U.S. Department of Energy Hydrogen Program

Producing Hydrogen from Nuclear Energy

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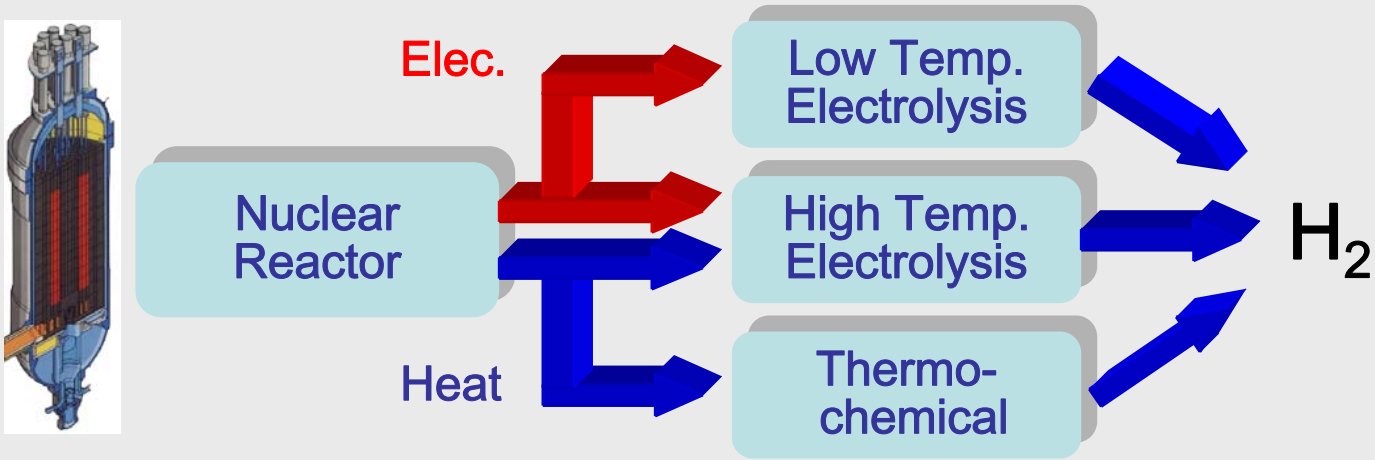
Hydrogen Manufacturing Using Clean Nuclear Energy

Nuclear power provides a viable source of energy for hydrogen production via several pathways.



All of these methods split water into hydrogen and oxygen.

Nuclear Hydrogen Initiative

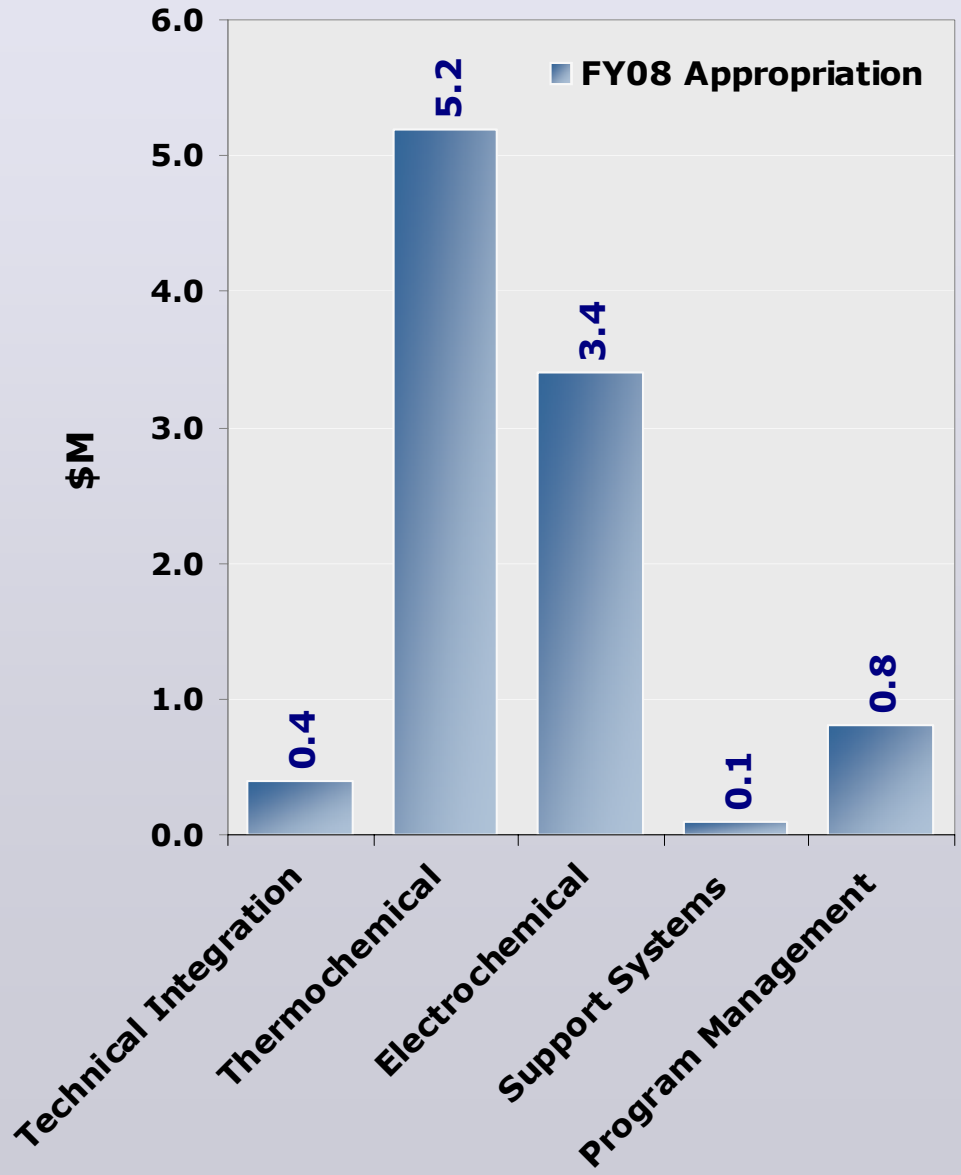
FOCUS: Hydrogen production technologies that are compatible with nuclear energy systems and do not produce greenhouse gases

