

Hydrogen with Carbon Management Overview

2024 FECM/NETL Spring R&D Project Review Meeting

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U.S. DEPARTMENT OF
ENERGY



Achieving a Carbon-free Power Sector by 2035



01

NETL lends its expertise toward achieving a carbon-free power sector by 2035 and a net-zero economy by 2050.

02

NETL research catalyzes economic revitalization, creating good-paying jobs and supporting workers in energy communities, especially hard-hit coal, oil and gas, and power plant communities, across the country.

03

One of the most rewarding aspects of NETL's research is that our innovations & technologies have the potential to improve people's lives in meaningful ways.

NETL Supports FECM's Strategic Vision



Advancing Carbon Management Approaches Toward Deep Decarbonization

- Point-source carbon capture
- Carbon dioxide conversion
- Carbon dioxide removal
- Reliable carbon transport and storage

Advancing Technologies that Lead to Sustainable Energy Resources

- Hydrogen with carbon management
- Domestic critical minerals production

Advancing Justice, Labor, and Engagement

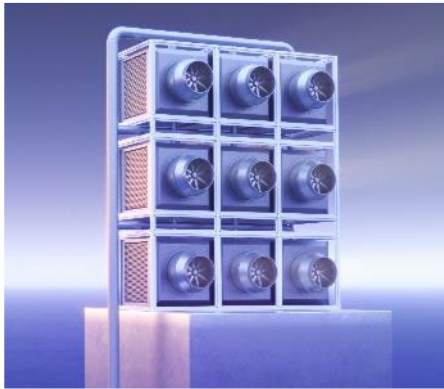
- Justice
- Labor
- International and Domestic Partnerships



Empowering a Low-Carbon Economy

Carbon Management Technologies

Enable Carbon Dioxide Removal



Removing CO₂ from the atmosphere while storing or utilizing the resultant carbon

Advanced Hydrogen Technologies



Enabling carbon - negative hydrogen fuel for transportation, power generation, & industrial processes

