Reversible Solid Oxide Fuel Cell Systems for Energy Storage and Hydrogen Production

- **DE-FE0032032**

FuelCell Energy, Inc. (FCE)

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Sub-Recipients:
- **Versa Power Systems**
- **EPRI**
- **AECOM**

Location: Danbury, CT

DOE: $199,999
Non-DOE: $50,000

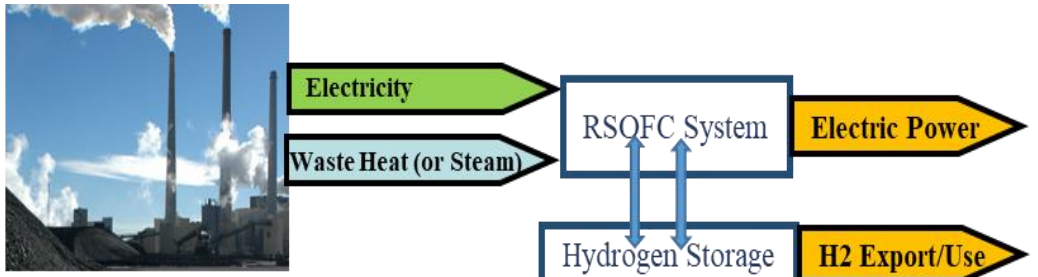
Total: $249,999

Objectives

- The main objective is to develop reversible solid oxide fuel cell (RSOFC) energy storage technology for integration with fossil-fueled Electricity Generating Units (EGUs)
- The anticipated MW-scale RSOFC Metric Targets are:
  - Round Trip Efficiency (RTE) 70%
  - Capital Cost - Power $1000/kW
  - Capital Cost - Energy $150/kW-h
  - Levelized Cycle Cost $0.05/kWh-cycle

Relevance and Outcomes/Impact

- Integration of RSOFC systems with fossil-fueled plants will result in increased flexibility of operation, life extension of the capital assets, and increased revenues for the asset owners. For the utility customers, it will result in grid stability and reduced cost of electricity



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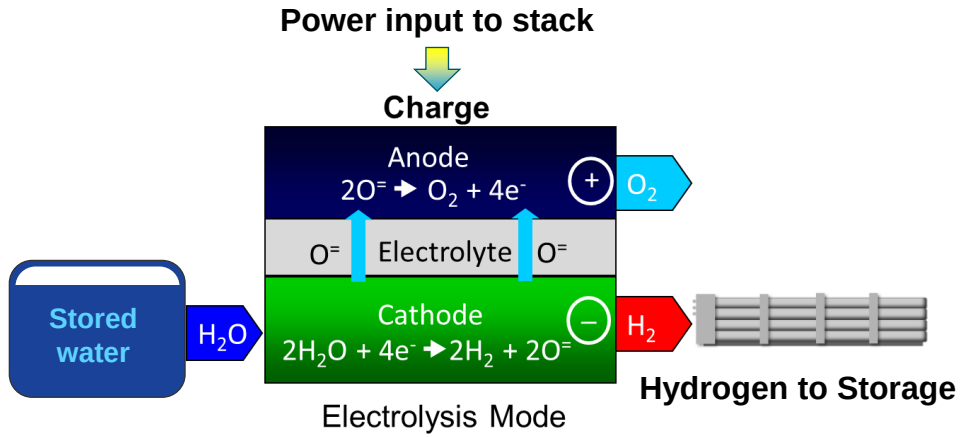
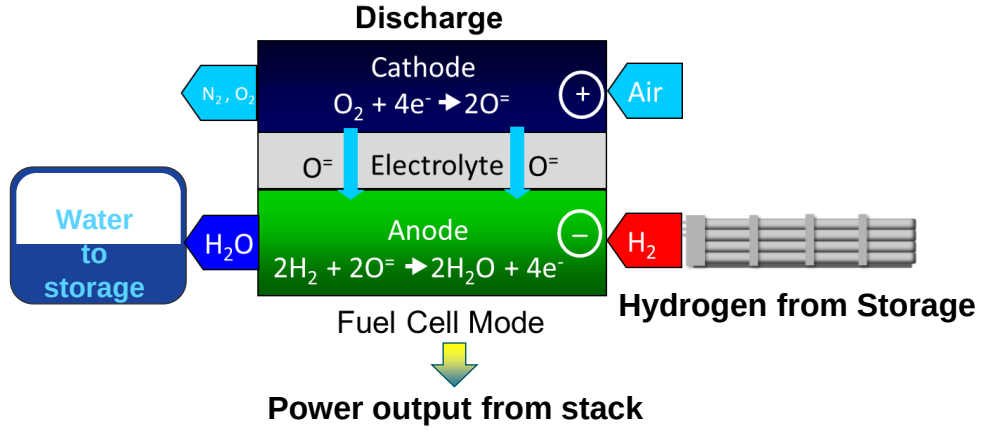
- Solid Oxide Fuel Cells (SOFC) have demonstrated capability to run in **electrolysis mode** and **fuel cell mode**, and the ability to switch in between the two, called Reversible Solid Oxide Fuel Cell **(RSOFC)**.
- Solid oxide cells run much more efficiently than conventional electrolysis, and operate with high efficiency in power generation
- RSOFC stacks with hydrogen and water storage are an advanced energy storage approach:
  - High round-trip system efficiency (~70%)
  - Long duration achieved by adding low-cost hydrogen and water storage capacity, without the need to add more stacks
  - Inexpensive water is the only reactant – added as an initial fill and regenerated with each discharge cycle

