



Driving Innovation ♦ Delivering Results



Carbon Storage and Oil and Natural Gas Technologies Review Meeting

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Operations Center (Acting)

July 8, 2016



U.S. DEPARTMENT OF
ENERGY

National Energy
Technology Laboratory



To discover, integrate, and mature technology solutions to enhance the Nation's energy foundation and protect the environment for future generations

EFFECTIVE RESOURCE DEVELOPMENT

Developing technologies that improve the effectiveness and economics of producing our fossil energy resources

EFFICIENT ENERGY CONVERSION

Discovering cleaner, cheaper, and more efficient energy conversion technologies for the production of high-value energy commodities

ENVIRONMENTAL SUSTAINABILITY

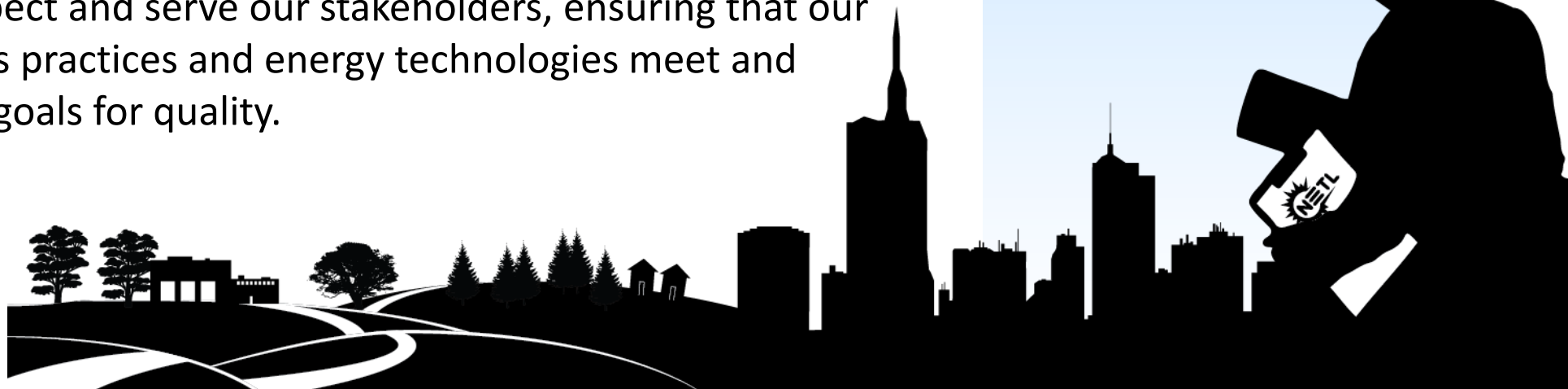
Accelerating the development of transformative and enabling solutions to protect our air, land, and water for future generations

NETL is a knowledge and technology generation center.
We develop vital energy resource technologies.

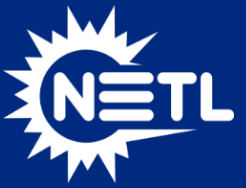
NETL is a technology convener.
We collaborate with public and private entities to pursue “all of the above” energy strategies and technologies.

NETL is a responsible steward.
We respect and serve our stakeholders, ensuring that our business practices and energy technologies meet and exceed goals for quality.

NETL Vision – *the premier fossil energy laboratory advancing science, engineering and technology to enable the energy future*



Three Research Campuses – Two Strategic Offices



ONE LAB System



- Process Systems Engineering
- Decision Science
- Functional Materials
- Environmental Sciences

Carbon Storage
Oil & Gas Technologies
All three Campuses

- Energy Conversion Devices
- Simulation-Based Engineering
- *In-Situ* Materials Characterization
- Supercomputer Infrastructure

21st Century Lab system strategically aligned with DOE Missions

- Over 350,000 square feet of Laboratory space
- Historical Alignment with FE missions

- Materials Performance
- Alloy Development/Manufacture
- Geospatial Data Analysis

