Exceptional service in the national interest

Sandia National Laboratories

Twitter: @SandiaEnergy

Website: energy.sandia.gov



Sandia National Laboratories Hydrogen and Fuel Cell Technical Advisory Committee Meeting, April 6–7, 2016

Marianne C. Walck, Ph.D.
Vice President, California Laboratory
Vice President, Energy & Climate Program

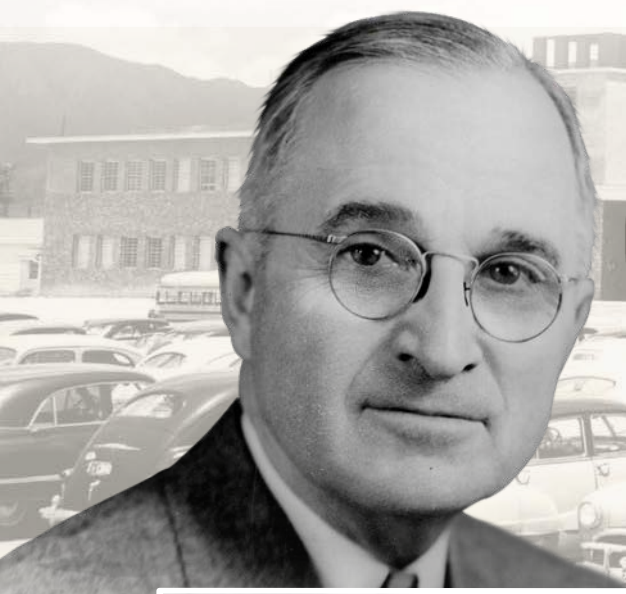
SAND2016-2931 PE

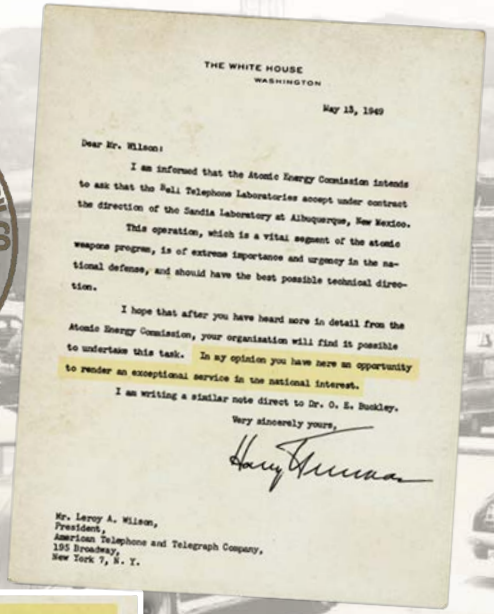
U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

Sandia's History

Exceptional service in the national interest





THE WHITE HOUSE
WASHINGTON

May 13, 1949

Dear Mr. Wilson:

I am informed that the Atomic Energy Commission intends to ask that the Bell Telephone Laboratories accept under contract the direction of the Sandia Laboratory at Albuquerque, New Mexico.

This operation, which is a vital segment of the atomic weapons program, is of extreme importance and urgency in the national defense, and should have the best possible technical direction.

I hope that after you have heard more in detail from the Atomic Energy Commission, your organization will find it possible to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.

I am writing a similar note direct to Dr. O. E. Buckley.

Very sincerely yours,

Harry Truman

Mr. Leroy A. Wilson,
President,
American Telephone and Telegraph Company,
195 Broadway,
New York 7, N. Y.

July 1945: Los Alamos creates Z Division

November 1, 1949: Sandia Laboratory established
1952: University of California Radiation Laboratory at Livermore (now LLNL) established

March 8, 1956:
Sandia officially establishes a second laboratory at the Livermore site

to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.

