

NETL Science & Technology Competencies

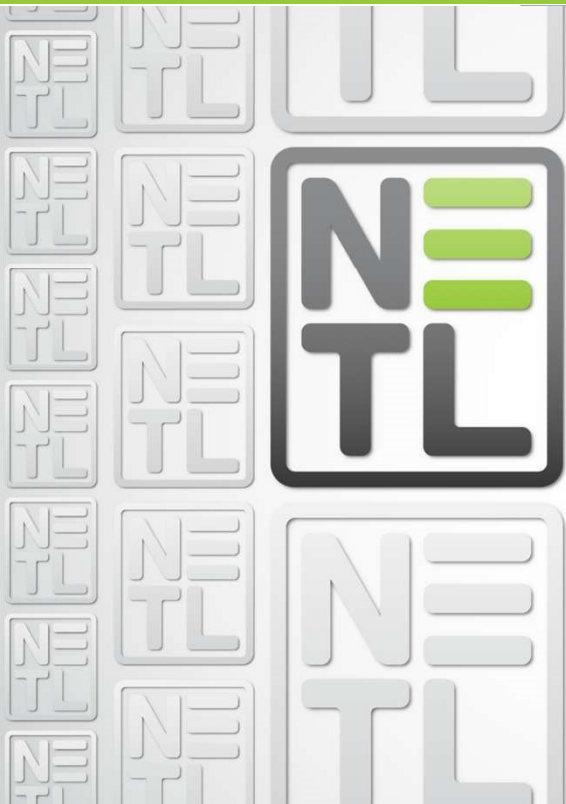
Solutions for Today | Options for Tomorrow

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Longview Power plant,
Madsville, West Virginia



U.S. DEPARTMENT OF
ENERGY

NETL Mission and Vision

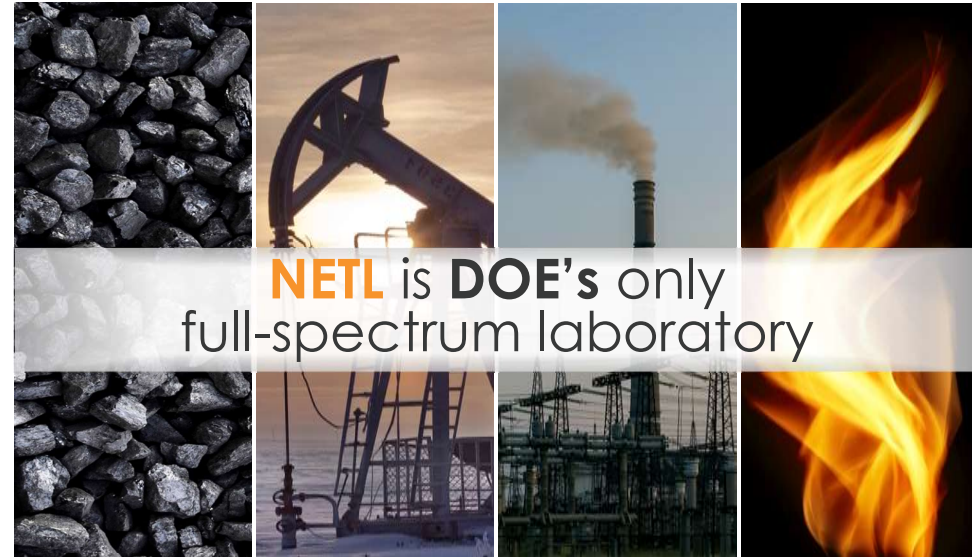


NETL MISSION

Discover, integrate, and mature technology solutions to enhance the nation's energy foundation and protect the environment for future generations.

NETL VISION

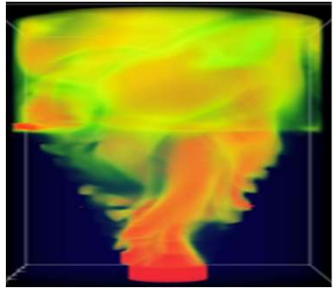
Leading integrated NETL technology teams to define, budget, and manage the execution of research elements to meet the goals of Congressionally funded FE research programs **while utilizing and strengthening NETL's capabilities and partnerships.**



MISSION ELEMENTS

Effective Resource Development,
Efficient Energy Conversion, and
Environmental Sustainability

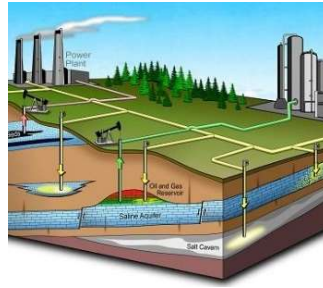
Core Competencies & FE Technology Thrusts