Oil and Gas Strategic Office

Oil and Gas Strategic Office

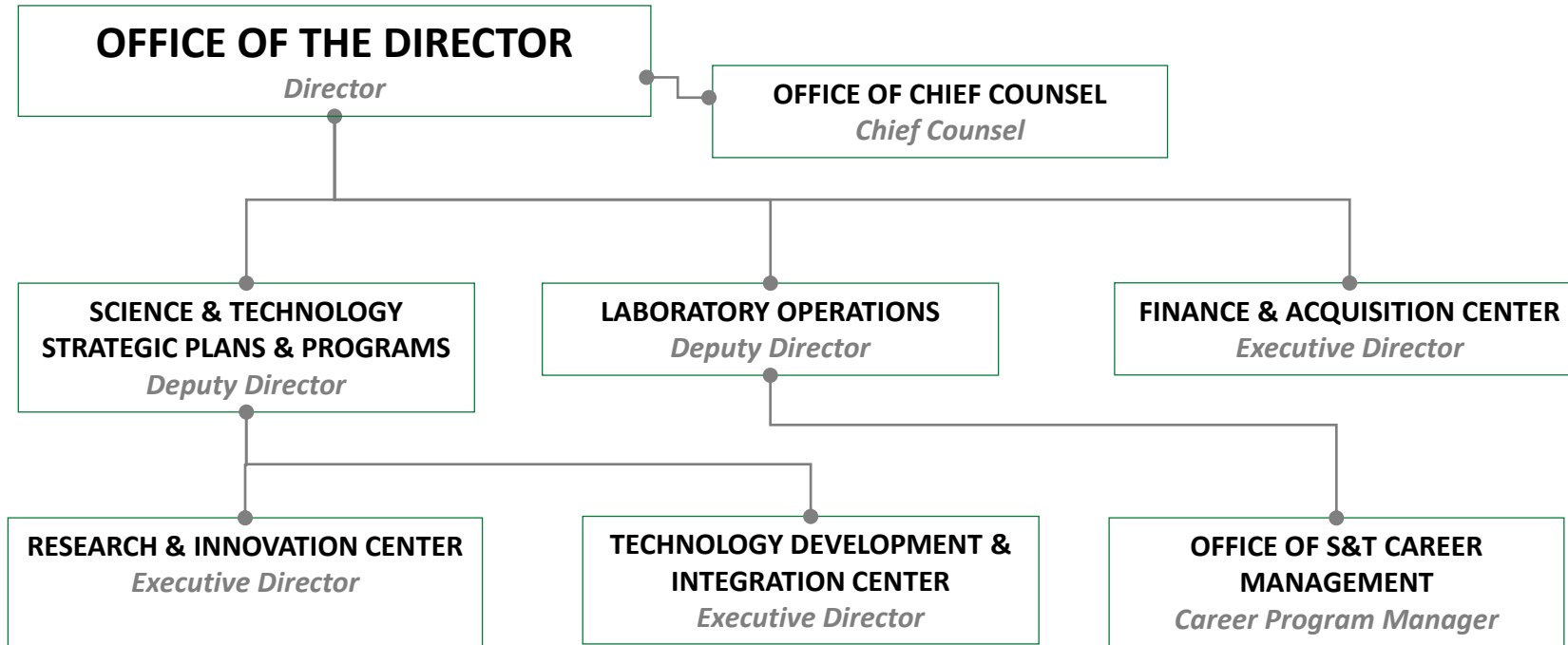
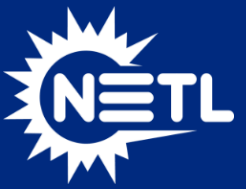
1,400 employees, FY16 Budget of \$896M, 1,000+ R&D projects in 50 states



U.S. DEPARTMENT OF ENERGY

National Energy Technology Laboratory

NETL's Organizational Structure

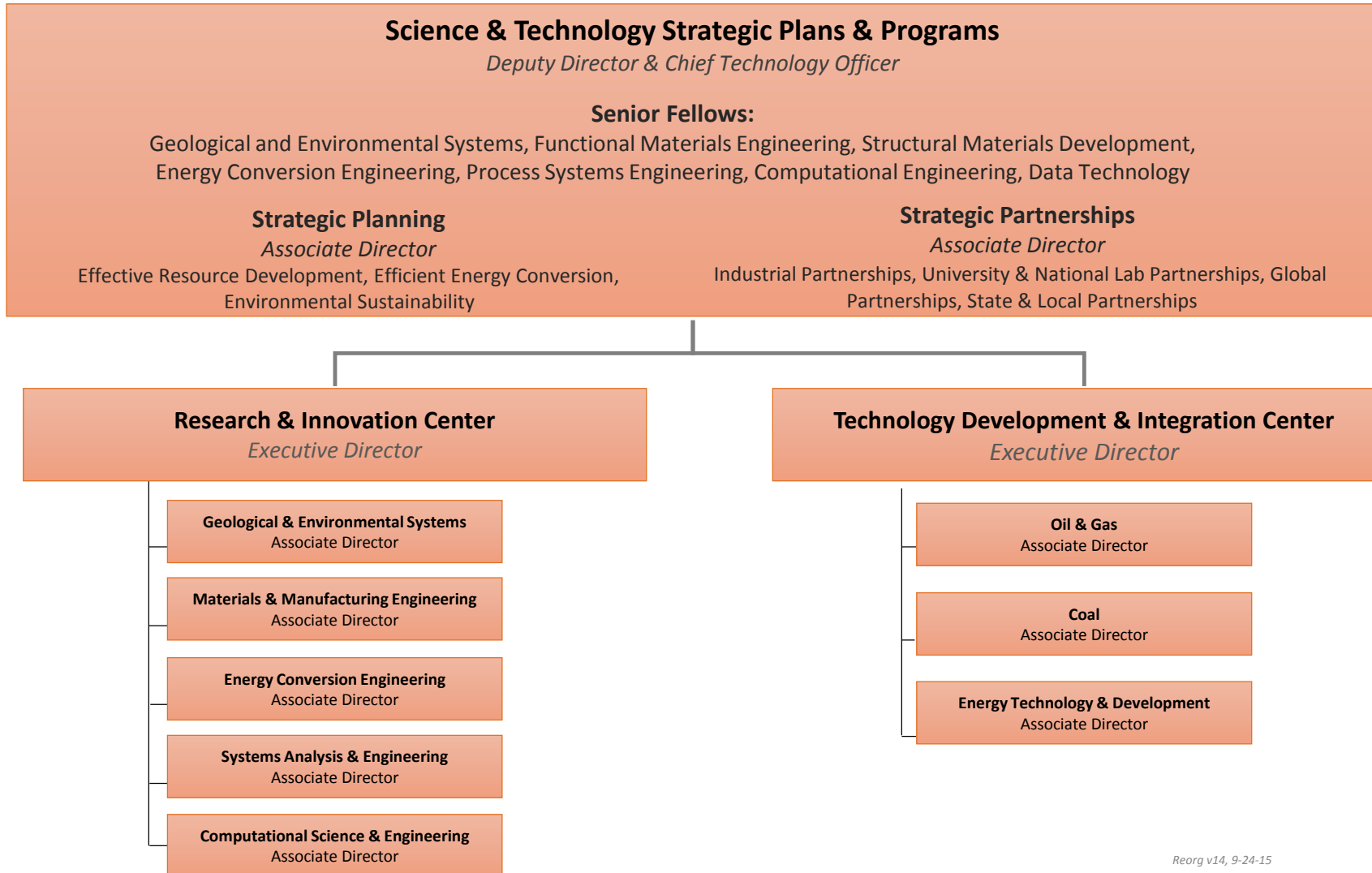
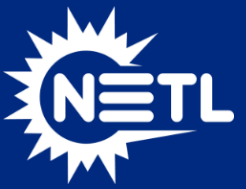