Sandia Operates in Many Locations

Sandia National Laboratories

Albuquerque, New Mexico

Livermore, California

Kauai, Hawaii

Waste Isolation Pilot Plant, Carlsbad, New Mexico

Pantex Plant, Amarillo, Texas

Tonopah, Nevada

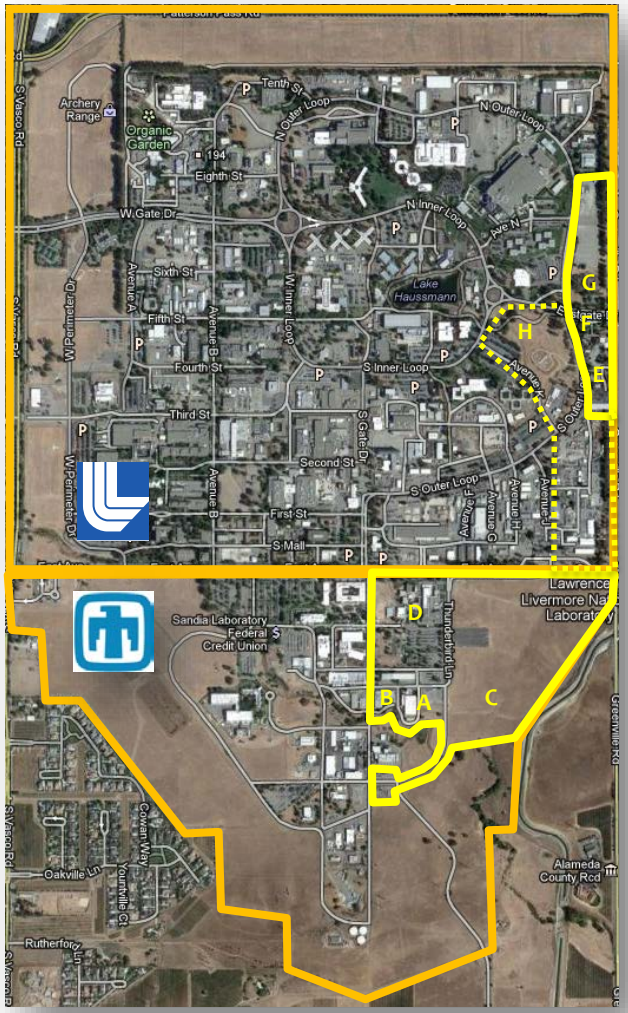
Sandia California Laboratory is a Strategic Asset

- National Laboratory Partnerships:
  - Lawrence Livermore
  - Lawrence Berkeley
- University Collaborations- provide access to world-class minds and unique facilities
- International Partnerships
- Industry Collaborations
- State of California – leadership in energy policy

LVOC enables partnerships that benefit the entire breadth of Sandia's mission space

Livermore Valley Open Campus (LVOC)

Enhance collaborations between the external world and the Labs



	South campus (SNL Facilities)	*North Campus (LLNL Facilities)*	
A. Cybersecurity Technology Research Laboratory			**E. High Performance Computing Innovation Center**
B. Bio-tech Facility			**F. Discovery Center**
C. Clean Energy Demonstration Field			**G. Hertz Hall Complex**
D. Combustion Research Facility			**H. HPCIC leverages proximity to future Advanced Computing Complex**