Computational Science & Engineering



Materials Engineering & Manufacturing



Geological & Environmental Systems



Energy Conversion Engineering



Systems Engineering & Analysis



Program Execution & Integration



Carbon Storage



Carbon Capture



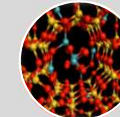
Sensors & Controls



Advanced Materials



Advanced Computing



Advanced Energy Systems



Water Management



Rare Earth Elements



Enhanced Resource Production



Environmentally Prudent Development



Methane Hydrates



Offshore



Natural Gas Infrastructure



Unconventional



Computational Science & Engineering

Core Competencies

- **Modeling and simulation is critical to all NETL research, development, and deployment**
 - Accelerating development continuum
- **NETL's Joule**
 - When installed, NETL's Supercomputer was ranked 55th in the world 11/2012, it is currently ranked 418th
 - Over 95% utilization (national asset)
 - *Significant upgrade underway*

Current Thrusts

- Code development spanning and linking orders of magnitude (angstroms to meters)
- Uncertainty quantification, data technology (i.e., informatics, AI)



Super Computer HPCEE-16

Materials Engineering & Manufacturing

Core Competencies

- **Performance-driven design enabling technology solutions**
 - Designing materials (and manufacturing processes) at the atomistic-level to control macroscopic properties
- **World-class facilities to understand and evaluate materials in “real” environments**

Current thrusts

- Soft materials
- Engineered particles
- Advanced alloys
- Composites, coatings, & ceramics



Leco CS744 - Oxygen/Nitrogen by Inert Gas Fusion Infrared and Thermal Conductivity Detection

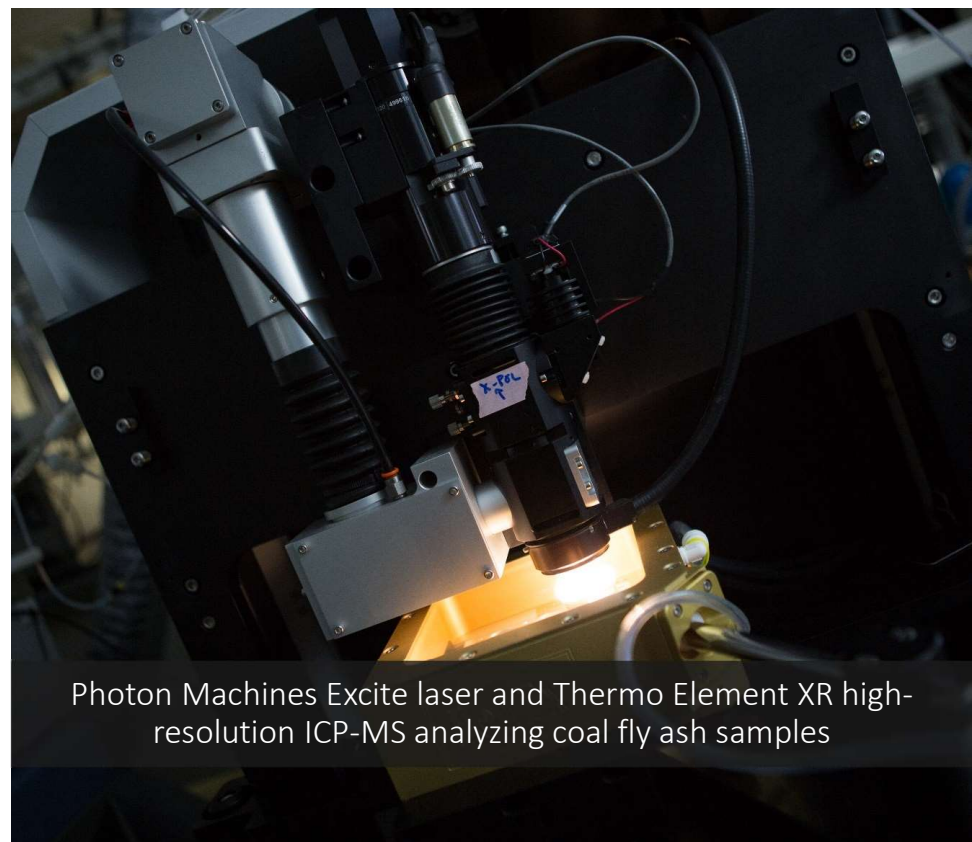
Geologic & Environmental Systems

Core Competencies

- Analysis across types of media and scales of observations to support FE resources extraction while minimizing adverse impacts
- World-class facilities for computed tomography imaging of cores under representative pressures, temperatures & fluid flow conditions
- World-class capabilities in data analytics & webification for the geosciences