Strengthening NETL to better support DOE and FE:

- Superior products
- Scientific excellence
- Flexible, dynamic expertise & capabilities
- Increased level of transparency
- Integrated strategic planning



S&T Strategic Plans & Programs



Reorg v14, 9-24-15



NETL Technology Development Pathway



An Active Portfolio from Concept to Market Readiness

COMMERCIALIZATION

Technology available for wide-scale market use

DEMONSTRATION

System demonstrated in operational environment

SYSTEM TESTING

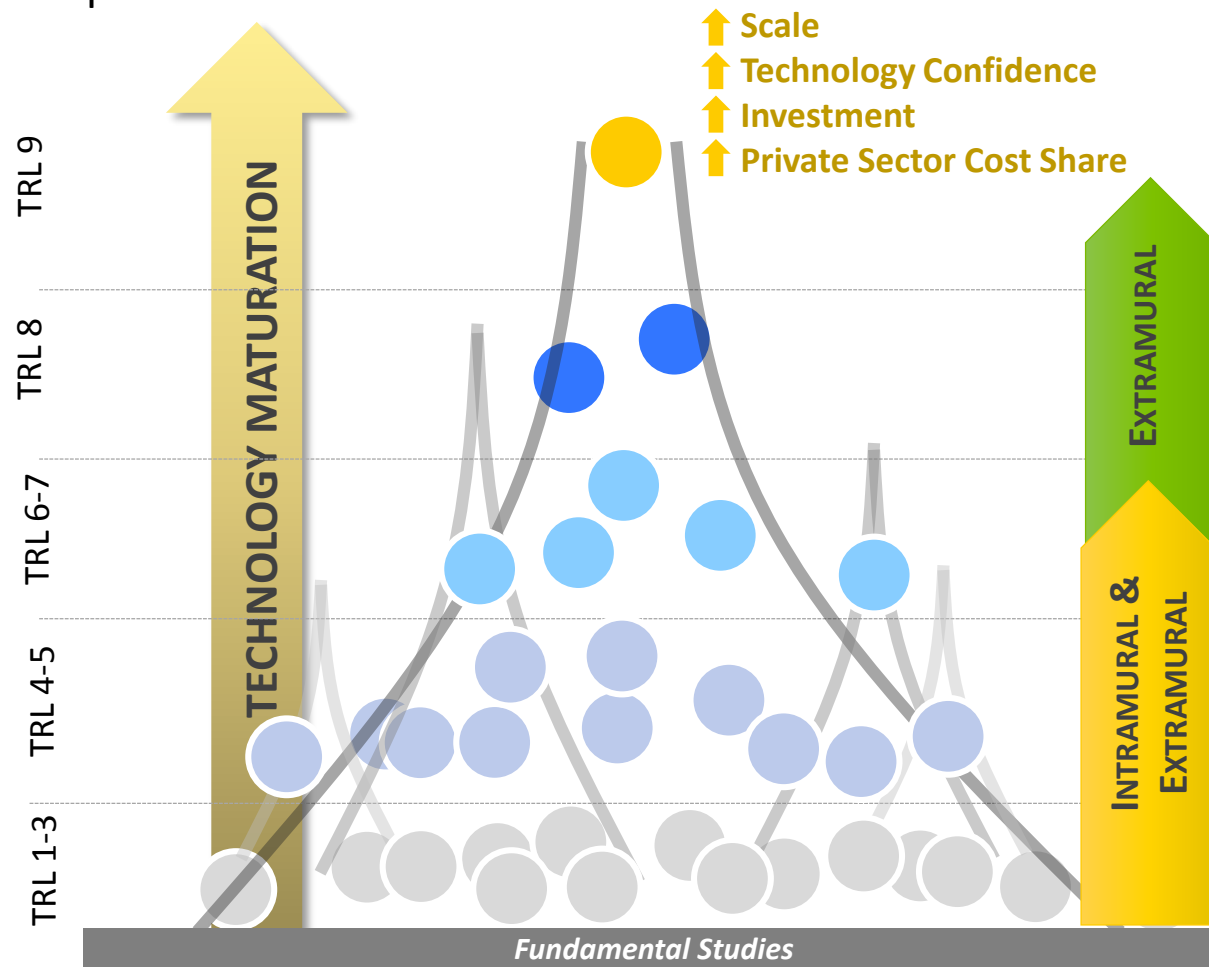
System performance confirmed at pilot-scale

