National Energy Technology Laboratory Overview

Foreign Service Officers' Coal & Power Training Course

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National Energy Technology Center

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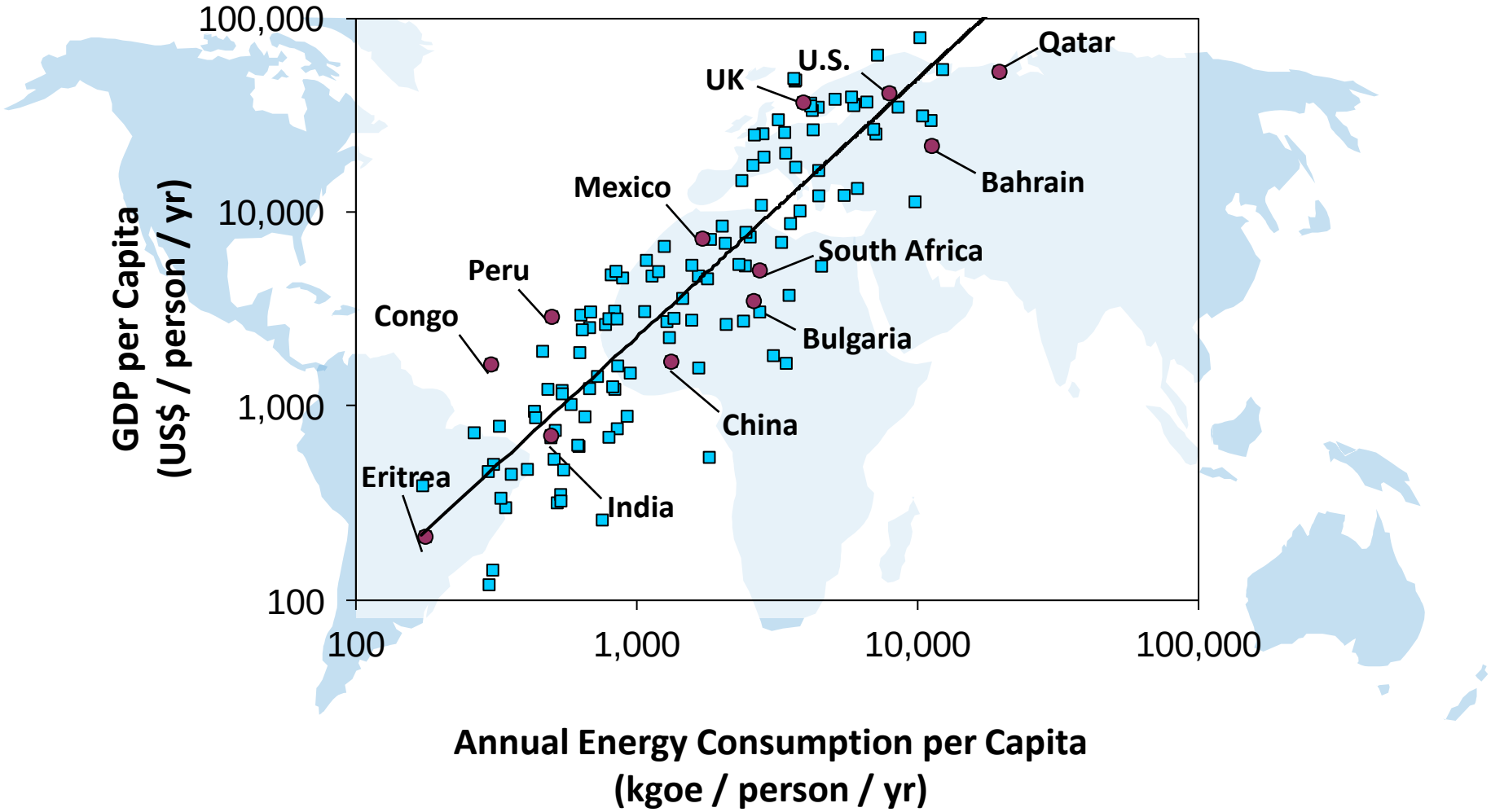
Energy Contributes to Quality of Life