Lower Carbon Capture Cost



Developing transformational technologies to lower the cost of CO₂ capture

Revitalizing Fossil Energy Related Communities

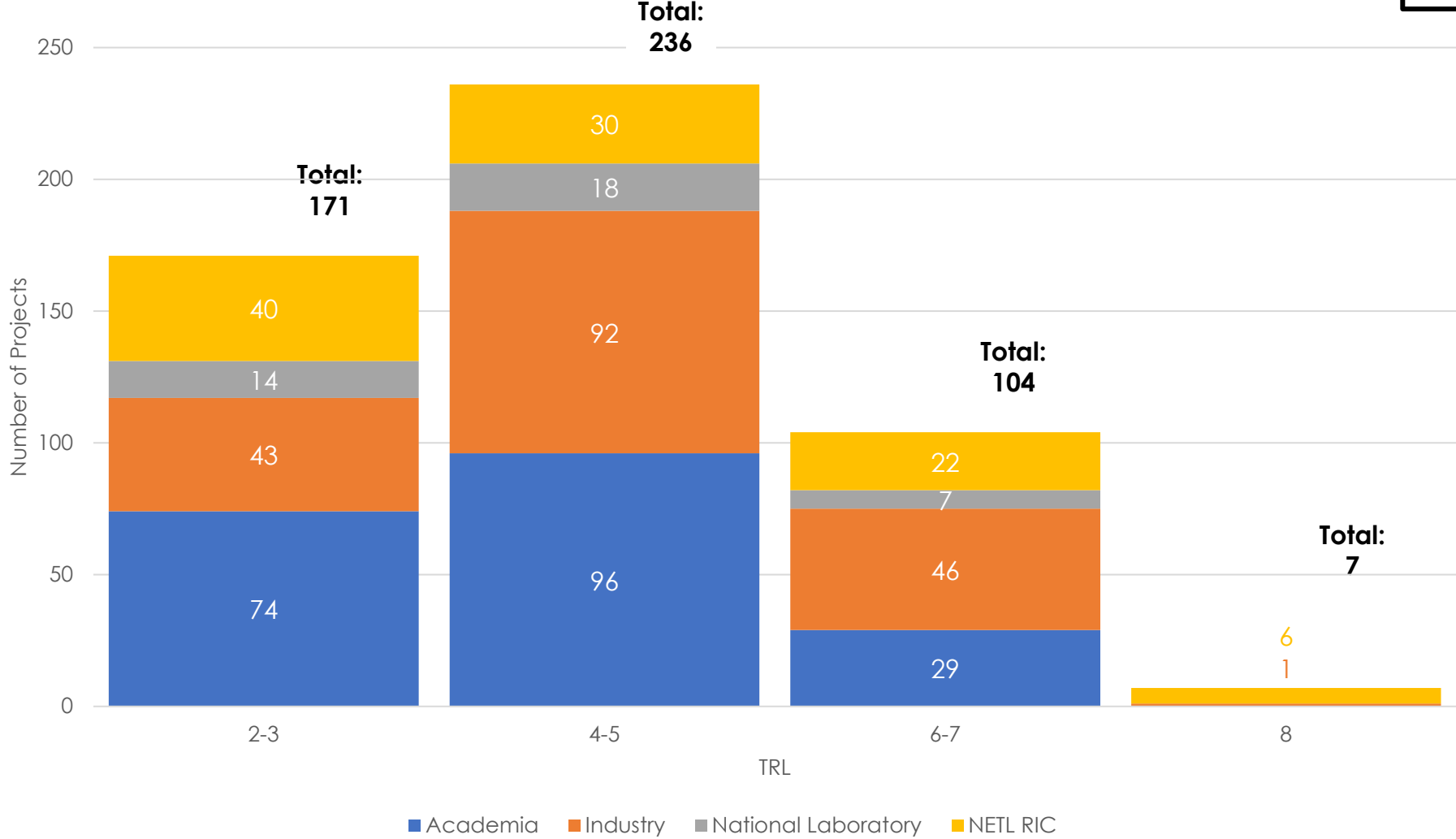


Benefiting communities having borne the brunt of fossil energy related pollution

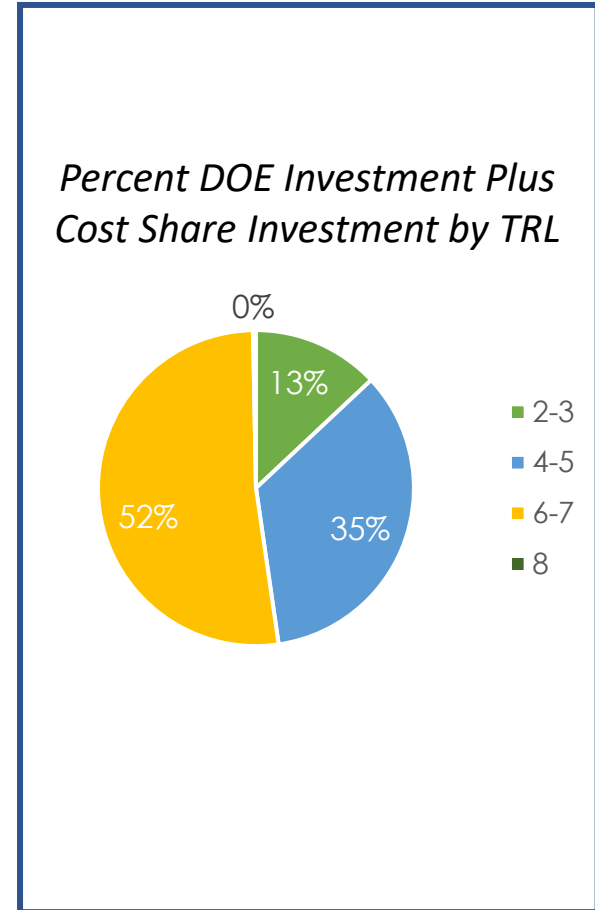
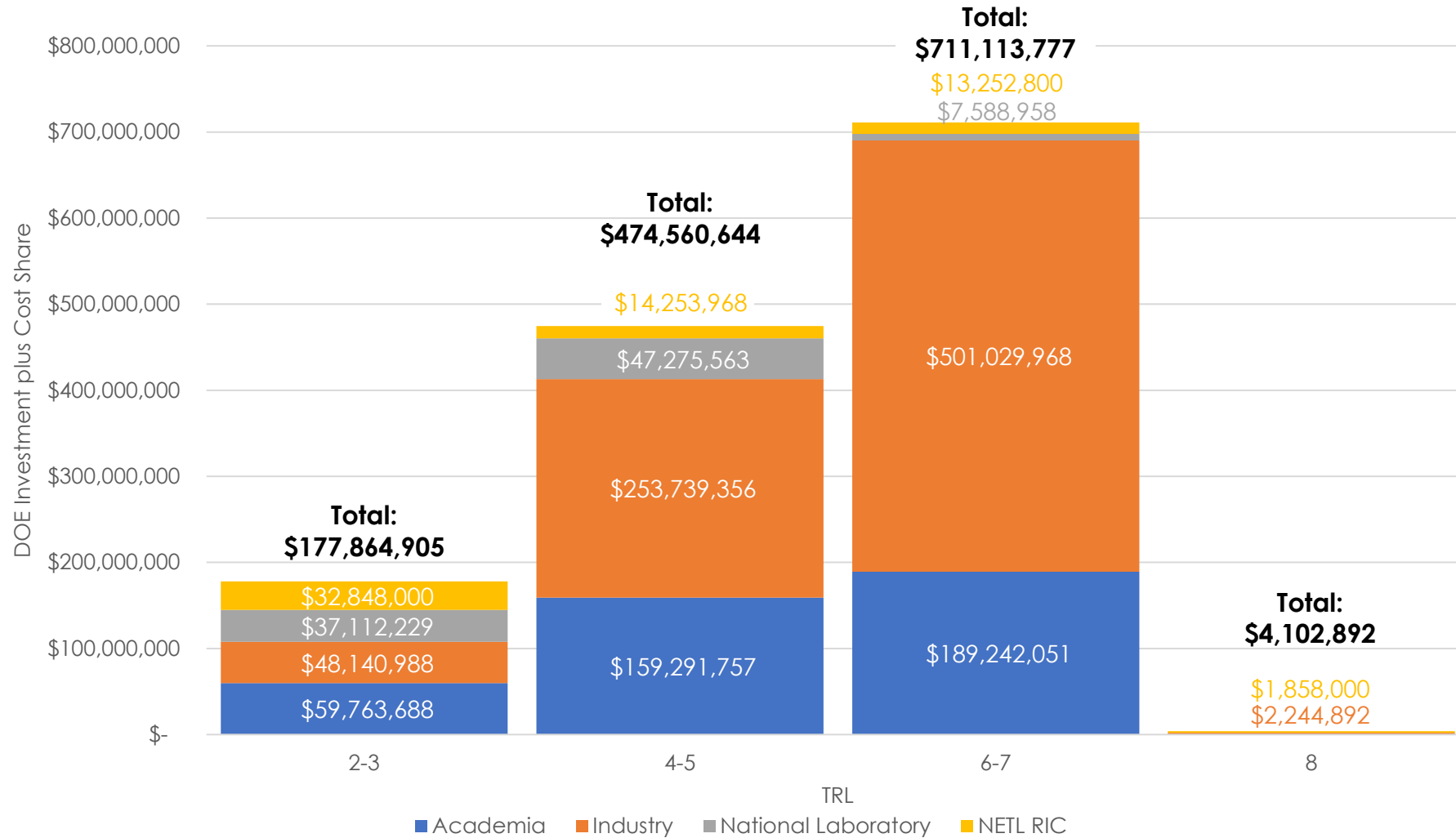
Recipient/Performer Type by Technology Readiness Level (TRL) (Active Projects as of January 2024)

Grand Total: 518

Grand Total: 518 Projects
 Academia: 199
 Industry: 182
 National Laboratory: 39
 NETL RIC: 98



DOE Investment Plus Cost Share by Technology Readiness Level (TRL) (Active Projects as of January 2024) Grand Total: \$1,367,642,218



Driving Innovations Through Partnerships



An Active Portfolio from Concept to Market Readiness

500+ partnerships with industry, academia, and gov't agencies

1,100+ research and development projects nationwide





- Cooperative Research and Development Agreement (CRADA)
- Contributed Funds Agreement (CFA)
- Memorandums of Understanding (MOU)/ Memorandums of Agreement (MOA)
- Informal Discussions

- Non-Analysis Agreements (NAA)
- Small Business Innovation Research (SBIR) & Small Business Technology Transfer (STTR) Programs
- Licenses
- Non-disclosure Agreement (NDA)
- Financial Assistance Awards (FA)

Available Technologies

- NETL's technology portfolio contains a broad range of innovations that have resulted from research
- Technologies and intellectual property available for licensing on NETL's website

Available Technologies:

<https://www.netl.doe.gov/business/tech-transfer/available-technologies>

Funding Opportunity Announcement (FOA)

- NETL uses FedConnect.net, EERE Program Information Center, Grants.gov, and Contract Opportunities to post FOAs
- Proposals and applications are only accepted electronically through FedConnect.net or Grants.gov

Funding Opportunities:

<https://www.netl.doe.gov/business/solicitations>



Thank You!