DEVELOPMENT

Technology component validated/integrated

DISCOVERY

Concept identified/proven at laboratory-scale



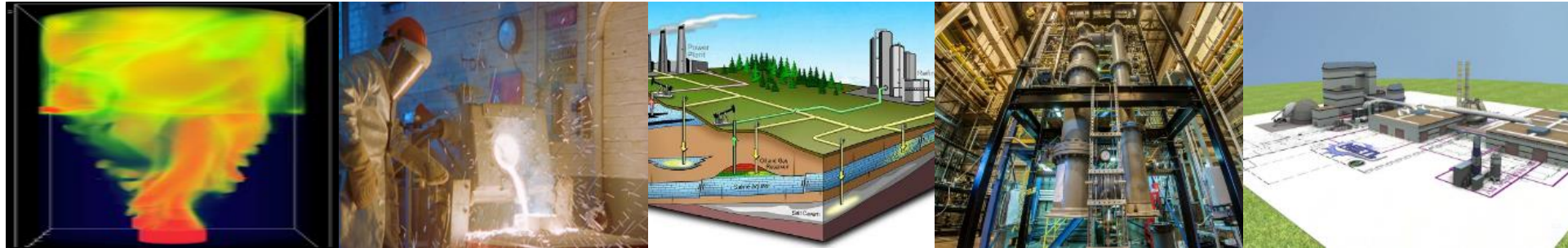
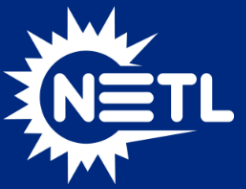
Tools

KNOWLEDGE-BASED DECISION MAKING

- Systems Engineering and Integration
 - Engineering analysis
 - Pre-FEED/FEED studies
 - NEPA
- Decision Science and Analysis
 - Screening studies
 - Techno-economic analysis
 - Technology Readiness Assessments



Core Competencies

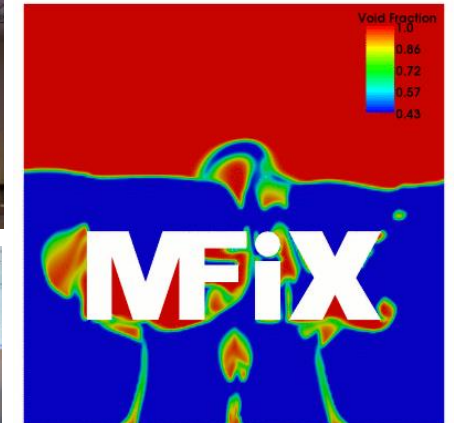
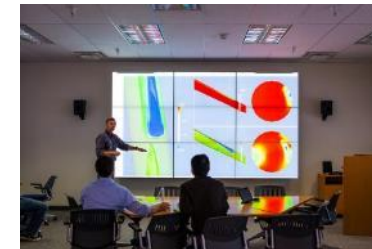


Computational Science & Engineering	Materials Engineering & Manufacturing	Geological & Environmental Systems	Energy Conversion Engineering	Systems Engineering & Analysis
High Performance Computing	Structural & Functional	Air, Water & Geology	Component & Device	Process & System
Data Analytics	Design, Synthesis & Performance	Understanding & Mitigation	Design & Validation	Optimization, Validation & Economics

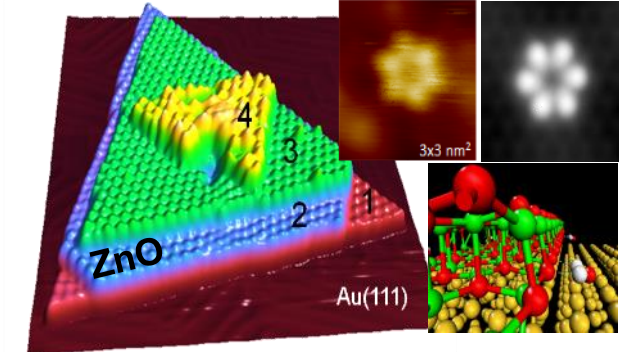
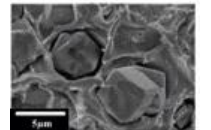
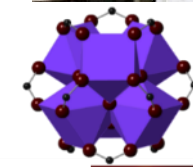
Effective Resource Development
 ~
Efficient Energy Conversion
 ~
Environmental Sustainability



