



*Idaho National Engineering and Environmental Laboratory*

# ***Nuclear Hydrogen Production RD&D***

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***At the Idaho National Engineering &  
Environmental Laboratory***

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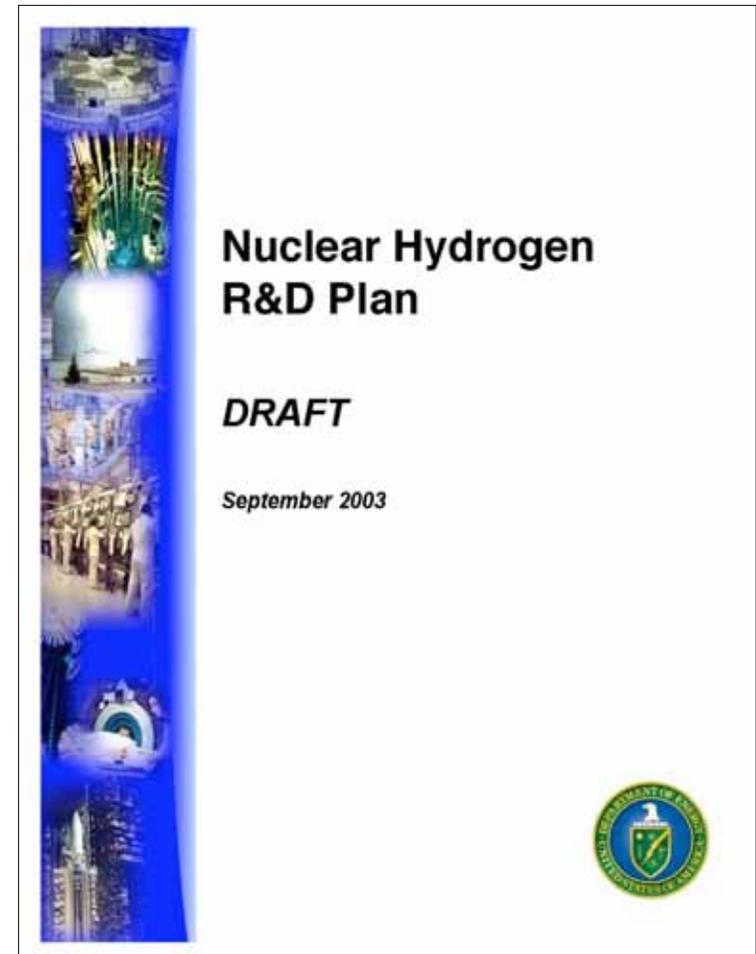
ANS Global 2003 Conference  
“Hydrogen Generation - 2003 and Beyond”  
November 18, 2003

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*[[http://nuclear.inel.gov/papers-presentations/Nuclear\\_Hydrogen\\_Production\\_RD&D.pdf](http://nuclear.inel.gov/papers-presentations/Nuclear_Hydrogen_Production_RD&D.pdf)]*

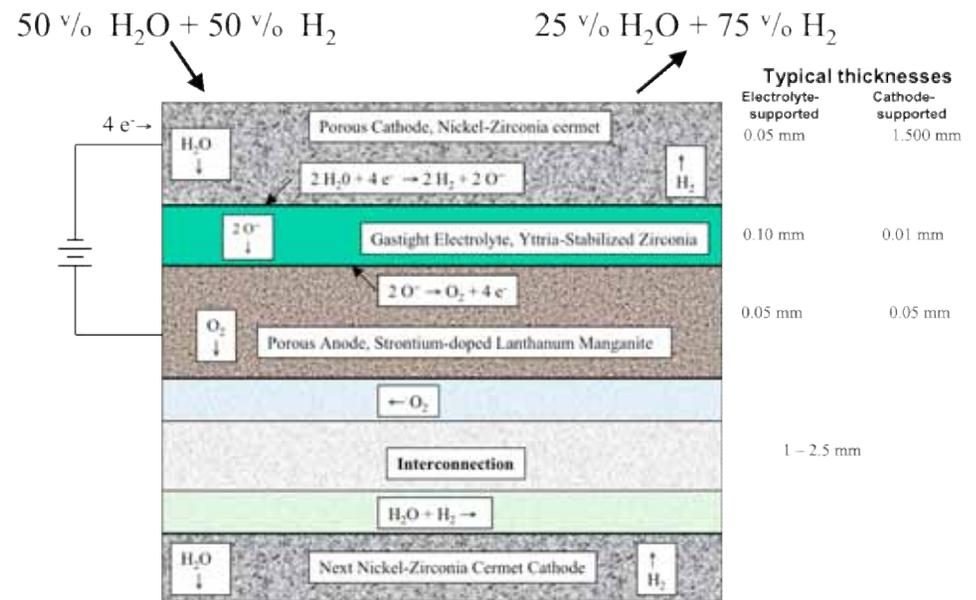
## **INEEL Nuclear Hydrogen RD&D Activities**