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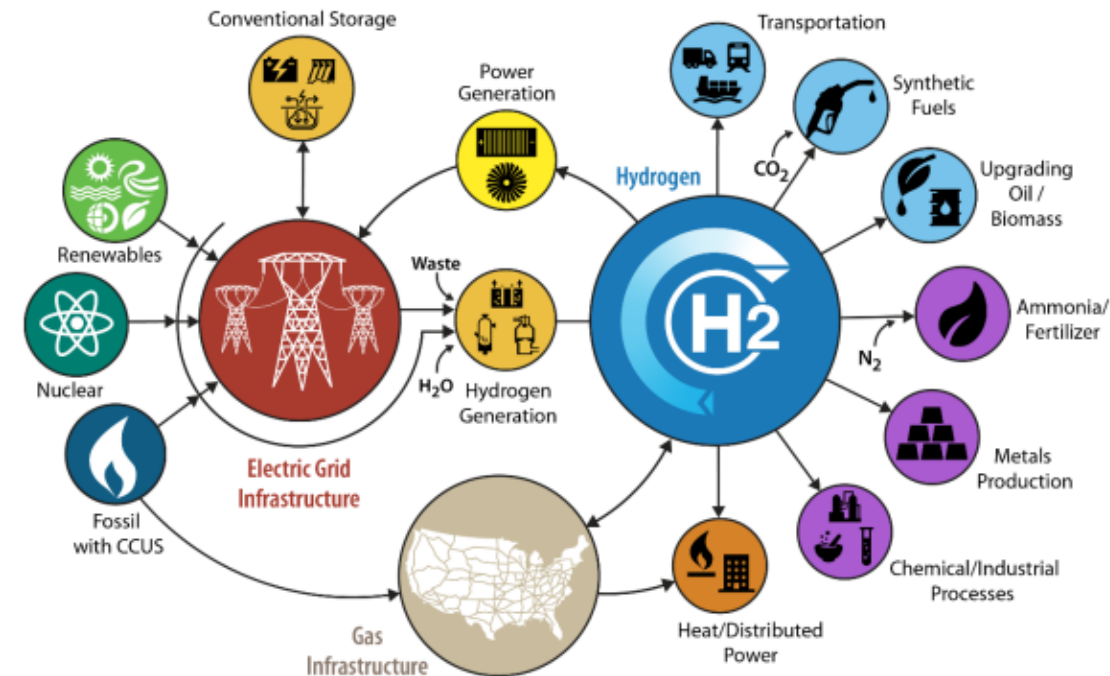
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Hydrogen Strategy

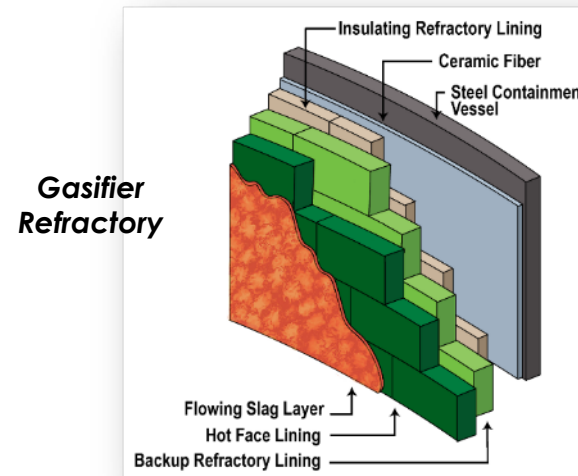
DOE National Clean Hydrogen Strategy and Roadmap 2022

- Hydrogen production, transport, storage and use in United States
- Opportunities for clean hydrogen to contribute to national goals
- Targets:
 - 10 million metric tonnes/year (MMTY) of clean hydrogen by 2030,
 - 20 MMTY by 2040, and
 - 50 MMTY by 2050
- Strategies:
 - High-impact clean hydrogen uses
 - Clean hydrogen cost reductions
 - Regional hydrogen networks
- Coordination with industry, academia, Tribal, environmental & justice communities

