# IV.H.8 System Design and New Materials for Reversible Solid-Oxide, High-Temperature Steam Electrolysis

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*Northwestern University, Evanston, IL*
*Functional Coating Technologies, LLC*

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## Objectives

- Design a pilot scale system achieving $2/kg hydrogen production cost
- Develop new low-cost reversible electrode materials

## Technical Barriers

This project addresses the following technical barriers from the Hydrogen Production section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- K. Electricity Costs

## Technical Targets

This project is developing a reversible solid oxide electrolysis system design capable of 1,000 kg/day $H_2$ production at a cost of $2/kg and the reversible electrode materials to enable the system design.

## Approach

Design a pilot scale system

- Develop a cost model for reversible hydrogen/electricity generation
- Produce a comprehensive heat and mass transfer systems model
- Design an optimized pilot-scale system

Develop low cost, reversible electrode materials

- Design electrolysis electrocatalytic materials for reversible solid oxide electrolysis cell (SOEC) electrodes

- Optimize electrode microstructures
- Optimize thin-electrolyte, reversible electrolysis cells
- Map reversible electrode performance and degradation within the system operating space determined by the system design
- Develop microstructure-based performance and failure modeling allowing predictive capability for assessing long-term operation and stability

## Accomplishments

- The project has not yet started.

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## Introduction

Electrolysis is one of the cleanest methods for producing hydrogen from an abundant source that produces no carbon emissions and allows for distributed hydrogen generation. High temperature steam electrolysis using solid oxide technology has the potential for highly efficient and affordable hydrogen generation. A reversible SOEC hydrogen production system capable of producing either hydrogen or electricity on demand is a potential pathway to a cost-competitive distributed system. System designs with high efficiency and low capital cost must be developed and new reversible electrode materials with high performance and durability must be identified.

## Approach

A system model detailed at the component level will define the plant configuration and operating parameters required to meet the cost targets. Electrode materials will be developed and demonstrated in a multi-generational approach. Performance and failure mechanisms in reversible electrolysis mode will be identified so that the materials structures can be designed with an understanding of the critical microstructural parameters. The most promising materials system will be down-selected for extensive performance and durability mapping through the pilot-plant design operating space, and system performance will be predicted.

## Results

This project has not yet started.