Over 250,000 square feet of office and lab space

5

Sandia's Energy Program

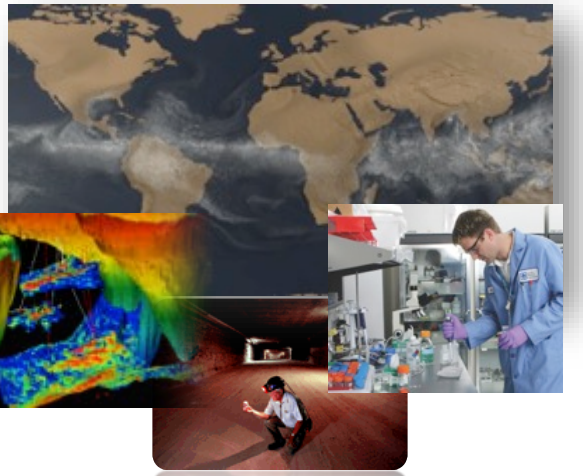
Sandia National Laboratories

Energy Research

Chemical, Geological, Biological, Materials, Computational, and Nano Sciences

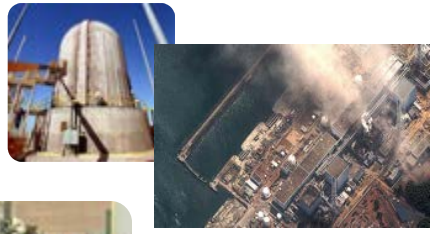
Climate & Engineered Earth Systems

Measurement & Modeling, Energy & Water, Fossil Energy, Biofuels, DOE Managed Nuclear Waste



Nuclear Energy & Fuel Cycle

Commercial Nuclear Power Generation, Nuclear Energy Safety & Security



Renewable Systems & Energy Infrastructure

Renewable Energy, Energy Efficiency, and Grid Modernization

Transportation Energy & Systems

Vehicle Technologies, Biomass, Fuel Cells & Hydrogen Technology

Sandia's Hydrogen Program

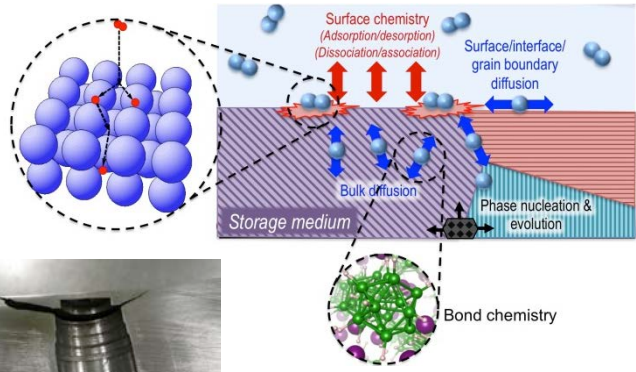
Sandia National Laboratories

Hydrogen Production

Develop concentrated solar power for large-scale, renewable production of hydrogen

Hydrogen Storage

Provide fundamental understanding of the phenomena limiting solid-state hydrogen interactions



Hydrogen Delivery

Identify pathways for reducing cost of steel hydrogen pipelines without compromising reliability and integrity

Safety, Codes and Standards

Facilitate safe deployment of hydrogen technologies with science-based codes and standards

Fuel Cells

Develop new membrane systems for enhanced electrochemical performance

Systems Engineering

Demonstrate innovative engineering solutions to harness clean energy technologies



FUEL CELLS TECHNOLOGY OFFICE (FCTO) and

SANDIA'S HYDROGEN CAPABILITIES

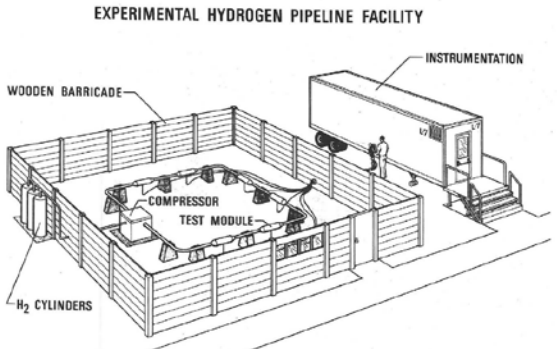
Chris San Marchi
Hydrogen Program Manager
Distinguished Member of the Technical Staff