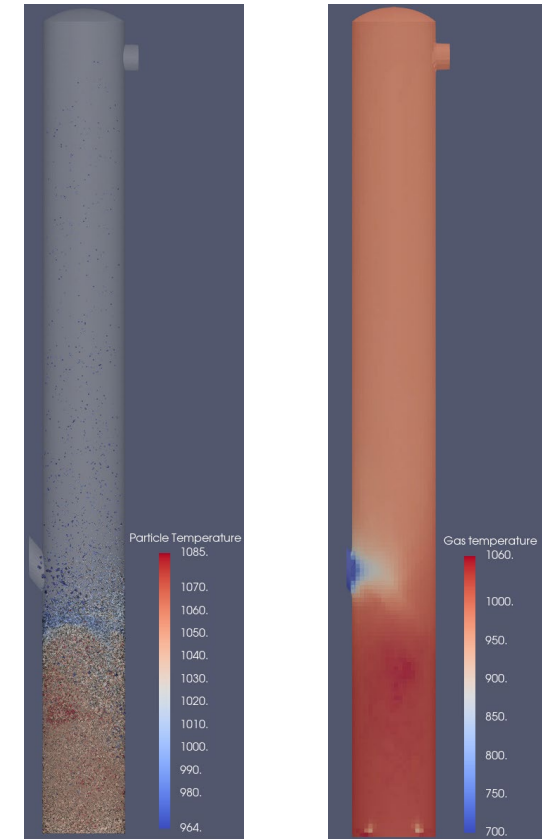


Gasification Systems

Program: Developing gasification & supporting technologies to enable the use of diverse waste & biomass feedstocks to produce hydrogen and other value-added products with net-zero carbon emissions



Biomass Particle Temperature (K) **Gas Temperature (K)**



MFiX
MFiX Model of Fluidized Gasification Reactor
located at Sotacarbo, Italy

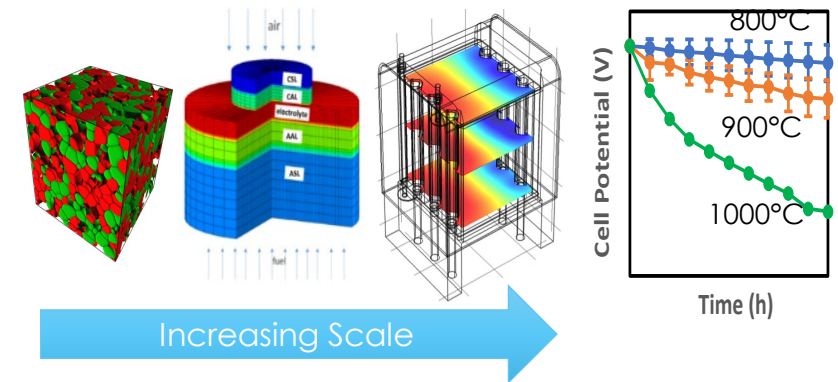
Reversible Solid Oxide Fuel Cells (RSOFC)

Program: Research, development, and demonstration to enable commercialization of low carbon emission RSOFC, specifically by:

- Developing of RSOFC systems
- Conducting basic R&D to mature RSOFC technologies
- Developing efficient and cost-effective electrolyzers for hydrogen production
- Validating small-scale SOFC systems

Performance Degradation Modeling

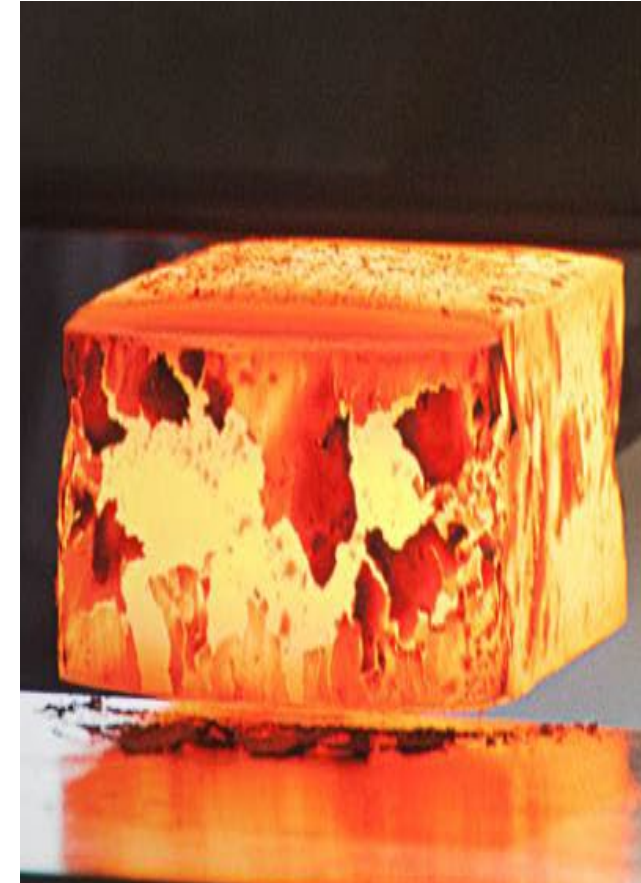
- Degradation prediction tools
- Atoms-to-System scale bridging
- Experimental validation
- Advanced Gas, Temperature Sensors