Current thrusts

- Subsurface Risk Assessment (Integrated Assessment, Materials Behavior, Fluid Flow Pathways, Monitoring Strategies)
- Resource Optimization (Reservoir Engineering: (1) Fractured Oil, Gas & Storage Reservoirs & Seals, (2) Natural Gas Hydrates)
- REE Characterization of Coal-Related Materials
- Geo-Data Analysis
- "Big Data" Approach
- Geostatistics & Geospatial Techniques
- Air-Quality Assessments for Upstream Oil & Gas Systems



Photon Machines Excite laser and Thermo Element XR high-resolution ICP-MS analyzing coal fly ash samples

Energy Conversion Engineering

Core Competencies

- **Engineering energy devices & processes**
 - Developing new devices & processes exhibiting transformational increases in conversion efficiencies
- **Simulation-based design, coupled with focused experiments**
 - Increased RD&D efficiencies
 - Reduces risks and costs

Current thrusts

- Reacting, multi-phase flow
- Micro- and modular-devices
- Extreme pressure reactions
- Gas-phase rotating detonations
- Direct energy conversion



Chemical Looping Reactor

Systems Engineering & Analysis

Core Competencies

- **Engineering complex multi-scale processes**
 - Holistic optimization of process, device, and material
- **Advanced models, optimization algorithms, and uncertainty quantification**
- **Current thrusts**
 - Interactions between energy systems at plant, regional, national, and global scales
 - Quantification of R&D performance targets & priority
 - Identification of new innovative process concepts



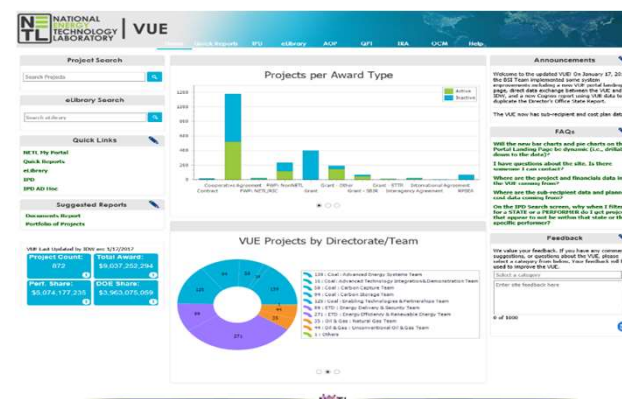
Program Execution and Integration



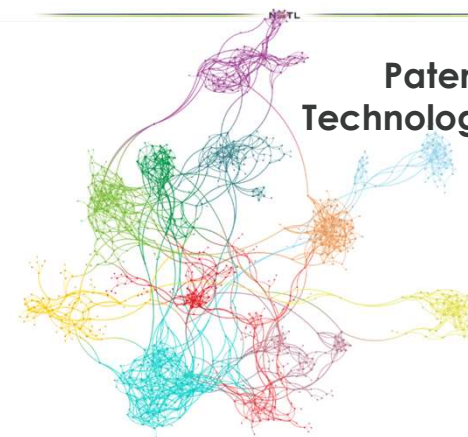
Core Competencies

- Full life-cycle to advance technology through range of technology readiness levels (TRLs)
- Scientific and technical expertise combined with program/project management proficiency
- Systems engineering capability that guides investment pathways for technology development
- **Current Program Sponsors**
 - Fossil Energy (Coal and Oil & Gas)
 - Energy Efficiency & Renewable Energy (Vehicles, Buildings, and Geothermal Technologies)
 - Electricity Delivery & Energy Reliability (Energy Infrastructure Modeling and Analysis, Infrastructure Security and Energy Restoration, National Electricity Delivery, Power Systems Engineering R&D)

Project Management Tools



Patent and Technology Analysis



Coal Technology Thrusts



Advanced Energy Systems

- Efficient Energy Conversion (Combustion, Gasification, Turbines, Fuel Cells)
- Zero-Emissions Power Production
- Minimize Water Use and Discharge



Carbon Capture

- Cost-Effective Capture Systems
- Minimize Energy Penalty for Capture and Compression
- Smaller Capture System Footprint



Carbon Storage

- Safe, Effective, Long-Term Storage
- Monitoring, Verification, Accounting, and Assessment
- Demonstrate Storage Infrastructure
- Utilization of Captured Carbon Dioxide