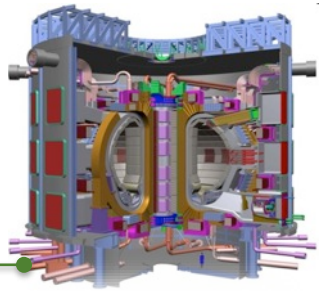
History of Hydrogen Sciences at Sandia

Sandia National Laboratories

Core mission to support the nuclear deterrent

Enabling science and engineering for energy programs

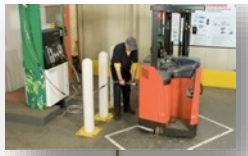




FUSION ENERGY

METAL HYDRIDE CENTER OF EXCELLENCE

Lift-Truck Lifecycle Requirements

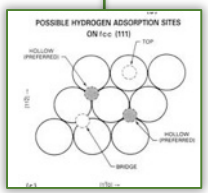


H2 Infrastructure Partnerships

H_2FIRST

1960 1970 1980 1990 2000 2004 2008 2012 2016

METALLURGY



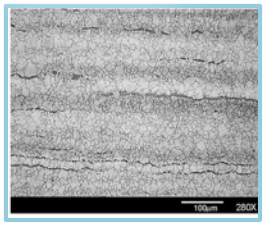
Embedded Atom Method

RATLER

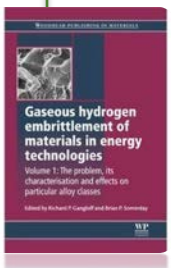
AUTOMOTIVE STORAGE

HyMARC

TRITIUM RESEARCH



MINING LOCOMOTIVE



Core Hydrogen Capabilities

- Hydrogen behavior and risk evaluation (QRA)
  - Turbulent Combustion Laboratory
- Compatibility of materials in high-pressure hydrogen
  - Hydrogen Effects on Materials Laboratory (HEML)
- Solar thermochemical hydrogen (STCH) production
  - National Solar Thermal Test Facility (NSTTF)
- Storage materials discovery and development
  - Hydrogen Materials – Advanced Research Consortium
- Membrane synthesis and development
- Infrastructure scenario and technoeconomic analysis
- Solid-state hydrogen storage system engineering
- Hydrogen Fueling Infrastructure Research and Station Technology
  - Hydrogen Station Equipment Performance (HyStEP) device

HyRAM HYDROGEN RISK ASSESSMENT MODELS

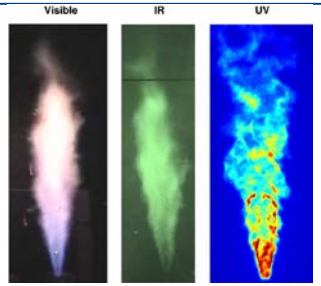
HyMARC

H2FIRST

Hydrogen Science is Key to Developing Predictive Engineering Tools for Safety, Codes and Standards

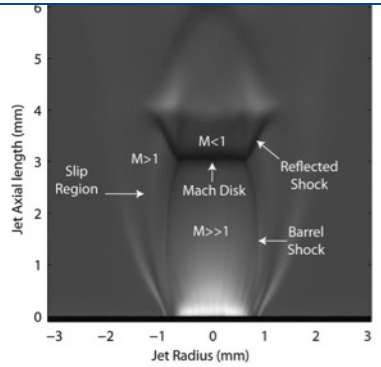
Sandia National Laboratories

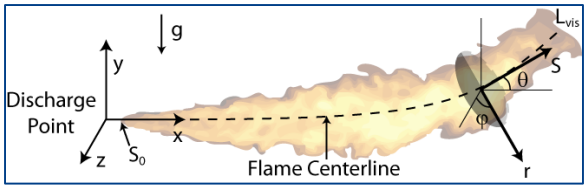
Radiative properties of H2 flames quantified