Advanced Energy Materials

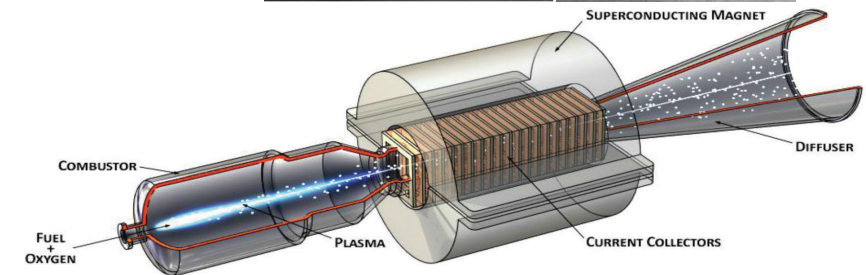
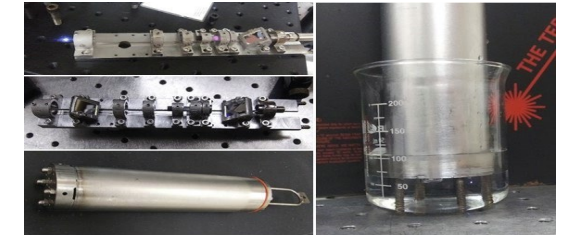
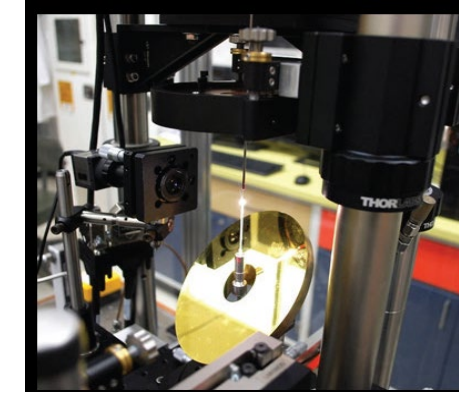
Program: Establishing a new domestic supply chain of hydrogen resistant materials and enhancing the supply chain for high-temperature materials to support a competitive U.S. industry base, including:

- Ceramic matrix composite materials for turbines to address 70% efficiency and firing 100% hydrogen
- High-Performance Computing for Materials (HPC4Mtl) for materials in energy
- Materials to overcome hydrogen embrittlement, high-temperature hydrogen attack, and creep
- Additive manufacturing for high-performance materials



