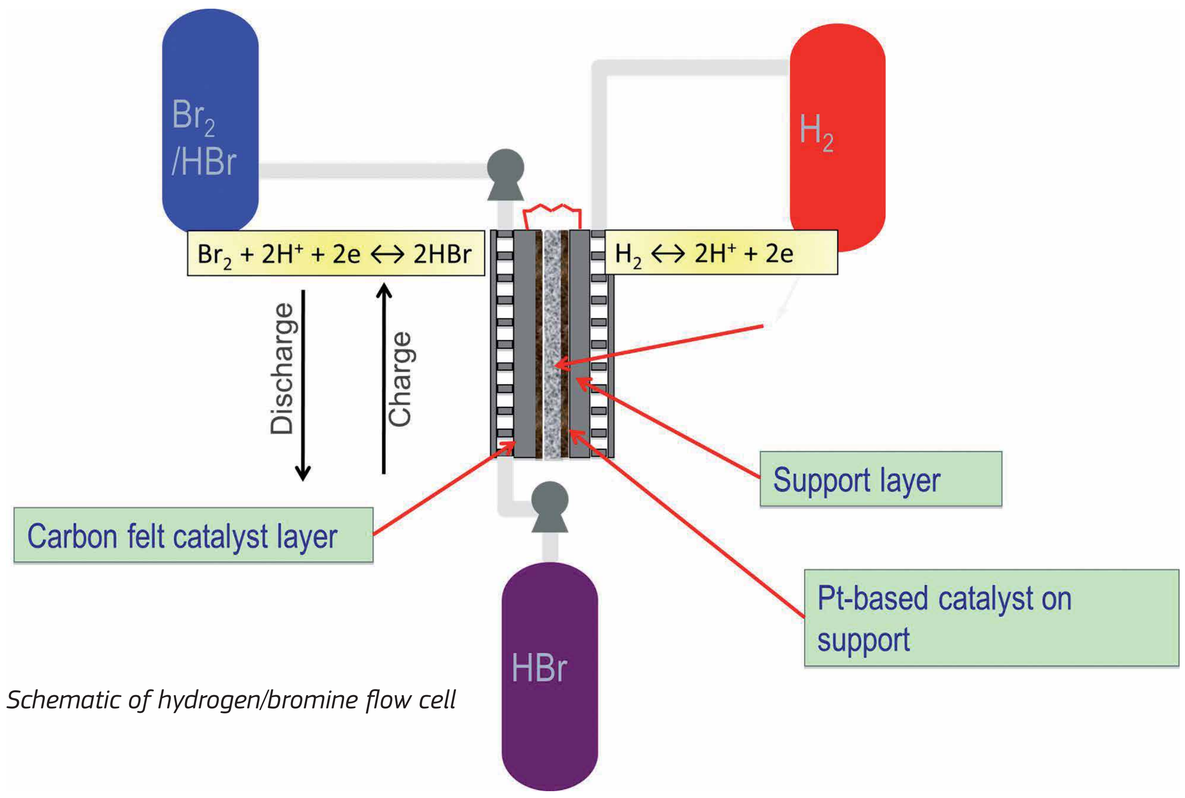
Technical accomplishments / progress / results

Achieved discharge peak-power densities of up to 1.4 W/cm^2 and 1 and 0.6 W/cm^2 at voltaic efficiencies of 80 and 90%, respectively; which are almost an order of magnitude greater than traditional redox flow batteries. The achievements were obtained by improving the bromine carbon-electrode design in terms of mass-transfer and pretreatment, and also by use of a reinforced thin ion-conducting membrane separator. The charge/discharge profiles are symmetric showing the viability of the system.

Cost analysis of this system demonstrates that for discharge times of 4 to 8 hours, battery cost is about 300 to 200 $/kWh, respectively.



Generational flow-cell discharge performance with 0.9 M Br_2 in 1 M HBr and 100% RH H_2 at ambient conditions (inset) generation 5 discharge/charge performance



Schematic of hydrogen/bromine flow cell

Future Work

Work will focus on examining cycling and durability issues with regard to the cell. In addition, scale-up of cell size and further benchmarking of existing cell components will occur.

Conclusions and major findings

Novel cell architecture and chemistry with an order of magnitude greater power densities than typical cells but still within the water stability window.

- Presently capable of >0.6 W/cm^2 at 80 % roundtrip efficieny.
- The system allows for high efficiency charge rates with no side reactions.
- Key cost components identified.
- Key performance barriers identified; further progress expected.

Project Overview

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  3M Company
  Proton OnSite
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