GDP vs. Energy Consumption

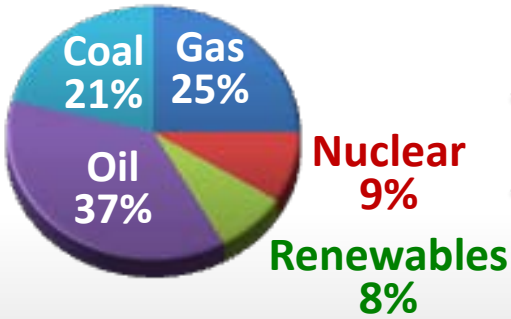


Development Data Group, The World Bank. 2008; Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat: IEA Statistics Division

Energy Demand 2010

Energy Demand 2035

98 QBtu / Year
83% Fossil Energy

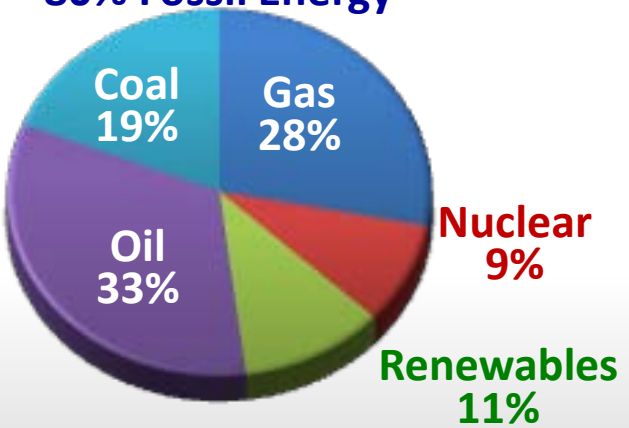


5,634 mmt CO_2

+ 6%

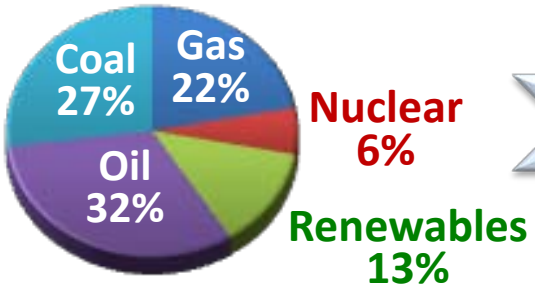
United States

104 QBtu / Year
80% Fossil Energy



5,607 mmt CO_2

505 QBtu / Year
81% Fossil Energy

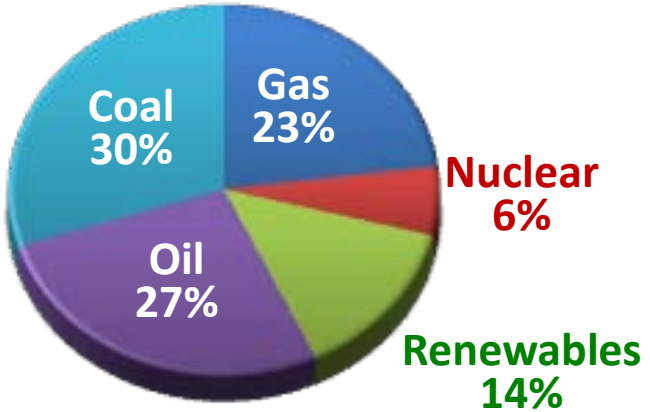


30,190 mmt CO_2

+ 47%

World

741 QBtu / Year
80% Fossil Energy



44,090 mmt CO_2

U.S. data from EIA, Annual Energy Outlook 2013 early release; World data from IEA, World Energy Outlook 2012

