# VIII.4 Adapting Planar Solid Oxide Fuel Cells for Use with Solid Fuel Sources in the Production of Distributed Power (New Project)*

*Dr. David J. Bayless*
*Ohio University*
*Department of Mechanical Engineering*
*248 Stocker Center*
*Athens, OH 45701*
*Phone: (740) 593-0264; Fax: (740) 593-4902; E-mail: bayless@ohio.edu*

*DOE Technology Development Manager: Matthew Kaufmann*
*Phone: (202) 586-5824; Fax: (202) 586-9811; E-mail: Matthew.Kauffman@ee.doe.gov*

*Subcontractors:*
*SOFCo-EFS Holdings LLC (SOFCo) (Alliance, OH)*
*Case Western Reserve University (CWRU), Cleveland OH*
*Nordic Energy LLC (Now BAARD)*

**Congressionally directed project*

## Objectives

- Integrate the existing solid oxide fuel cells (SOFC) and coal-derived syngas technologies.
- Demonstrate at the pilot-scale the combined technology.
- Demonstrate the combined technology at full-scale in a cogeneration power plant at Ohio University.

## Technical Barriers

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

- E. Durability
- F. Heat Utilization
- J. Durability (of Fuel-Flexible Fuel Processors)
- L. Hydrogen Purification/Carbon Monoxide Cleanup

## Approach

The objectives of the proposed project are

- Integration of existing solid oxide fuel cells (SOFCs) and coal-derived syngas technologies,
- Pilot-scale demonstration of the combined technology,
- Full-scale demonstration in a cogeneration power plant at Ohio University.

Integration of the technologies will include

- Modeling of SOFCs with syngas to predict the effects of the composition and elevated temperature of syngas on the chemical reactions and energy conversion of the fuel cell,
- Performance testing of the cells using synthetic syngas, a fixed mixture of gases that simulate coal-derived syngas, with and without contaminants, including sulfur, mercury, and particulates, and

- Development of hot-gas electrostatic separation and precipitation to purify the syngas stream. Pilot-scale demonstration, with minimum test duration of 1,000 hours, will be performed with small SOFC stacks. The full-scale demonstration will entail long-term performance testing of an equivalent 50 kWe SOFC stack in a cogeneration power plant.

Objective 1 consists of 8 tasks, including modeling of the syngas and SOFC system, fabrication and installation of the synthetic syngas gas system to be delivered to a test-stand (single cell and stack) of SOFC, structural characterization of the material of the SOFC, and testing of SOFC performance by varying fuel syngas composition and effects of contaminants (mercury, $H_2S$, particulates). Progress towards this objective will be measured by collecting sufficient data, estimated as 500 hours, utilizing doped synthetic syngas to understand the effects of known contaminants of syngas on the performance of solid oxide fuel cells.

Objective 2 includes 3 tasks, involving some space renovation, modification of an existing gasifier unit at Ohio University (OU), and testing the SOFC with the syngas produced at an OU gasifier unit. The progress here will be measured by collecting a minimum of 1,000 hours of performance data with a 5-10 SOFC stack and syngas utilizing a fluid bed gasifier equipped with a cyclone separator, ceramic filter, and hot-side electrostatic precipitator for syngas cleanup. Analysis of the performance data will be used to evaluate the long-term compatibility of the SOFC stack with syngas. Any changes in syngas cleanup, stack test stands, including modification of manifolds, ventilation, and monitoring, or test parameters will be identified.

Objective 3 consists of 2 tasks, including a new plant design for the existing OU power generation plant, and the demonstration of the technology by operating it at plant conditions. The effort will culminate in the demonstration of the combined technology, which is critical for successful commercialization. SOFCo is a recognized leader in solid oxide fuel technology that is compatible with carbon monoxide and sulfur. Their parallel development of natural gas-based fuel cells will provide critical marketing data and opportunities, and demonstration with syngas will allow them to provide potential customers a lower fuel cost.