- *Current INEEL Hydrogen R&D Program Includes Projects in Production, Separations, Storage, Utilization and Infrastructure:*
  - *Diesel Reformer Demonstration*
  - *Thermochemical Materials, Kinetics, and Separations*
  - *High Temperature Electrolysis*
  - *Borohydride Regeneration*
  - *SOFC Development*
  - *Phoenix Hydrogen and Hydrogen/CNG Fueling Station and Vehicle Testing*
- *Topics for Further Discussion*
  - *High Temperature Electrolysis Approach and R&D Needs*
  - *Hydrogen Plant Systems Interfaces with the Nuclear Heat Source*
  - *NGNP Demonstration Program*



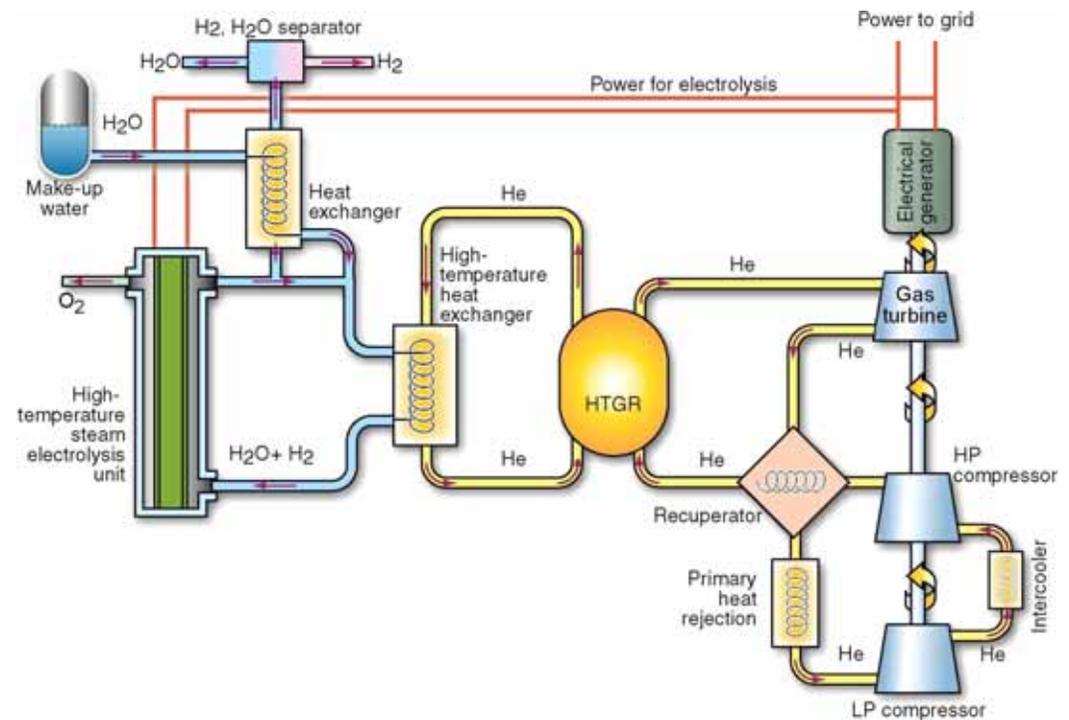
# High Temperature Electrolysis (HTE)

- *HTE Electrolyzer Similar to a Solid Oxide Fuel Cell (SOFC)*
- *Use of High-Temperature Steam Reduces the Electrical Energy Required for Electrolysis with a Net Reduction in Total Energy Required for H<sub>2</sub> Production.*
- *Target H<sub>2</sub> Production Efficiencies Exceeding 50% and H<sub>2</sub> Cost Less Than \$2/kg*
- *SOFC Technology and Materials R&D Leveraged from DOE FE Programs (cost is a major issue)*
- *HTE RD&D Focused on:*
  - *Conceptual Design of an HTE Plant Coupled to a VHTR (Cost and Performance Assessment).*
  - *Demonstrate Cell Performance at Scale*



# Hydrogen Plant System Design Challenges

- *Heat Exchangers and Materials*
- *Thermal Management*
- *Steam/Hydrogen Separations*
- *Systems Economics*
- *Safety*



# Summary of High-Temperature Electrolysis Research Needs

R&D Area	Technical Issues	HTE Requirement	Research Lead	Needed Research
System Design Studies	HTE System Configuration	100 – 300 MW hydrogen	NE lead	Design and trade studies for materials and component selection.  Cell-level and plant –level modeling necessary
	Plant Design Trade Studies	Engineering economics		
	HTE Process Models	Reheat of steam		
	Power electronics costs	Rectifiers AC to DC		
	Material Demands	HTE large materials req's		
Cell / Stack optimization	Interconnections	Thermal cycling	FE lead.	Monitor FE research
	Cell Sealing	Compressive or steam sealing		
	Electrolyte performance	YSZ satisfactory at high temps		
	Cathode Material	HTE less challenging		
	Anode Materials	Oxygen diluent		
Cell/Stack demonstration	Performance for NHI temp, pressure conditions	Technology demo by 2006	NE Lead	Test program for candidate HTE options

## ***The NGNP Demonstration Program Includes the Reactor-Hydrogen System Interfaces and the Balance of Plant Systems***

- *Intermediate Loop Working Fluid, Materials, Engineering Design*
- *Heat Exchangers*
- *Isolation Approach Between the Reactor and Hydrogen Plant*
- *Regulatory Approach*
- *Gas Handling, Storage and Process Support Systems*
- *Hydrogen Plant Economics*
- *Safety and Risk Analysis*