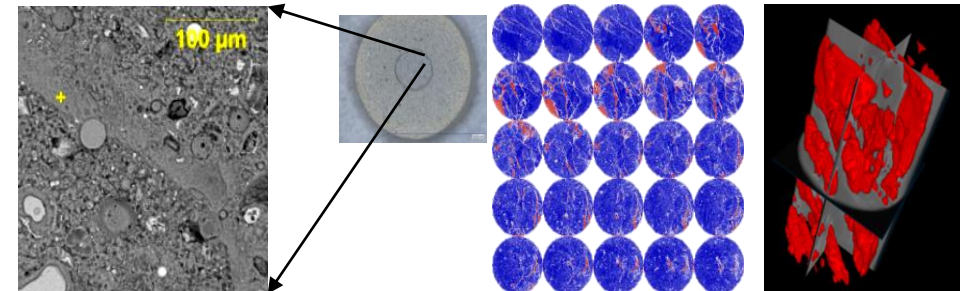
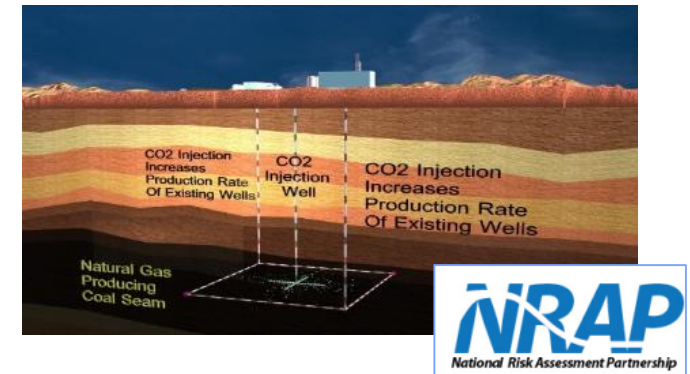
- **Modeling and simulation critical to all NETL research, development and deployment**
 - Accelerating development continuum
- **NETL's Joule**
 - 0.5 PFLOP (top 200)
 - One of the most energy efficient supercomputers in the world
 - Over 95% utilization (national asset)
- **Current Research Thrusts:**
 - Code development spanning and linking orders of magnitude (angstroms to meters)
 - Uncertainty quantification, data technology (i.e. informatics, AI)



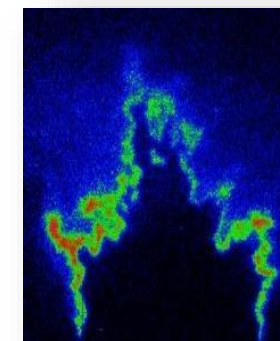
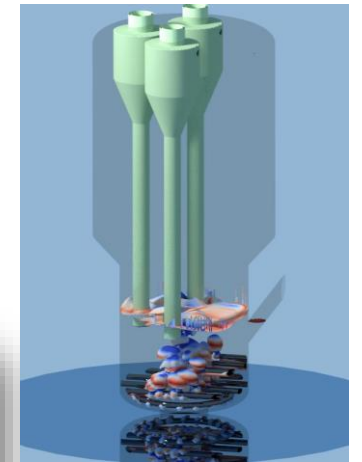
- **Performance driven materials design to enable technology solutions**
 - Designing materials (and manufacturing processes) across size scales to control macroscopic properties
- **Research facilities to synthesize and fabricate materials, and evaluate them under “real” environments**
- **Current Research Thrusts:**
 - Carbon Capture Materials
 - Extreme Environment Materials
 - Oxygen-Generating Materials
 - SOFC Electrode Development
 - Atomically-Precise Catalysts
 - Separation Materials & Processes for extracting REEs from Coal and Coal By-Products