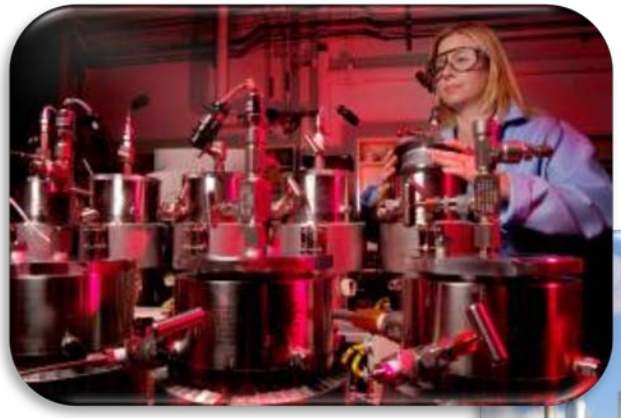
National Energy Technology Laboratory

- **Full-service DOE federal laboratory**
  - Program planning
  - Budget formulation and execution
  - Procurement
    - Contracting & financial assistance
  - Project management
    - Including NEPA
  - Legal
  - Financial management & reporting
  - Onsite research
  - Program performance & benefit analysis

- **Dedicated to energy RD&D, domestic energy resources**
  - Fossil Energy
  - Support Offices of Electricity and Energy Efficiency
- **Fundamental science through technology demonstration**
- **Unique industry–academia–government collaborations**

What we do…

- Utilize domestic resources for abundant, low cost power
- Design, develop, and demonstrate highly efficient and environmentally benign power and fuel systems.
- Perform and manage research, development, and demonstration projects in the areas of resource utilization, equipment for energy conversion, processes for separation, and approaches to carbon capture & storage.



NETL's Customer Base

Fiscal Year 2013 Budget

Fossil Energy **~ $ 507 million***

Energy Efficiency & Renewable Energy **~ $ 153 million****

Electricity Delivery & Energy Reliability **~ $ 57 million**

Reflects a 5% reduction for Sequestration

****NETL also financially manages an additional $800 million for EERE's PMC (Golden/NREL)***

Some NETL Vital Statistics

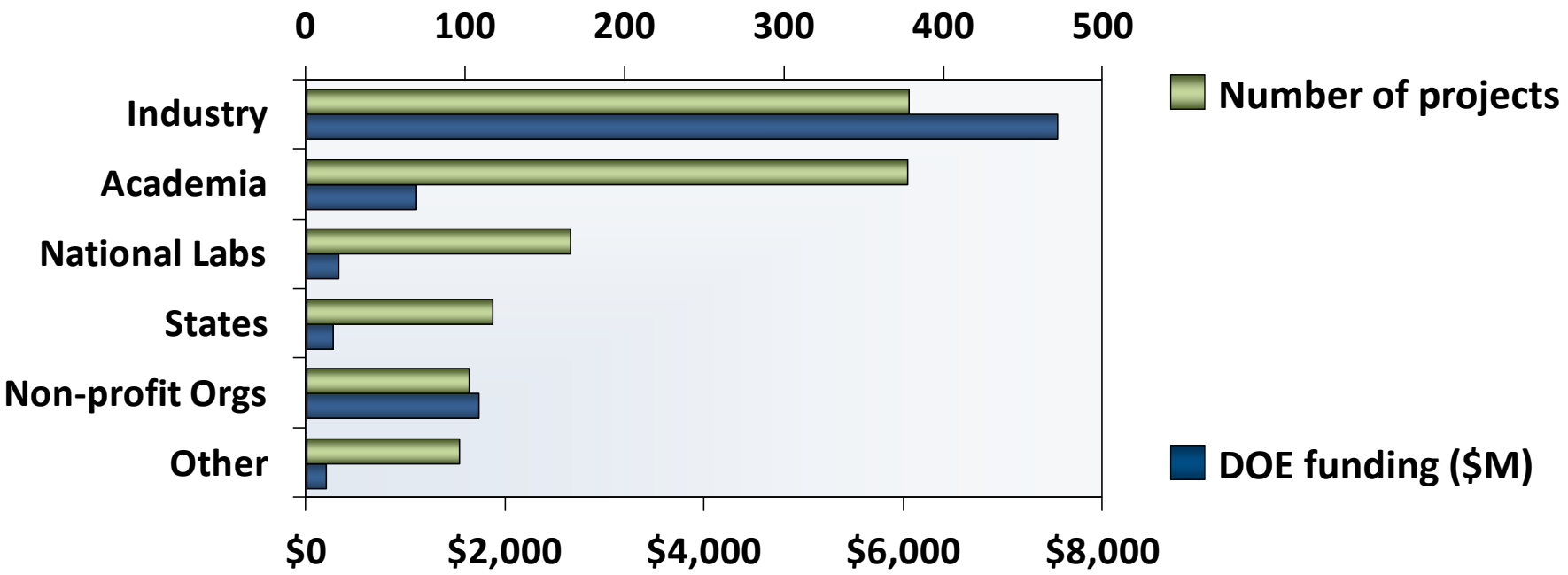
- Provide $200M per year to local economies through operations
- Over 1,700 employees: 40% federal, 60% support contractors
- Strongly technical-based staff

