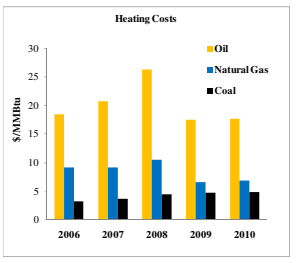


## Coal is Important. Highest BTU/g

- Abundant domestic reserves
- Low and stable prices
- Provide > 1/2 nation's electricity
- Future source of H<sub>2</sub>



- Economic prosperity
- Energy security



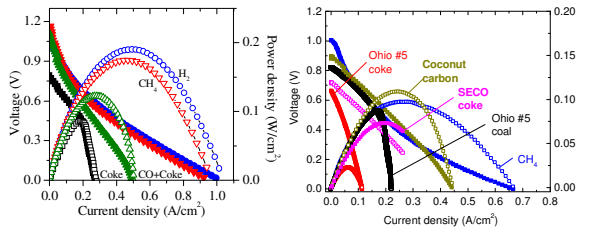
1. Prices from 2006-2010 ([www.eia.doe.gov](http://www.eia.doe.gov))  
 2. Natural Gas prices: DOE (Average Commercial Prices)  
 3. Gasoline & Diesel Fuel Prices ([trends.eia.doe.gov](http://trends.eia.doe.gov))

Rita Bajura, CCPI-Round 2, Planning Workshop, Aug. 23, 2003

## Objectives / Relevance

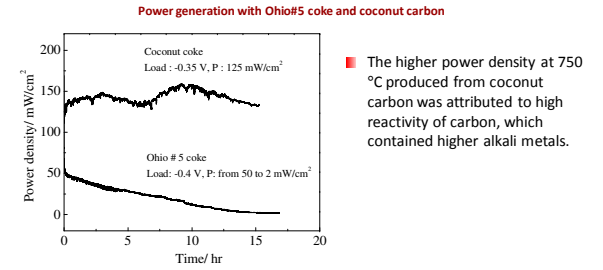
- Overall Objective:** Develop a Kilowatt-scale coal fuel cell technology. The results of this R&D efforts will provide the technological basis for developing Megawatt scale coal fuel cell technology.
- Relevance:** The development of a coal fuel cell technology constitutes a highly efficient, clean, multi-use technology, which promises to provide low cost electricity, expanding the utilization of domestic coal supplies, and providing a smooth transition from a fossil-fuel economy to a hydrogen-based economy. The anode developed for coal fuel cell exhibit high resistance to sulfur compounds. This novel anode allow the direct use of sulfur-containing hydrogen without complex costly purification steps.
- 2010
  - Evaluate the long term anode and cathode catalyst activity as well as interconnect durability
  - Improve the coal injection and fly ash removal systems.
- 2011
  - Develop the process for fabrication of large scale fuel cell components by tape casting and screen printing.
  - Test the long term durability of fuel cell components

## Carbon-based Fuel Cell Performance



.....To be completed

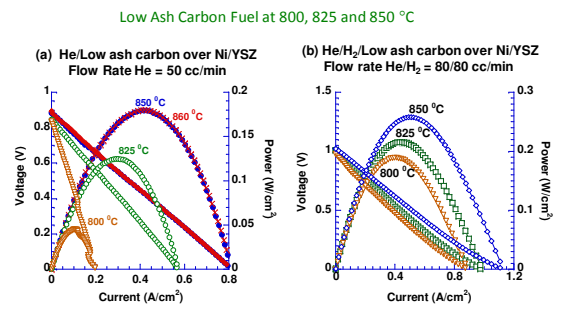
## Long Term Carbon-Based Fuel Cell Testing



Fuel / Composition	K %	Ca %	Br%	Cl %	Fe%	S %	Ni %	Cr%
Coconut carbon	63.1	13.8	8.91	8.81	2.40	2.09	0.93	
Ohio coke #5	4.0	4.9						

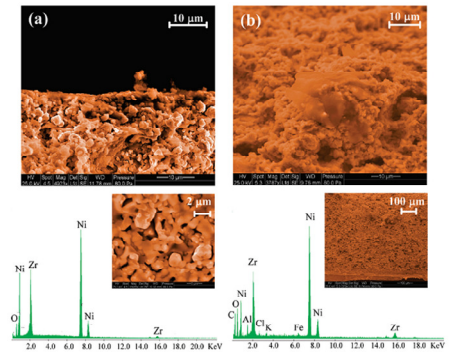
\*Carbon is excluded from the composition

## Effect of Temperature on the Performance of the carbon-based fuel cells

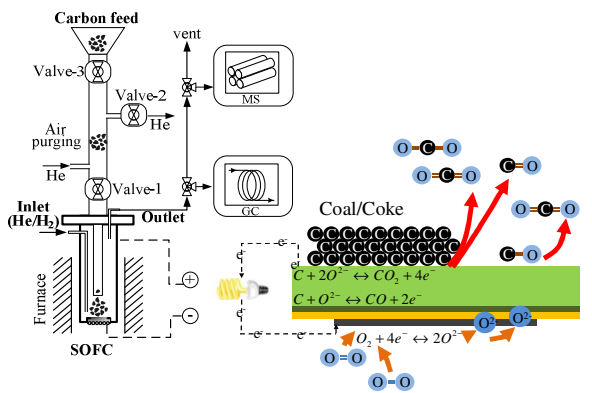


- Electric power produced by low ash carbon increased by more than 3 times when raising the temperature from 800 to 850 °C.

## SEM-EDS Characterization of the Fuel cell after testing in Sulfur-Containing coke

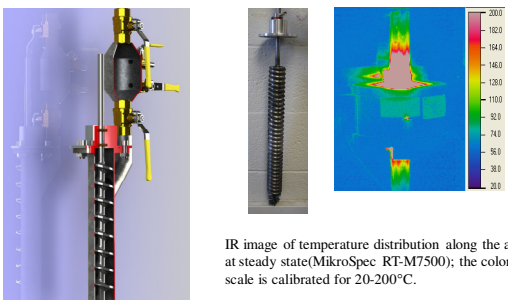


## Carbon-based Fuel Cell: Operating Principle



## Coal feeding mechanism

Test of the coal feeding unit with steel auger – Temperature distribution



Coal feeding equipment

## Conclusions/Future work

.....To be completed

## Publications and Presentations

- "Direct Use of Sulfur-Containing Coke on a Ni-Yttria-Stabilized Zirconia Anode Solid Oxide Fuel Cell" Felipe Guzman, Rahul Singh, and Steven S.C. Chuang, Energy & Fuels, 25, (5), 2179-2186, 2011
- "Catalyst Compositions for Use in Fuel Cells," U.S. Patent Application, filed by The University of Akron on Sept 13, 2006

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- Ohio Coal development Office, OCDO
- FirstEnergy Corp.