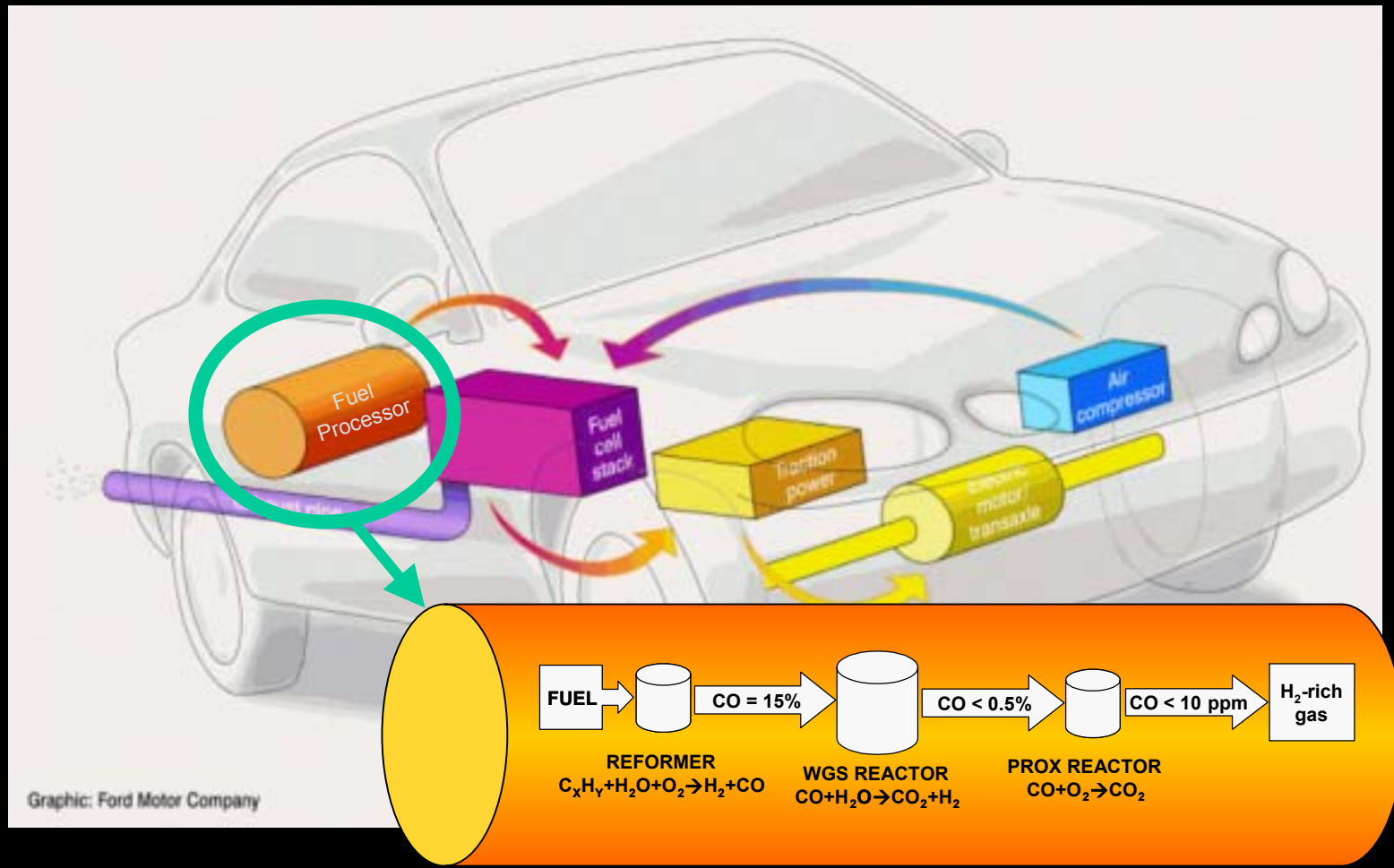
Fuel Processing



Patrick Davis

Targets and Status

Fuel Processor for 50 kWe (net) Fuel Cell Systems

Fuel processor generating hydrogen-rich gas from reformulated gasoline

containing 30 ppm sulfur, average

Characteristics	Units	2001 status	2005	2010
Power density	W/L	500	700	800
Cost	$/kW	85	25	10
Durability	Hours	1000	4000	5000
Cold start-up time to max power from +20ºC ambient temp.	Min	<10	<1	<0.5