Federal Employees	
Scientists	17%
Engineers	39%
Technical	9%
Professional	12%
Administrative	20%
Other	3%

Site Support Contractors	
Scientists	10%
Engineers	21%
Technical	17%
Professional	26%
Administrative	9%
Other	17%

NETL Key Points

- **Founded in 1910 to investigate coal mine issues**
- **Annual Budget on the order of $800 Million**
- **Over 1,200 activities in U.S. and more than 40 countries**
- **Total award value of contracts is more than $25 billion**
  - Private sector cost-sharing nearly $14 billion
- **Provide $200M per year to local economies through operations**
- **Over 1,700 employees, largely technical-based staff**



NETL Program Areas

Strategic Center for Coal

Strategic Center for Natural Gas and Oil

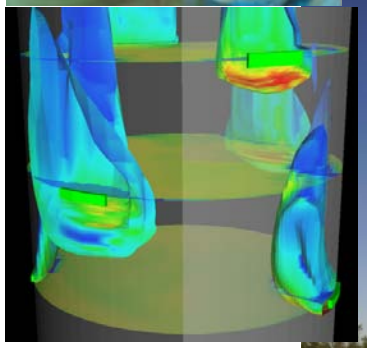
Project Management Center

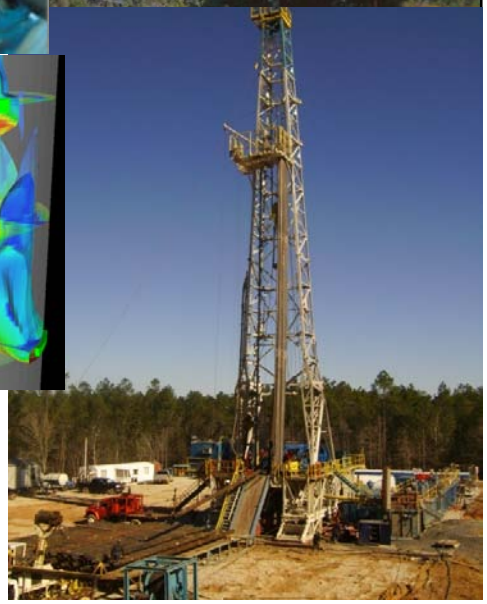
Core Program Components

Office of Coal and Power R&D

Total FY 2012 Funding ~ $333 Million

- **Carbon Capture - $68.9 Million**
- **Carbon Storage - $115.4 Million**
- **Advanced Energy Systems- $99.9 Million**
  - Advanced Combustion - $15.9 Million
  - Gasification - $39 Million
  - Turbines - $15 Million
  - Fuel Cells - $25 Million
  - Fuels - $5 Million
- **Crosscutting Research - $49.1 Million**