OBJECTIVE: By 2019, operate a nuclear-compatible hydrogen production plant to produce hydrogen at a cost competitive with other alternative transportation fuels

Major Program Milestones

- FY 2007: Construction of laboratory-scale experiments
- FY 2011: Select hydrogen production technology to be coupled with the Next Generation Nuclear Plant (EPACT requirement)
- FY 2013: Operate pilot-scale hydrogen production experiments
- FY 2019: Demonstrate commercial-scale hydrogen production system for use with advanced nuclear reactors

NHI Budget



FY2009 Budget Request = $16.6M

FY2008 Budget = $9.9M

FY09 Emphasis

Operate laboratory-scale experiments:

- Continue testing of Sulfur-Iodine cycle
- Evaluate process improvements (membranes and improved catalysts)
- Design laboratory-scale experiment for Hybrid Sulfur cycle for construction in FY 2010.
- Continue High Temperature Electrolysis experiments begun in FY 2008
- Incorporate the results from the integrated laboratory scale experiments into the hydrogen production economic analysis model.

NHI R&D Approach

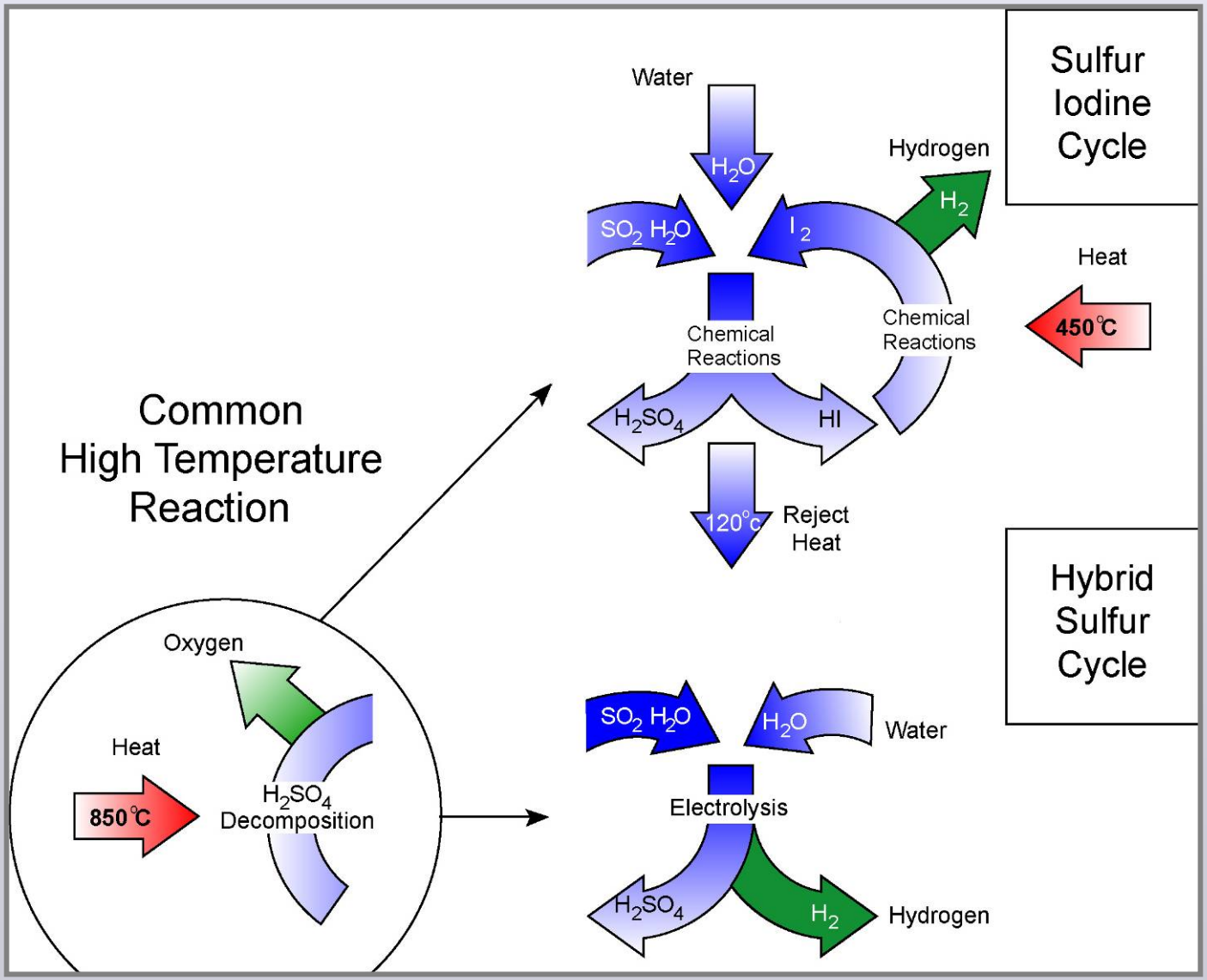
1. Thermochemical Cycles

- Process – performance potential and technical issues
- Integrated lab scale experiments (S-I, hybrid S, approx. 5 -10 kW)
- Pilot scale experiment (approx 0.5 - 1 MW)