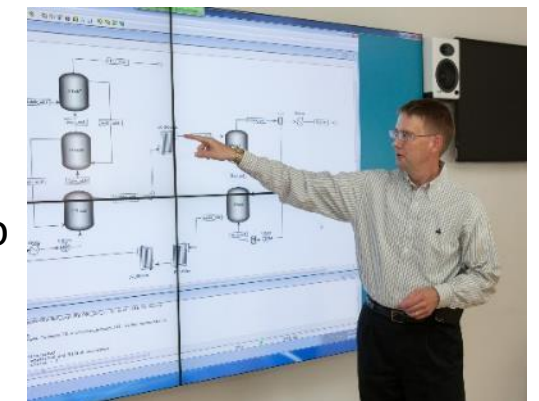
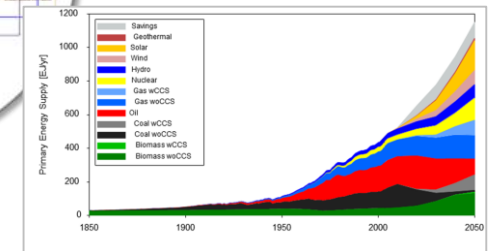
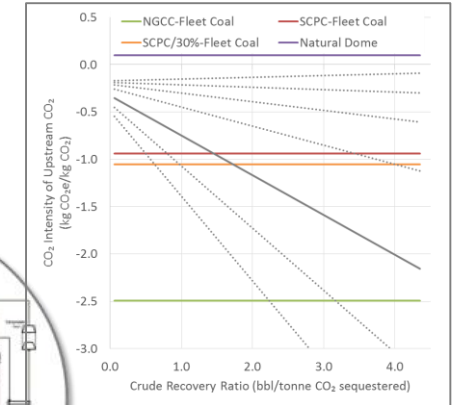
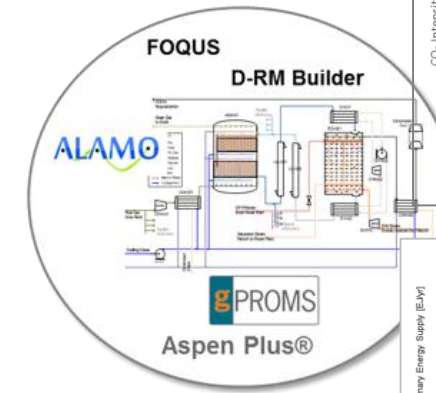
- Enabling the production and use of our Nation's fossil fuels in an environmentally safe manner through engineering the subsurface.
- Research capabilities to evaluate and predict subsurface behavior across space & time scales.
- **Current Research Thrusts:**
 - National Risk Assessment Partnership (NRAP)
 - CO₂ Storage
 - Reservoir Seal Performance
 - Ground Water Impacts
 - Resource Assessments



- **Pioneering innovative efficient energy-conversion systems that can enable affordable utilization of fossil resources in an environmentally-constrained world.**
- **Simulation-based design, coupled with focused experiments**
 - Increased RD&D efficiencies
 - Reduces risks and costs
- **Current Research Thrusts**
 - Reacting, multi-phase flow
 - Micro- and modular-devices
 - Extreme pressure reactions
 - Gas-phase rotating detonations
 - Non-equilibrium ionization and microwave chemistries
 - Cyber-Physical process/system optimization

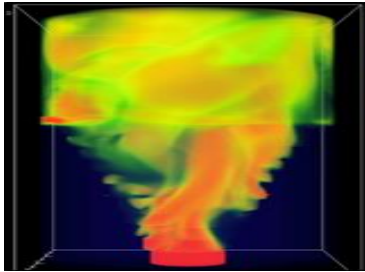


- **Accelerating technology innovation & development utilizing a variety of multi-scale computational tools and approaches to support decision-making and provide in depth, objective analysis**
- **Expertise in:**
 - Process Systems Engineering
 - Techno-Economic Assessment of Advanced Energy Systems
 - Integrated Energy Systems/Market Analysis
- **Current Research Thrusts:**
 - IDEAS (Institute for Design of Adv. Energy Systems)
 - CCSI²
 - Updates to NETL Cost & Performance Baselines for FE Systems
 - Tools to improve Techno-economic assessments of carbon capture systems
 - Integration of NETL Energy-Water module and CO₂ & EOR cost model updates into energy-economy forecasts



Core Competencies & Technology Thrusts

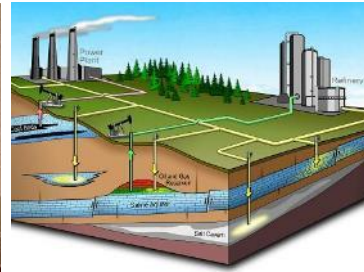
Leverage and Matrix Capabilities to Maximize Efforts



