NETL Overview: Accelerating Technology Innovation for a Decarbonized Energy Future

Driving Innovation and Delivering Solutions

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MISSION

Driving innovation and delivering solutions for an environmentally sustainable and prosperous energy future:

- Ensuring affordable, abundant and reliable energy that drives a robust economy and national security, while
- Developing technologies to manage carbon across the full life cycle, and
- Enabling environmental sustainability for all Americans

VISION

To be the nation's premier energy technology laboratory, delivering integrated solutions to enable transformation to a sustainable energy future.









Federal

490

Contractor

843

By the Numbers

3 labs across U.S. 1000+ R&D projects in 50 states \$5.0B total award value \$1.2B FY22 budget

Workforce

- 1,344 Full Time Equivalent Employees (FTEs)
 - 4 Joint Faculty
 - **2** Postdoctoral Researchers
 - 8 Graduate Students
 - Undergraduate Students

NETL manages & implements an array of activities for multifaceted R&D programs

- Program planning, development, and execution
- Legal, financial, procurement and Head of Contracting Activity (HCA)
- Project management expertise







600+ partnerships with industry, academia, and gov't agencies 1000+ research and development projects nationwide





NETL Budget

FY2022 Budget \$1.2B

Carbon Management

Carbon Capture \$ 99M Carbon Dioxide Removal \$ 49M Carbon Utilization \$ 29M Carbon Storage Adv. Energy Systems Crosscutting Research Mineral Sustainability **STEP**

Resource Sustainability

Resource Tech. and Sustainability

Collaborative Research and Engagement

Other



\$

15M

\$110M

FF

FECM Program Support Program Direction Special Recruitment S NETL Research & Ops. \$

- NETL Infrastructure \$ 97M Congressionally Directed
- \$ 94M Spending \$ 33M \$ 53M

Non-Fossil Programs*

\$

\$

OF CESER



*estimated and subject to change

NATIONAL

TECHNOLOGY ABORATORY

ENERGY



Fossil Energy and Carbon Management Priorities



RDD&D Priorities



Demonstrate and Deploy Point-Source Carbon Capture RDD&D for CCS in the power and industrial sectors to enable wider, strategic commercial deployment to meet net-zero emissions goals by 2050.

Advance Carbon Dioxide Removal & Low Carbon Supply Chains for Industry

Air capture and mineral carbonation projects and develop novel approaches to recycle carbon emissions.



Low-Carbon Industrial Supply Chains

Develop novel approaches to recycle carbon emissions into value-added products such as concrete, steel, chemicals and fuels using systems-based carbon management approaches consistent with realizing a net-zero carbon economy by 2050.



Accelerate Carbon-Neutral Hydrogen (H₂) Develop technologies that leverage the natural gas intrastructure

Develop technologies that leverage the natural gas infrastructure for H₂ production, transport, storage and use, coupled to carbon management.







Reduce Methane Emissions

Develop technologies and deploy regional initiatives to monitor and reduce methane emissions from fossil fuel infrastructure including coal, oil and gas.

Advance Critical Minerals, Rare Earth Elements (REE) and Mine Remediation

Improving REE separation/recovery technologies to manufacture products from CO₂ and carbon ores and to address current market and process economics. Advancing R&D to address abandoned mines.

Increase Efficient Use of Big Data and Artificial Intelligence

Use AI, machine learning, and data analysis to create learning algorithms within large datasets to help discover new material, optimize processes and run autonomous systems.

Address the Energy Water Nexus

Improve our efficient use of scarce water resources and advance water remediation technologies to address the environmental impacts related to produced or displaced water associated with oil, gas and coal industries, in addition to that associated with dedicated CO_2 storage.

Invest in Thoughtful Transition Strategies

Invest in technologies and approaches and deploy regional initiatives to help create an equitable and just transition to a net-zero carbon economy in energy communities.



Core Competencies & Technology Thrusts







NETL RIC R&D Enabling Gasification Systems



Microwave- Assisted Waste/ Biomass Gasification:

Utilizing non-traditional feedstocks, enabling decarbonization, modular design and integration

- Oxygen Generation: Enabling pre-combustion carbon capture
- Modeling & Simulation: Accelerating technology development
- Systems Life-Cycle Analysis: Minimizing GHG emissions



Clean hydrogen solutions through application of computational tools and novel technology development.



Waste plastic Biomass









Goals:

- Develop state-of-the-art emission control and reduction technologies for CCRs
- Advance the beneficial use of CCRs

Current RIC focus:

 AI/ML algorithm(s) as design tool for development and production of fly ash-based zeolites

Benefit:

 Zeolite sorbents for treating leachates from ash impoundments



Solutions for Coal Combustion Residuals (CCRs) Landfills and Impoundments





NETL RIC R&D – Advanced Sensors and Controls

- Optical Fiber Sensors for Harsh Fossil Energy Environments
- Field Test and Improve the Raman Gas Analyzer (RGA)
- Field Test and improve the NETL Developed Laser Induced Breakdown Spectroscopy (LIBS)
- Testing of Online System
 Identification for Equipment
 Malfunction Detection
- Cyber-Physical Systems as a Power System Development Tool



Roman gas analyzer field prototype





Sensors and Controls

NETL RIC R&D - Direct Power Extraction

- **Goals:** Develop magnetohydrodynamic (MHD) power generation concepts and components for future fossil-derived electrical power generation and "blue hydrogen (H₂)" production.
- **RIC Focus:** Establish the performance of MHD energy conversion systems and experimental validation of the performance and reliability of key components for those systems.
- **Benefit:** Improved viability of MHD power generation for future fossil-derived electrical power generation.