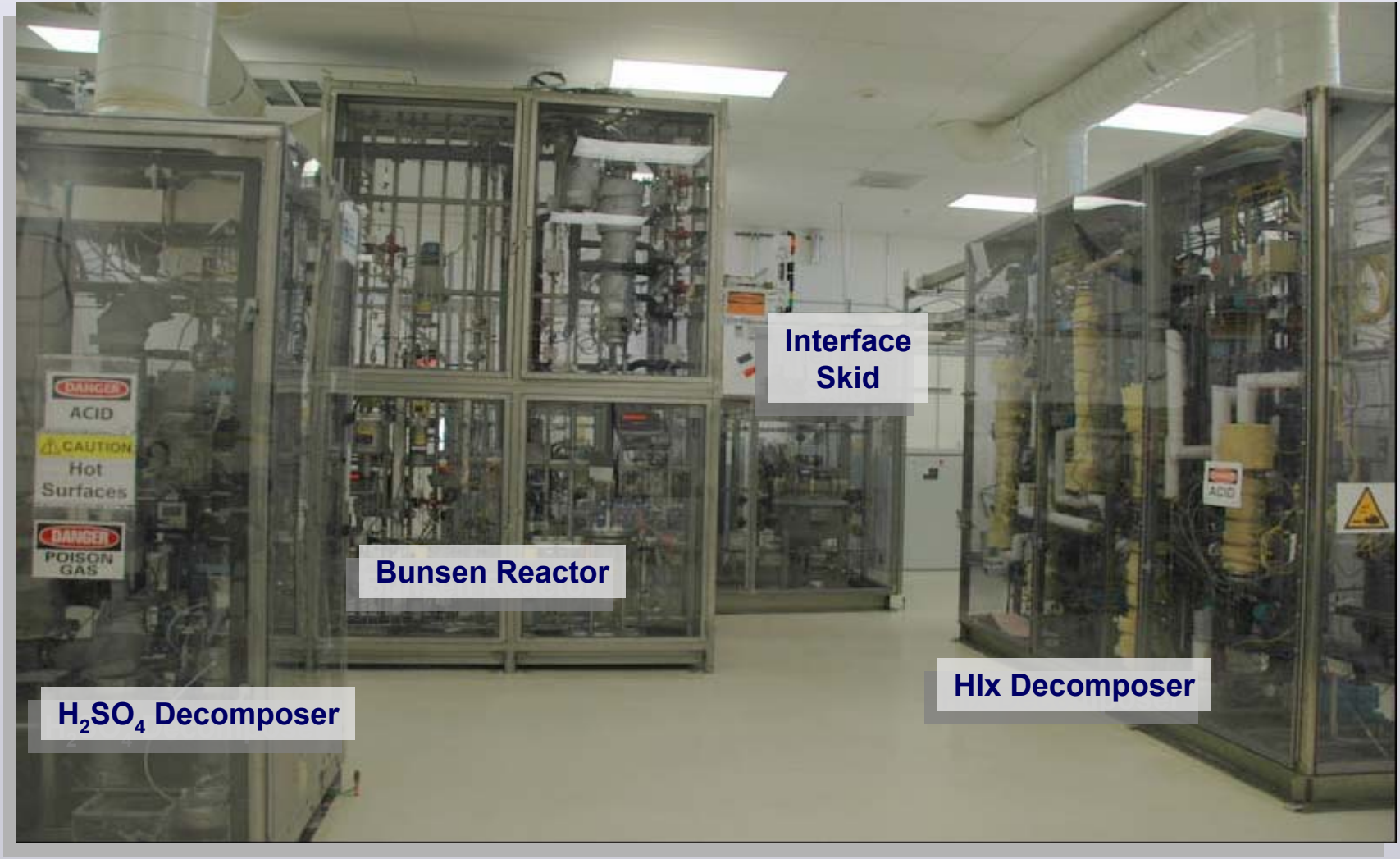
2. High Temperature Electrolysis

- Technology development – single, multi-cell stack experiments
- Scaling experiments (approx.15 kW)