Computational Engineering



Materials Engineering & Manufacturing



Geological & Environmental Systems



Energy Conversion Engineering



Systems Analysis & Engineering



Carbon Storage



Carbon Capture



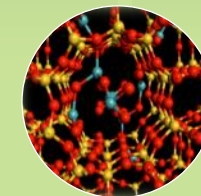
Sensors



Advanced Materials



Advanced Computing



Advanced Energy Systems



Enhanced Resource Production



Environmentally Prudent Development



Transmission & Delivery



Methane Hydrates

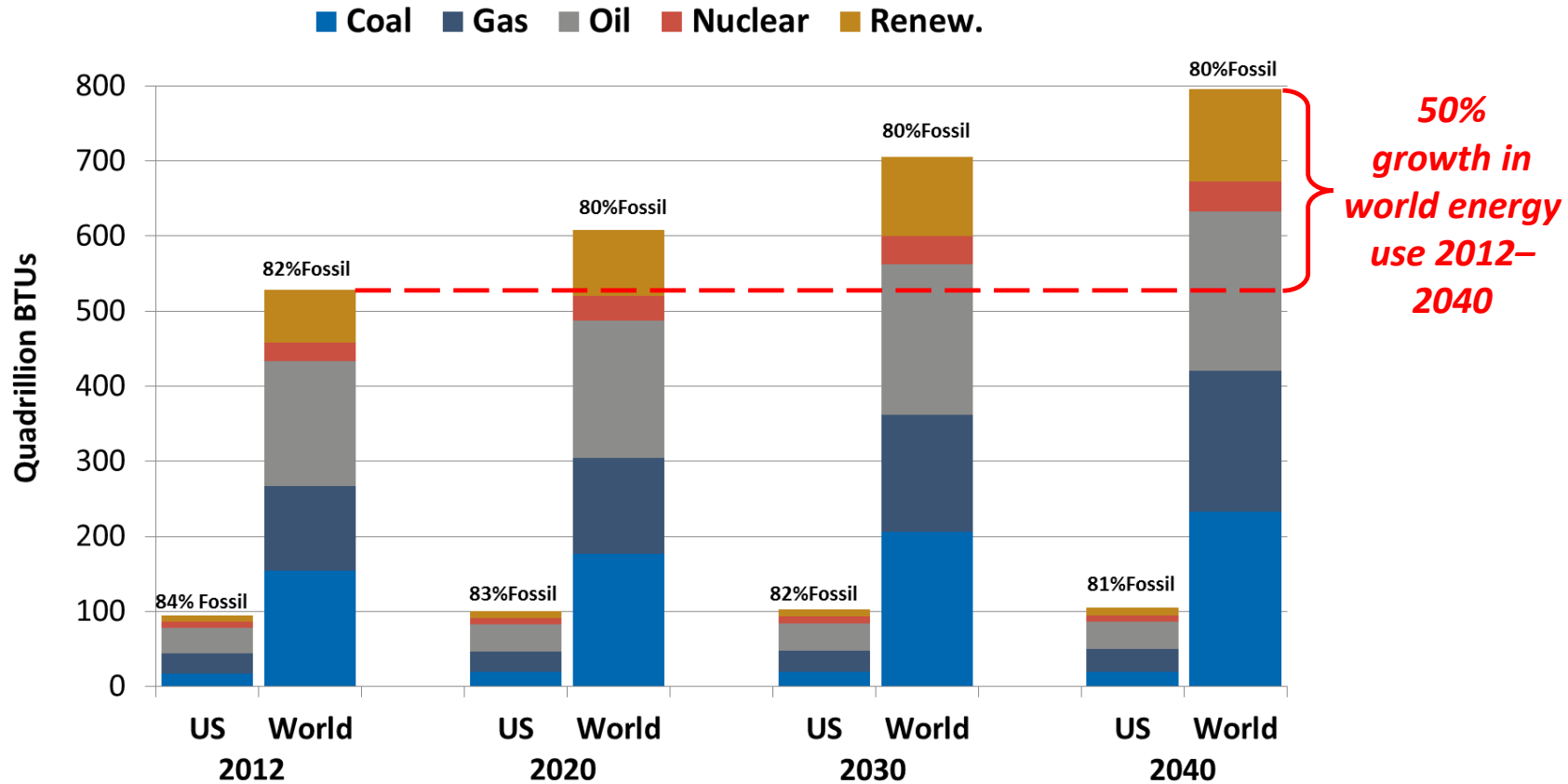


Importance of Technologies at This Review Meeting

The World and U.S. Energy Future - *Fossil Energy is Vital*

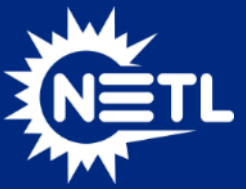


EIA, Annual Energy Outlook 2015; IEA, World Energy Outlook 2014, Current Policy Scenario