Early-stage R&D project is investigating and testing MHD power generation concepts for future fossil-derived electrical power generation with and without carbon capture.





NETL RIC R&D Advanced Energy Storage

NATIONAL ENERGY TECHNOLOGY LABORATORY

• Energy Storage FOA 0002332:

Focused on maturing energy storage technologies that have the potential to be integrated with large scale fossil assets.

- Repurposing Fossil Assets: Interactive webpage with 200+ retiring FE plants ready for repurposing.
- Market Analysis:

Interactive database showing characteristics for integration of energy storage in fossil energy power plants in CAISO and PJM.

• First Principles Analysis:

Developed an analysis to identify promising energy storage media under 10\$/kWh energy capital cost.





Developing solutions to enhance value from U.S. fossil-fuels energy system assets, including integration with long-duration energy storage technologies.





Simulation-Based Engineering

NETL RIC R&D Modeling/Analysis of Complex Energy/ Chemical Processes

- Goals: Support the development of IES and industrial processes, accelerate development and deployment to enable more rapid decarbonization.
- RIC Focus: Open-source IDEAS Integrated Computational Platform. Digital twin models, investigating effects of cycling, and ash deposition prediction.
- **Benefit:** Fossil energy and industry research and development; technology development, scale up, and commercialization to enable ongoing energy transition.



Next Generation Multi-Scale Modeling & Optimization Framework



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TECHNOLOGY



Incorporation and Assessment of Uncertainty Across Models/Scales



Framework for design, optimization, and control of steady state and dynamic processes.



Simulation-Based Engineering

NETL RIC Computational Fluid Dynamics (CFD) for Advanced Reactor Design (CARD)

- **Goals:** Develop NETL's MFiX suite of multiphase CFD software and toolset.
- **RIC Focus:** Development of the MFiX suite of multiphase flow modeling software for modeling of large-scale reactor systems.
- **Benefit:** Development of tools and capabilities used to investigate technologies optimized for existing fleet, future power plants, CCUS technologies.

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NETL RIC R&D Advanced Energy Materials & Advanced Manufacturing



Developing new materials and solutions for traditional and novel applications.

- Field Work Proposal 1022406: Developing materials to enable efficient advanced energy systems.
- **eXtreme (XMAT) Materials Modeling:** Working to predict the relationship between microstructure, chemistry & creep response.
- Advanced Alloy Development: Creep & fatigue modeling and exploring alloys in energy applications through process optimization.
- Workforce Development:

DOE and the ARC establish in advanced welding program that awarded a total of \$1 million in grants 2021.









University Training and Research Program



Education and Training Program for Next Generation of Engineers and Scientists

University Coal Research (UTR)

- Expanded research capabilities and facilities
- Enhance U.S. Competitiveness
- Supports early-stage R&D in fossil energy

\$400K - \$500K per award no cost share required

Historically Black College and Universities and Other Minority Institutions

- Inclusion for underrepresented groups
- Develop highly skilled & well-qualified workforce



UTR Projects by Technology Focus (2010-2021)



Legend: Energy Storage (technology focus), 1 [project count], 1% (% of total project count)















Key Decarbonization Technologies

- Transformative CO₂ separation technologies.
- Manufacturing and design technologies applied to carbon capture system components.
- Engineering scale testing and validation of technologies at the National Carbon Capture Center and Technology Center at Mongstad.
- Development of material, components, and integrated systems for Negative Emission Technologies.
- The Strategic Systems Analysis & Engineering team assesses the best low cost and clean development path and strategy.



Achieving net-zero goals in the power sector requires an understanding of energy platforms and their respective value chains to inform the optimal strategies that minimize carbon footprint while balancing the nation's economic interests.









Key Decarbonization Technologies

- Natural gas pyrolysis: using highperformance catalysts co-produces hydrogen, carbon fibers, and carbon nanotubes to yield very low hydrogen production costs, even with a low carbon selling price of \$2/kg.
- Modular, flexible ammonia production: Developed and demonstrated hydrogen carrier production inherently modular and virtually instantaneous at startup.
- **Hydrogen utilization**: NETL's Rotating Detonation Combustors operate best on hydrogen and have the potential to provide a 4-7% step change in gas turbine efficiency.

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A KEY ENABLER

TO NATIONAL

DECARBONIZATION







Key Decarbonization Technologies

- Microwave catalysis technology revolutionizes
 energy intensive chemical processes
 - Enables electrification of chemical production
 - Modular and distributed solutions
 - Rapid startup/shutdown
 - Enhanced reaction rate and selectivity
- Potential applications:
 - Dry methane reforming for distributed hydrogen production from natural gas with captured CO₂
 - Conversion of hydrogen, natural gas, or other feedstocks to ammonia, liquid fuels, or chemicals
 - Enables on-demand base-scale or aircraftscale fuel reforming, chemical production, or waste disposal



Significantly improve the energy efficiency of industrial processes, increasing selectivity, and enabling scalable and distributed low carbon applications.







The TOOLBO 🛠



- Cooperative Research and Development Agreement (CRADA)
- Contributed Funds-In Agreement (CFA)
- Memorandums of Understanding (MOU)/ Memorandums of Agreement (MOA)
- Interagency Agreements (IAA)

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

- Interinstitutional Agreements (IIA)
- Small Business Innovation Research (SBIR) & Small Business Technology Transfer (STTR) Programs
- Unsolicited Proposals (USP)
- Non-disclosure Agreement (NDA)
- Funding Opportunity Announcement (FOA)

Funding Opportunity Announcement (FOA)

- NETL uses FedConnect.net, Grants.gov and SAM.gov 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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