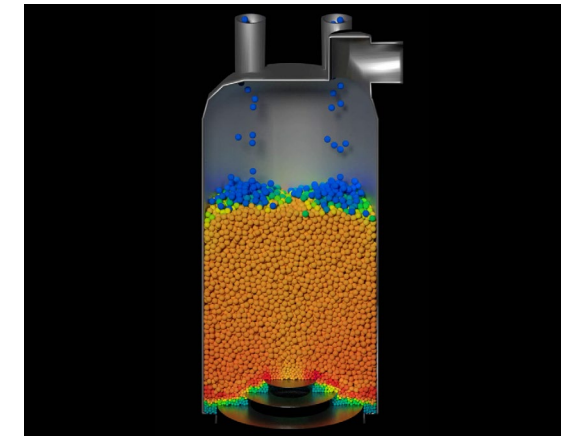
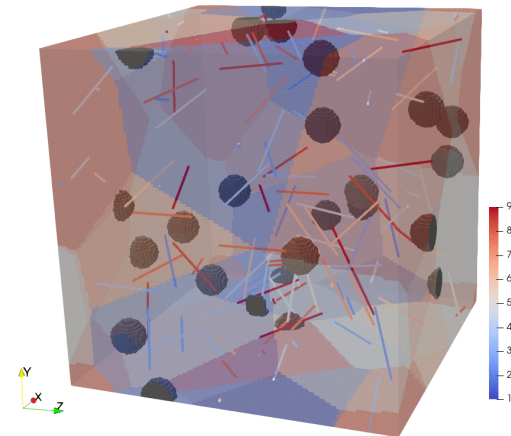
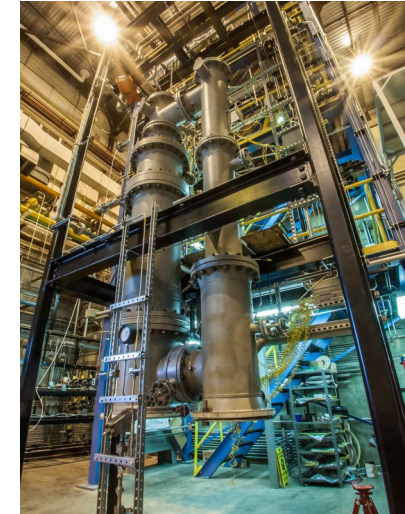
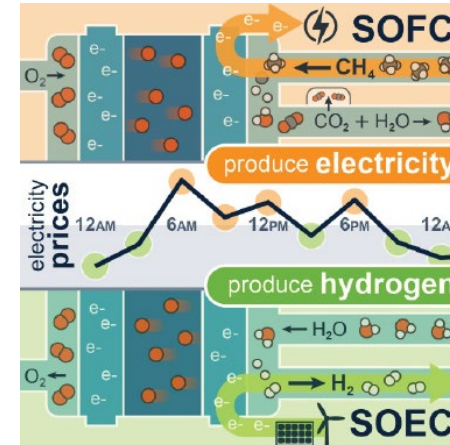
Sensors, Controls, and Other Novel Concepts

Program: Conduct research and development for technologies that will provide pivotal insights into optimizing performance, reliability, and availability of integrated energy and carbon management systems



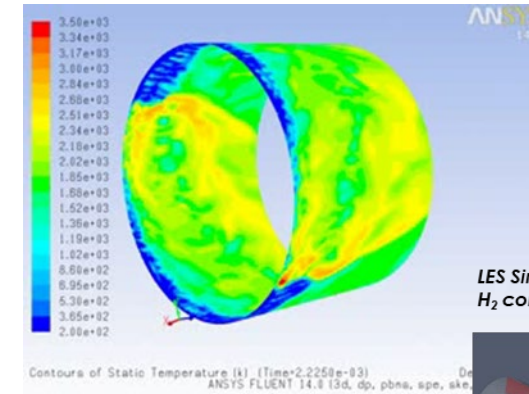
Simulation-Based Engineering

Program: Simulate challenges to enable technology solutions at multiple scales to accelerate development and deployment

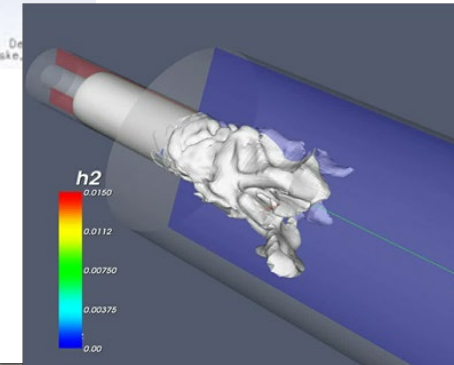


Advanced Turbines

Program: Developing near-zero-emission advanced turbine technologies that will accelerate turbine performance, efficiency, and cost effectiveness beyond current state-of-the-art, as well as provide tangible benefits of eliminating CO₂ emissions, lowering cost of electricity, and reducing the emissions of criteria pollutants.



LES Simulation of flashback with increasing H₂ content in a NG fuel



University Training & Research



Program: Preparing the next generation to meet future energy challenges

Focus:

- Educate and train the next generation of engineers and scientists
- Support novel, early-stage research that advances FECM's mission of delivering integrated solutions related to fossil energy and carbon management
- Increase R&D opportunities for underrepresented and structurally marginalized communities
- Ensure that students are being equipped with cutting-edge, translatable skillsets