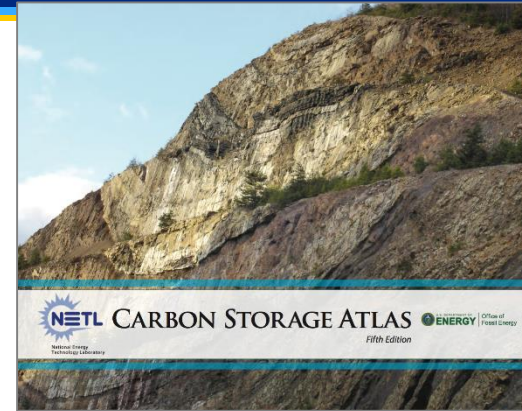


***≥80% Fossil Energy Today AND Tomorrow
Dominated by Global Growth***

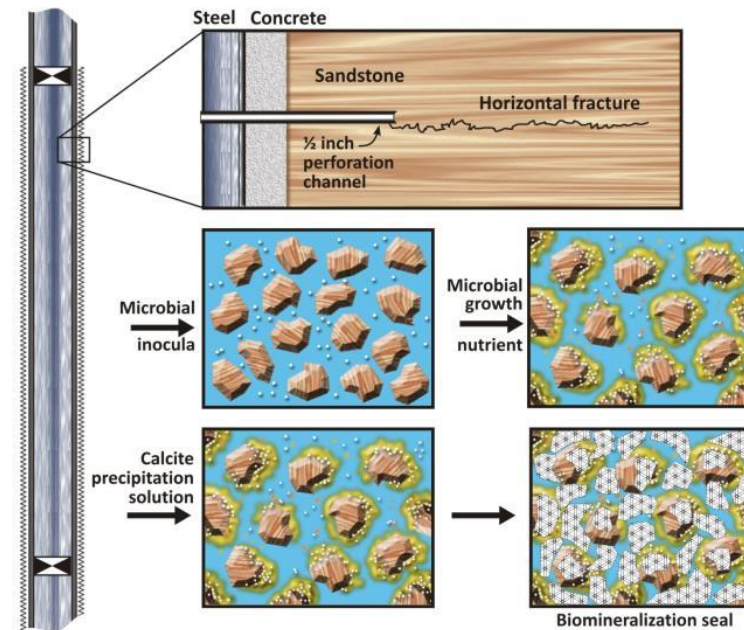
Carbon Storage: Recent Accomplishments



- The fifth edition of the Carbon Storage Atlas was completed and released.
- Lessons learned from the Regional Carbon Sequestration Partnerships large-scale field tests (safely injected ~ 9.8 million metric tons of CO₂) have been integrated into updates of Best Practices Manuals
- A new technique has been developed for monitoring the CO₂ plume and pressure front
 - Distributed Acoustic Sensor (DAS) arrays, incorporating novel fiber optic sensor technology, has been successfully field tested
- A microbially induced calcite precipitation (MICP) wellbore sealant was successfully field tested.
 - After 1 year, the MICP treatment continued to plug off the well.

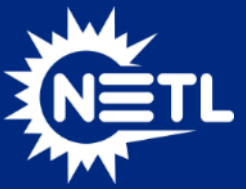


Flat pack - Contains the fiber optic based DAS array



Hydraulic fracturing sealing: conceptual model

Oil and Gas: Recent Accomplishments



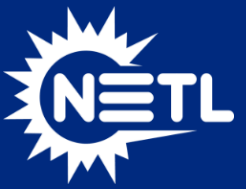
- Significant new findings regarding hydraulic fractures in horizontal wells at NETL's Hydraulic Fracturing Test Site in Texas' Permian Basin
- New data on environmental impacts of shale gas development over time at MSEEL in WV
- Offshore Integrated Risk Model that BSEE may use in offshore leasing assessments

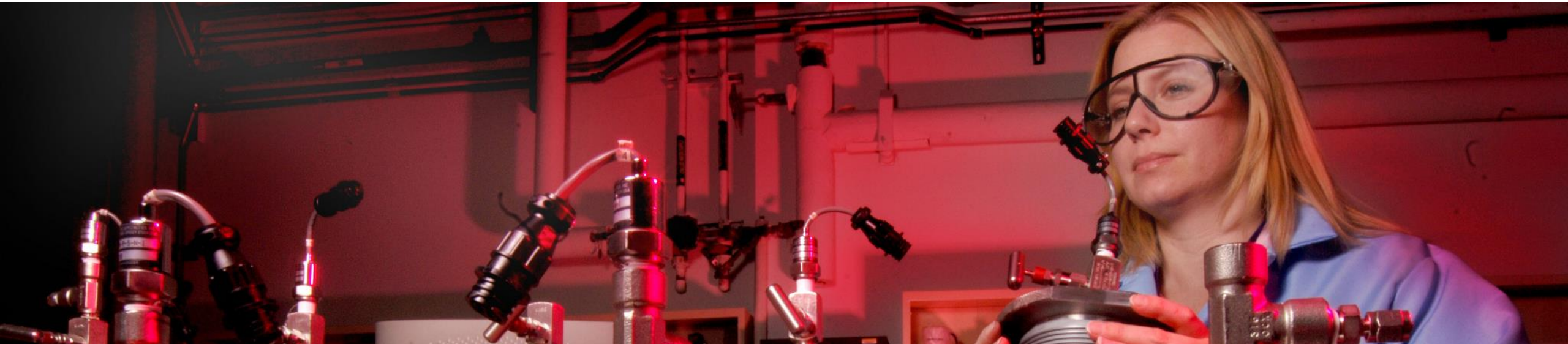


Marcellus Shale Energy and Environment Laboratory (MSEEL) at Northeast Natural Energy's site in Morgantown, WV



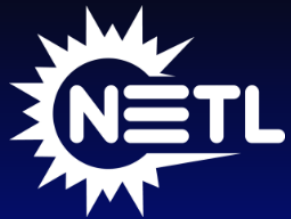
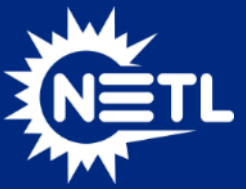
Collaboration is Key



- 
- Bringing together the Carbon Storage and Oil & Gas Technologies in one Review Meeting
 - This workshop is our opportunity to collaborate, to help refine our research agenda that works to resolve the technology challenges.
 - Our research is helping to solve some of these important challenges.



Solutions for Today....Options for Tomorrow



For More Information, Contact NETL

the ENERGY lab

www.netl.doe.gov