- Pilot scale experiment facility (approx. 200 kW)

Sulfur-Based Thermochemical Cycles for Hydrogen Production



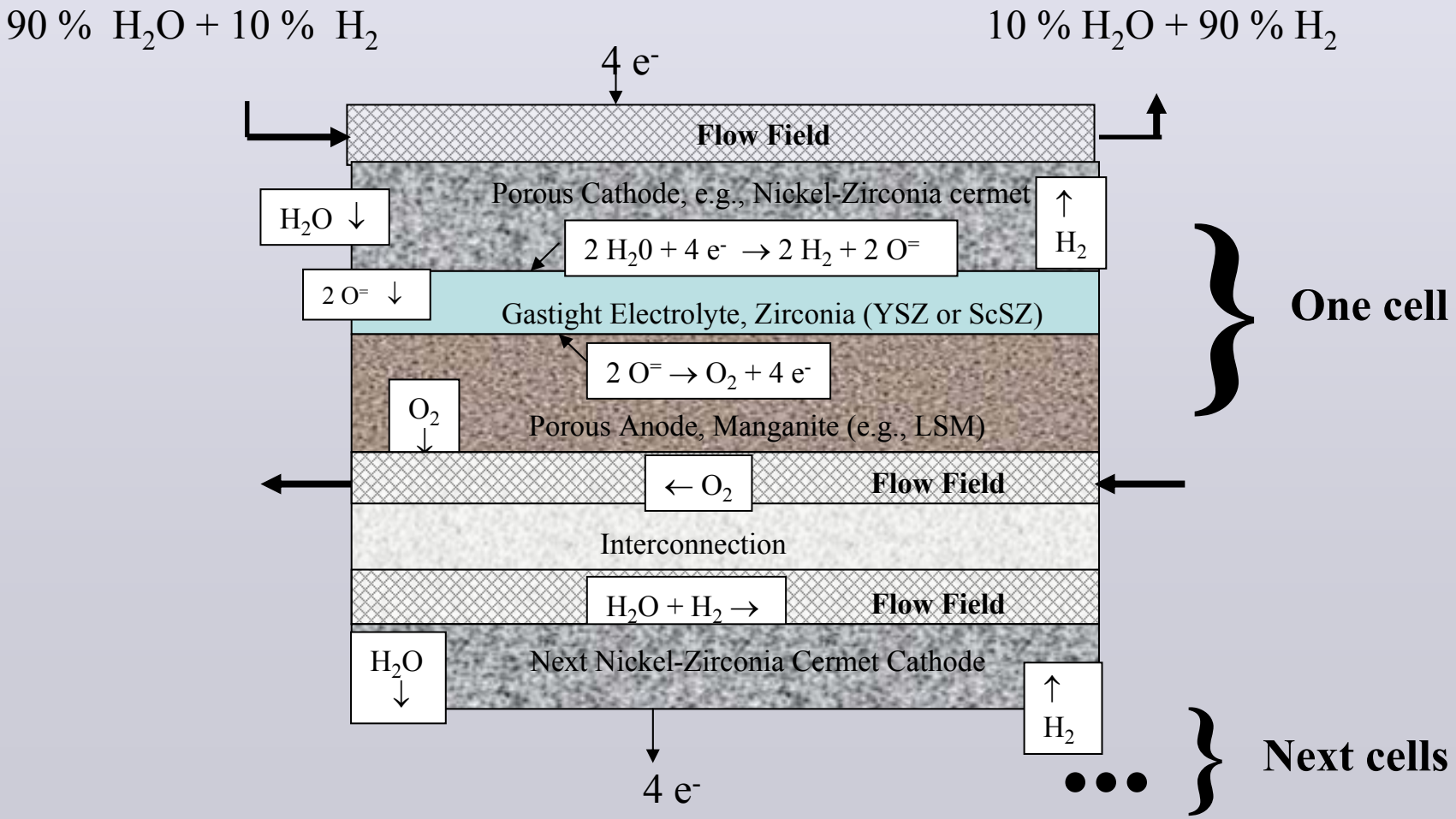
Sulfur-Iodine Integrated Laboratory-Scale Experiment