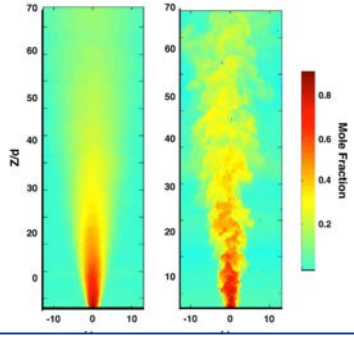
Barrier walls for risk reduction

Ignition of under-expanded H2 jets



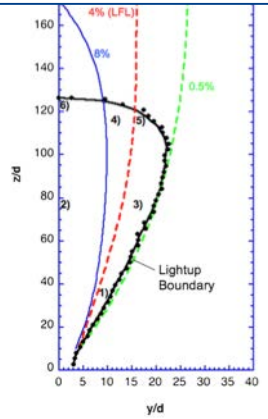


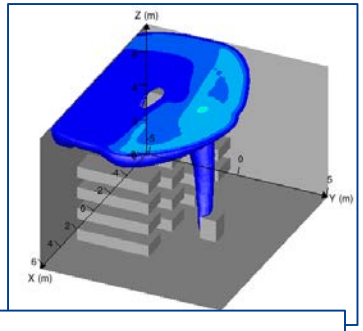
Buoyant jet flame model with multi-source radiation



Advanced laser diagnostics applied to turbulent H2 combustion

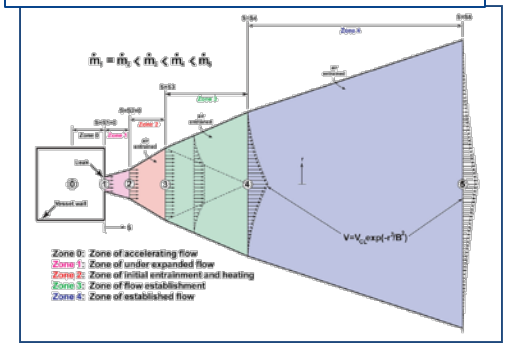
Ignition limits of turbulent H2 flows





Experiment and simulation of indoor H2 releases

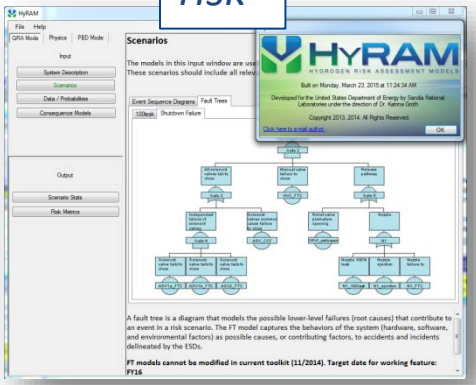
Laboratory-scale characterization of LH2 plumes and jets



Making Science Accessible through Integrated Tools

Sandia National Laboratories

risk



Develop integrated methods and algorithms

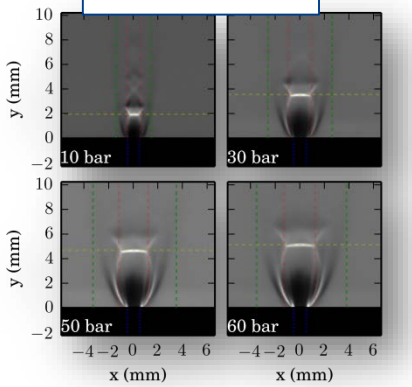
for enabling consistent, logical and defensible QRA

application

Apply quantitative risk assessment techniques

in real hydrogen infrastructure and emerging technology

behavior



Develop and validate scientific models

to accurately predict hazards and harm from liquid releases, flames, etc.

hyram.sandia.gov

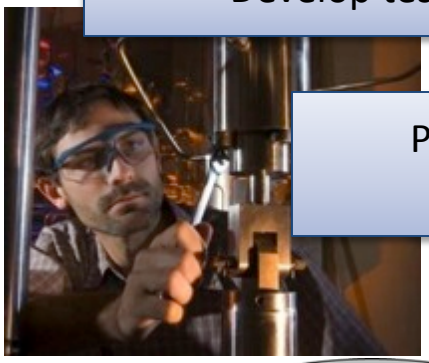
HyRAM
HYDROGEN RISK ASSESSMENT MODELS

Official public release: April 26th webinar

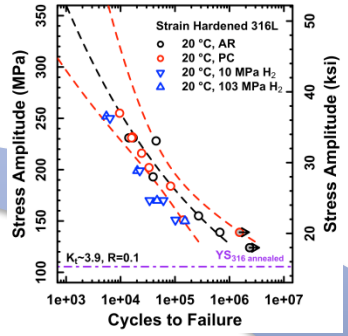
International Leadership in Materials Compatibility Enables Innovation of Hydrogen Technologies