Crosscutting Research & Analysis

- High-Performance Materials
- Sensors and Controls
- Water Management
- Simulation-Based Engineering
- Historically Black Colleges and Universities and Other Minority Institutions (HBCU-OMI)
- University Coal Research (UCR)



STEP (Supercritical CO₂)

- High-Efficiency Power Cycle
- Reduced Water Consumption and Air Emissions
- Reduced Power Cycle Footprint



Rare Earth Elements

- Efficient Rare Earth Element (REE) Recovery
- Cost-Competitive Domestic Supply of REEs
- Coal Byproduct Utilization

Oil and Gas Technology Thrusts



Unconventional

Developing technologies to maximize recovery and reduce operational impacts from unconventional oil & gas resources



Offshore

Minimizing the environmental impacts of deepwater and ultra-deepwater oil and natural gas production



Natural Gas Infrastructure

Developing technologies and practices to assess and mitigate emissions from natural gas transmission, distribution, and storage facilities



Methane Hydrates

Improving the characterization of methane hydrates and developing ways to tap their massive energy potential

EERE and OE Technology Thrusts



Support
to Other
DOE
Offices

Energy Efficiency & Renewable Energy (EERE)

Vehicles



Solid State Lighting



Geothermal



Electricity Delivery & Energy Reliability (OE)

Microgrid



Energy Storage



Energy Security
& Restoration



Helping to Implement DOE & Gov't Programs for 25+ years

- Department of Defense
- Environmental Management
- Legacy Management
- Dept. of Homeland Security

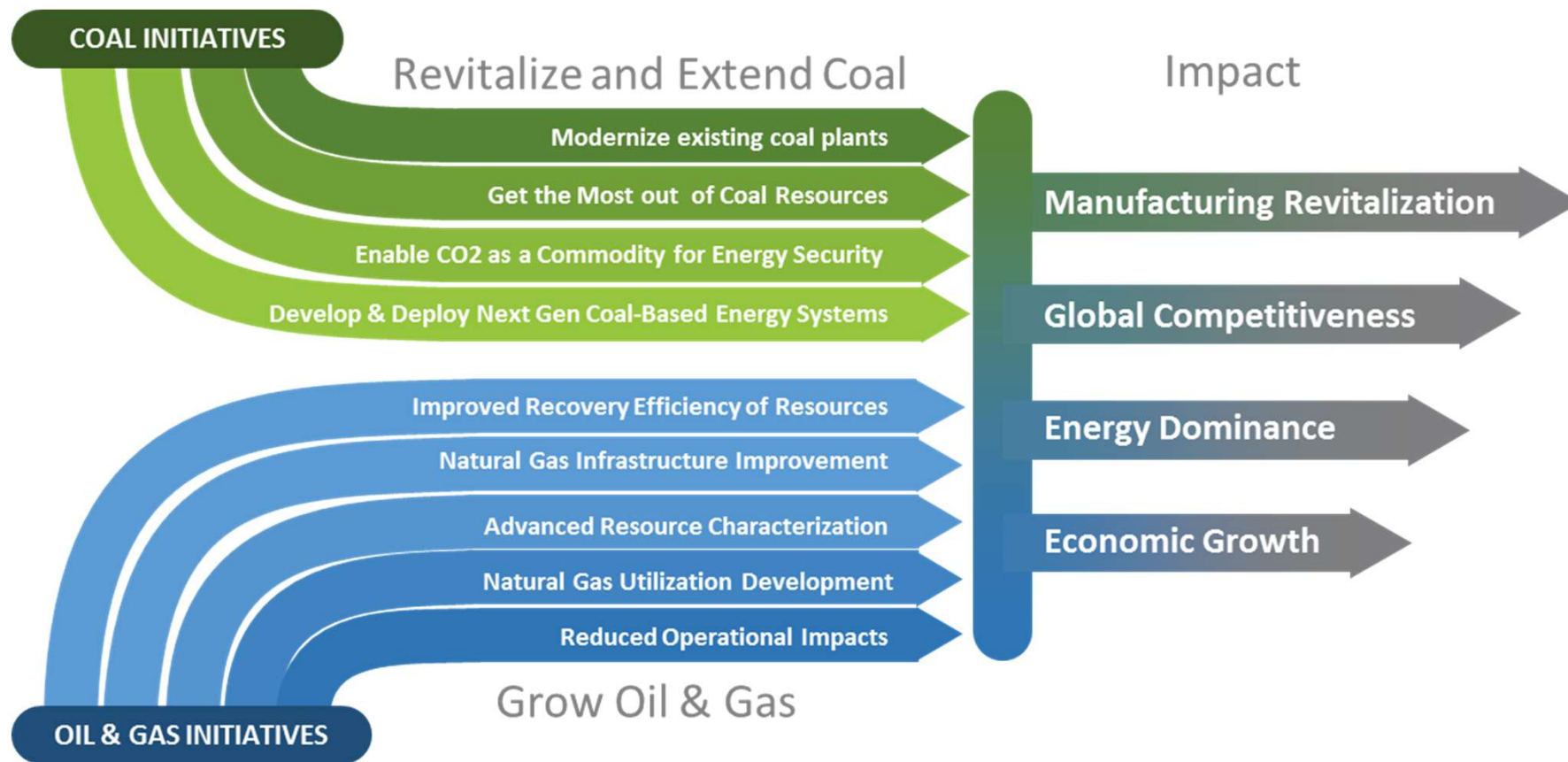
Technical, Administrative, Project Management Support