Charging in electrolysis mode:



Discharging in fuel cell mode:



Compact SOFC Architecture (CSA) Stack

CSA is FCE's trade name for solid oxide stacks used for power generation, electrolysis, and energy storage applications

With water as the only stored reactant, hydrogen based storage has significant advantages for long duration

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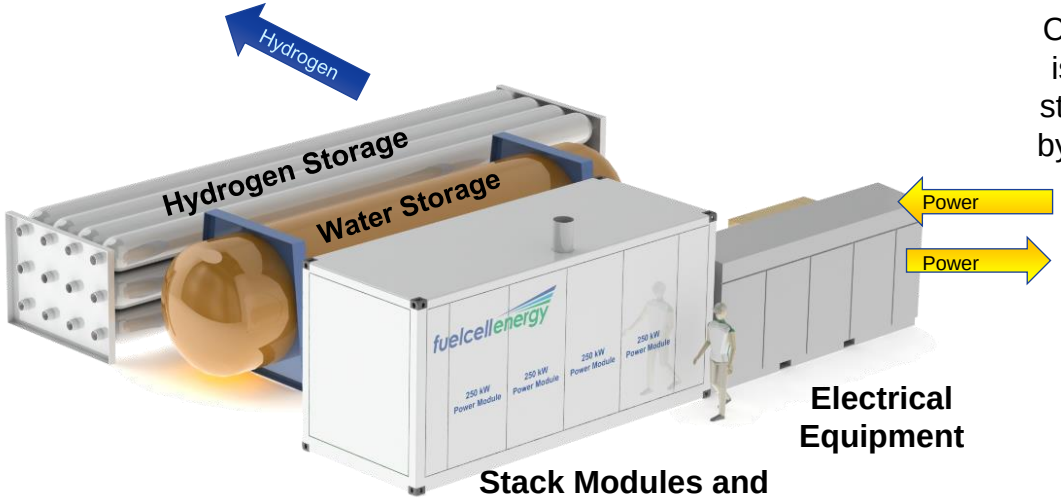
- Hydrogen during charge cycle can be used to provide power during discharge cycle or can be exported to hydrogen users
- Geological storage of hydrogen can provide weekly or seasonal storage
- The storage reactant is water, which is regenerated during power generation discharge – does not depend on limited supply of lithium or cobalt as in lithium-ion batteries
- Discharge duration is increased by adding inexpensive hydrogen and water storage – so cost of storage capacity reduces significantly with longer duration

H_2 can be converted back to power or supplied to H_2 users, enhancing project economics



Charging power is converted to stored hydrogen by electrolysis of stored water

Stored hydrogen is converted back to power and water in fuel cell mode

1 MW RSFOC System

Flexible energy storage approach based on high efficiency conversion of power to hydrogen and hydrogen to power

Thank You

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