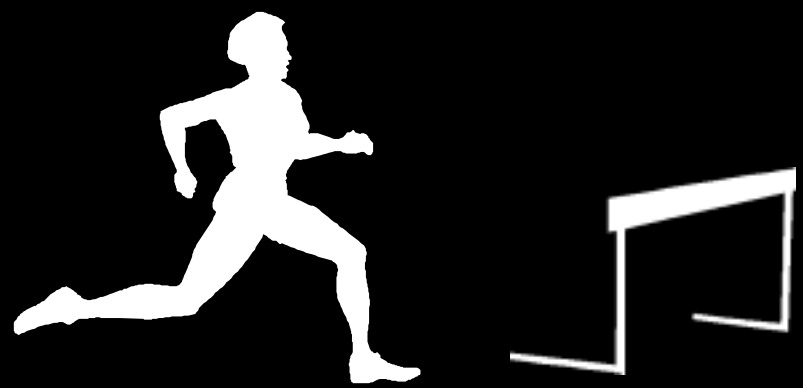
On-Board Fuel Processing Challenges & Objective

CHALLENGES

- CO cleanup
- Fuel processor system integration and efficiency
- Fuel processor start-up/ transient operation
- Thermal management
- Durability
- Cost
- Impurity management

OBJECTIVE

- Develop compact, energy-efficient, integrated fuel processing systems using multiple feedstocks



Fuel Processing Projects

LABS / UNIVERSITIES

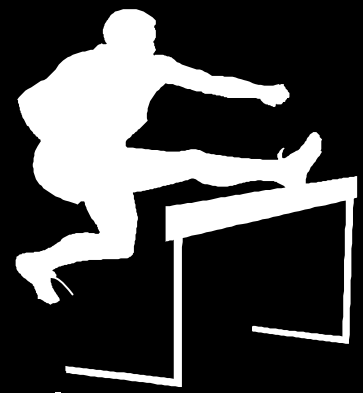
- ANL: Integrated Fuel Processor Development
- PNNL: Microchannel Fuel Processing
- LANL: Reformate Fuel Cell System Durability
- ANL: Catalytic Autothermal Reforming
- LANL: Reformate Clean Up Development
- University of Michigan: Microsystem-Based Fuel Processors for PEM Fuel Cells

INDUSTRY

- Nuvera Fuel Cells, Inc.: Advanced Fuel Processor Development for Transportation Fuel Cell Power Systems (STAR and Hi-Q)
- McDermott Technology, Inc.: Multi-Fuel Processor for Fuel Cell Vehicle Applications
- Catalytica Energy Systems, Inc.: Plate-Based Fuel Processing System
- Honeywell Engines & Systems: Novel Breadboard Device Suitable for CO Remediation in an Automotive PEM Fuel Cell Power Plant
- Arthur D. Little: Evaluation of Partial Oxidation Fuel Cell Reformer Emissions

Industry Interactions/ Technology Transfer

- ANL reformer catalyst licensed to Süd-Chemie for commercialization
- H2FUEL using LANL PrOX and Argonne fuel processing technology for stationary systems
- McDermott integrating LANL PrOX
- PNNL providing microchannel components to various developers (i.e.PNNL steam generator for McDermott system deliverable)
- NUVERA working with ANL on Hi-Q system modeling
- ANL working with Arthur D. Little on cost analysis



Discussion Points

- Start-up times are inadequate: Must be <30 seconds, difficult to achieve through reliance on battery
- Major Go/NoGo decision in FY04 on whether to continue fuel processing technology
- Cost
- Major issues with durability of fuel processor and PEM systems running on reformate
  - ✓ Sulfur compounds
  - ✓ Ammonia
  - ✓ Organic Compounds
  - ✓ Thermal effects & cycling