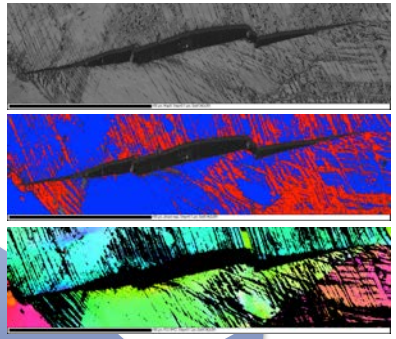
Sandia National Laboratories

Develop test methods

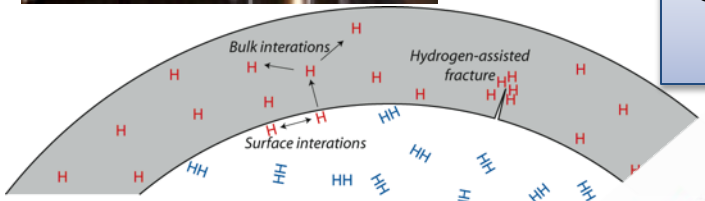


Performance-based testing (compatibility)

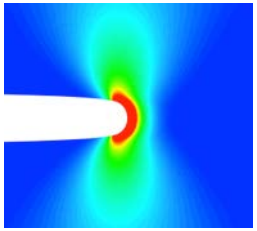




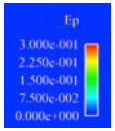
Understanding physics of hydrogen embrittlement

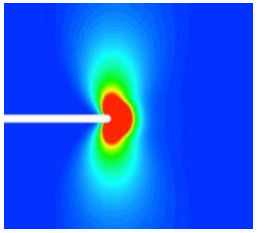


Predictive models

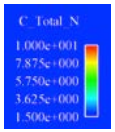


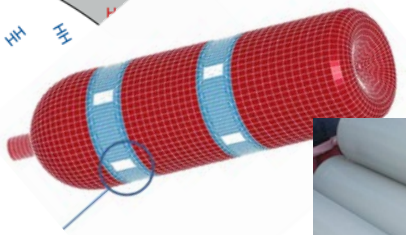
Transport



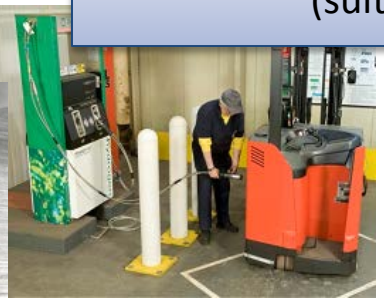


Mechanics





System validation (suitability)



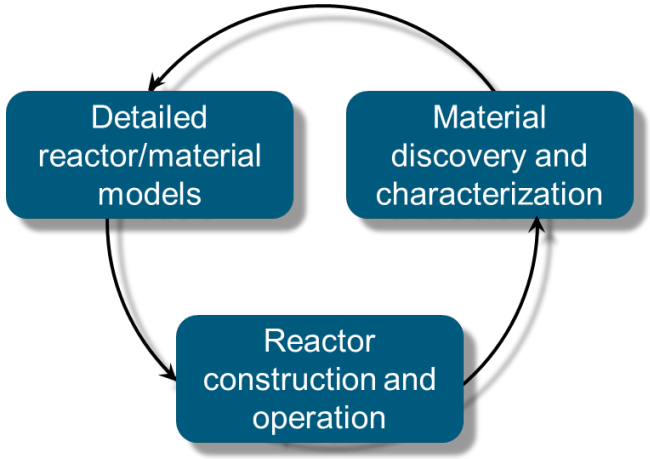
Large-Scale Renewable Hydrogen Production using Solar Power Leads to a Sustainable Energy Future