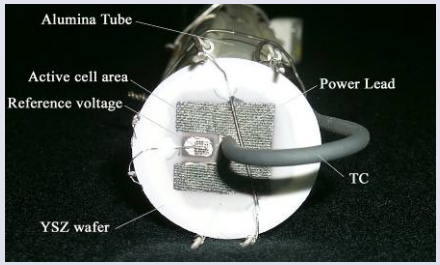
(General Atomics, Sandia National Laboratory, Commissariat à l'Energie Atomique of France (CEA))

High Temperature Steam Electrolysis for Hydrogen Production

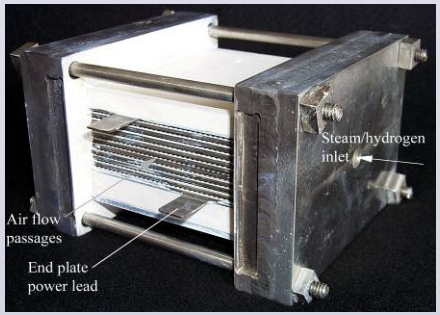
Planar Solid-Oxide Electrolysis Stack



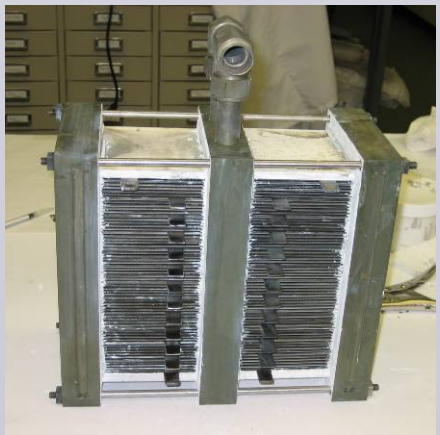
High Temperature Electrolysis: from Button Cells to the Integrated Laboratory Scale Experiment



Button cell (2003) 3.2 cm²



10-cell stack (2004) 640 cm²



120-cell half-module (2006) 7,680 cm²

Integrated Laboratory Scale (operational 8-22-07)
720 cells, 3 modules (2008) 46,080 cm²
(Idaho National Laboratory)

Generation IV International Forum Interest in Very-High-Temperature Reactor (VHTR) Hydrogen Project

Canada   ***United States***

France   ***South Africa***

Japan   ***European Union***

Korea   ***Switzerland***

Then what ???

Progressive uses of hydrogen produced through nuclear energy

- Upgrading of heavy crude oils for the production of gasoline
- Upgrading of Athabasca Oil Sands for production of diesel and gasoline
- Fischer-Tropsch synthesis of diesel, jet fuel, and gasoline using CO from coal gasification
- Utilization of bulk-stored H2 and O2 for peak power generation
- Co-electrolysis of CO2 from biomass and steam to produce CO and H2 for synthetic, GHG-neutral, gasoline, diesel and jet fuels
- Nuclear production of H2 for use in fuel-cell-powered vehicles as well as stationary fuel cells.