- Documented Procedures and Policies
- Disciplined Process w/Tracking

Implementation Mechanisms

- Technical Advice/Consulting
- Acquisition (contracts)
- Financial Assistance (can only be awarded by Federal personnel)

Revitalize and Grow the Fossil Value-Chain



Fossil-focus in Advanced Manufacturing



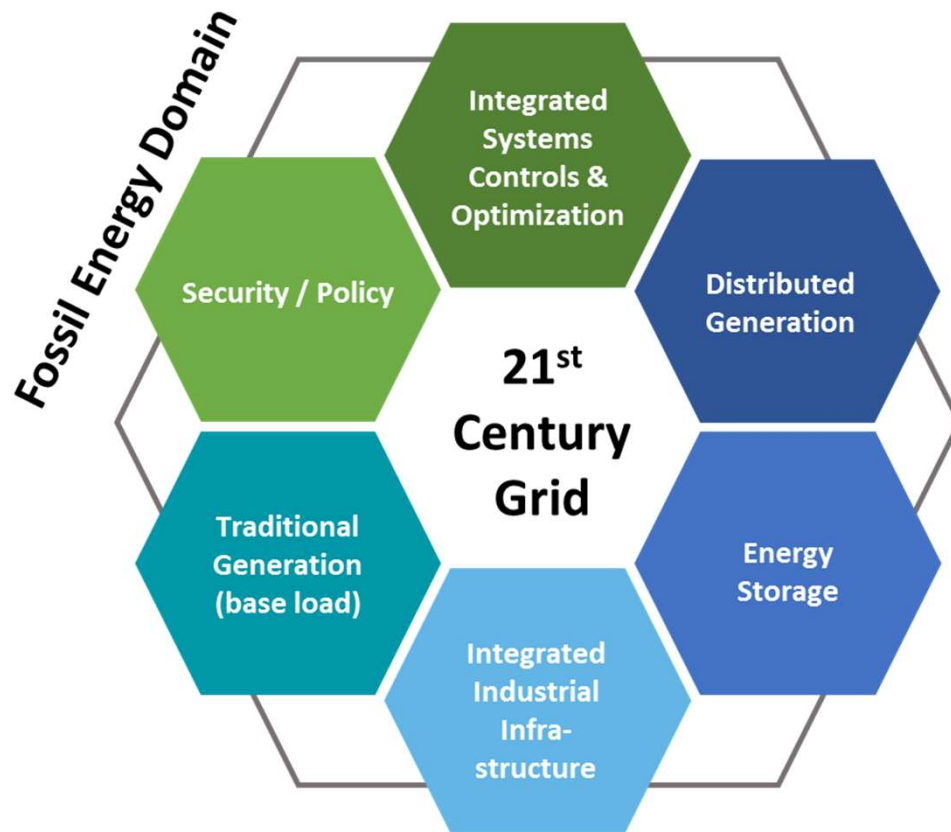
Advanced manufacturing to improve the performance and economics of energy and materials systems

Expand materials and advanced manufacturing to extreme operational environments

Develop carbon-based source materials

Synthesize inter-disciplinary approaches to manufacturing

Infrastructure: 21st Century Grid



Design and optimize modern transmission, storage, and distribution energy infrastructure

Systems analyses to inform and align investments

Increase security and reliability to improve the delivery of domestic resources

Integrate advanced power systems and domestic resources

QUESTIONS?

VISIT US AT: www.NETL.DOE.gov

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