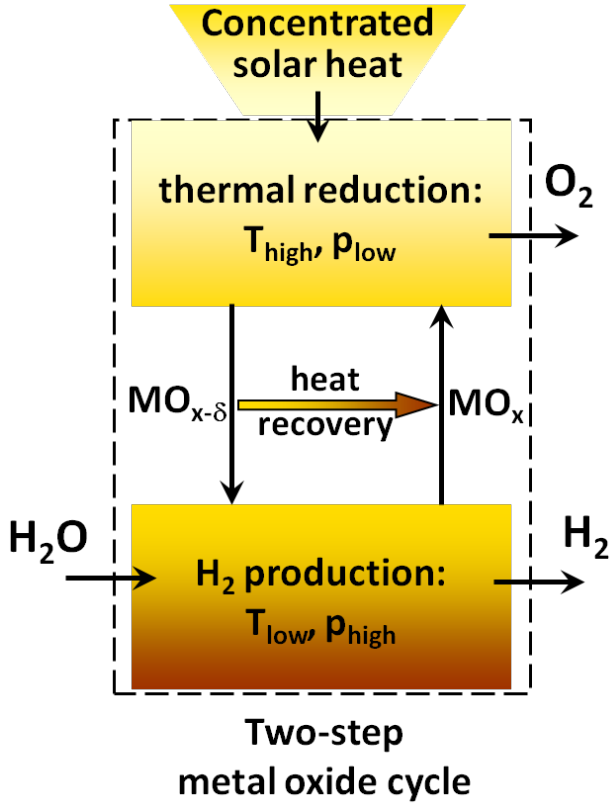
Sandia National Laboratories

Two-step thermochemical water-splitting cycle

MW scale concentrating solar power facilities provide heat for

1. Metal oxide reduction
2. Oxidation with water ***producing hydrogen***





Two-step metal oxide cycle

The challenge is to develop efficient and scalable solar-powered reactors up to 100,000 kg/day

Early Hydrogen Market Demonstrations

Hydrogen Fuel Cell Mobile Light Tower

- Zero emissions
- Quiet alternative to mobile diesel power

Hydrogen Fuel Cell Generator for Maritime/Ports

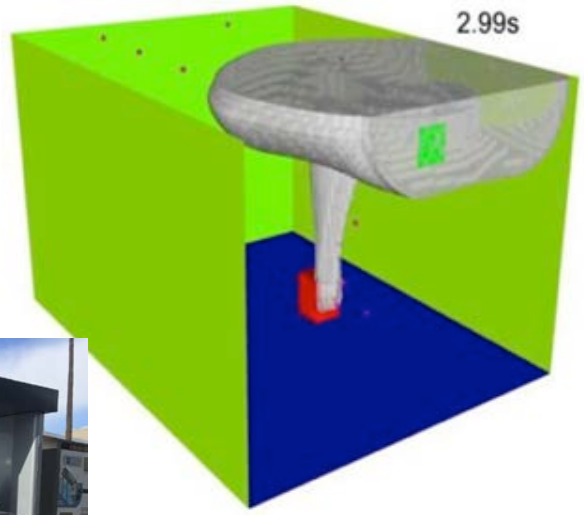
- Quiet deployable power
- Containerized, clean power

Zero Emission Hydrogen Passenger Ferry *(study)*

- Green transportation over water
- Multi-use hydrogen station

Sandia's Hydrogen & Fuel Cells Program

Providing the science and engineering to accelerate the deployment of clean and efficient hydrogen and fuel cell technologies



Commercial hydrogen systems today are safer and less costly due to Sandia's scientific and technical leadership