Working in synergy, these programs are developing technologies to increase power plant efficiency, lower electricity costs and mitigate GHG emissions in both existing and advanced power facilities

Advanced CCS Power Systems

Advanced Combustion

5 MWE Oxycombustion Pilot

- ❑ Pressurized
- ❑ O_2 Membrane
- ❑ Chemical looping
- ❑ USC Materials

Integrated Gasification Combined Cycle

- ❑ Feed Pump
- ❑ O_2 Membranes
- ❑ Syngas Cleaning
- ❑ H2 Membranes
- ❑ 2,600 °F H_2 Turbine

6 MWE Transport Gasifier

Efficiencies > 45%

↓ Capital Cost by 50%

$10 - $40/tonne CO_2 Captured

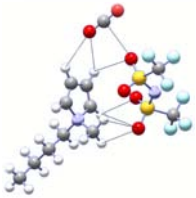
Near-zero GHGs

Near-zero criteria pollutants

Near-zero water usage

Account for 99% CO_2 Storage

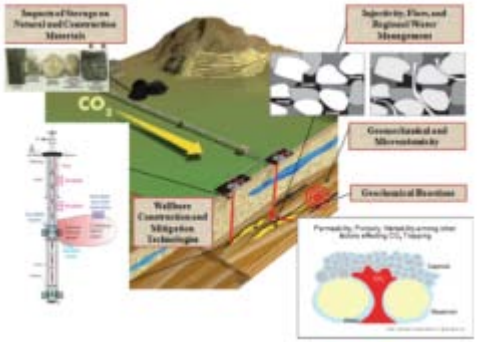
Advanced CO_2 Capture and Compression



- ❑ Solvents
- ❑ Sorbents
- ❑ Membranes
- ❑ Hybrid
- ❑ Process Intensification
- ❑ Cryogenic Capture
- ❑ Shockwave Compression

CO_2 Storage

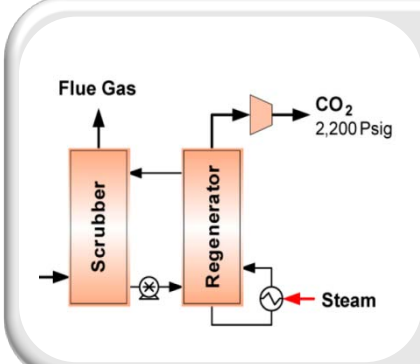
- ❑ Carbon Utilization
- ❑ Saline Storage
- ❑ Infrastructure (RCSPs)
- ❑ Geological Storage
- ❑ Monitoring, Verification and Accounting

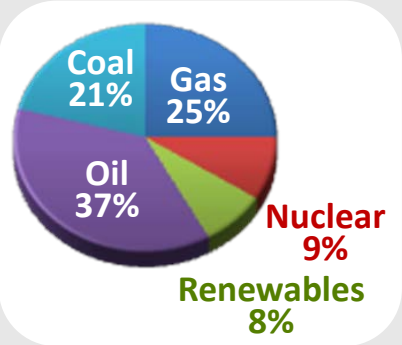


Systems, Analyses, and Planning

Informing Energy Policy Development & Technology Deployment

Analyses





Drivers

Technologies	Benefits	Situations & Trends	Integrated Electric Power Systems
• Technology evaluation • Process & cost engineering • R&D targets	• Policy scenarios • Market deployments • National benefits of R&D	• Current conditions • Future scenarios	• Cost of electricity • System design & integration

Strategic Center for Natural Gas and Oil

Advancing Technologies Supporting Development of Domestic Unconventional Resources

Tens of billions of barrels of residual oil recoverable via CO_2 enhanced oil recovery in mature fields in 22 states

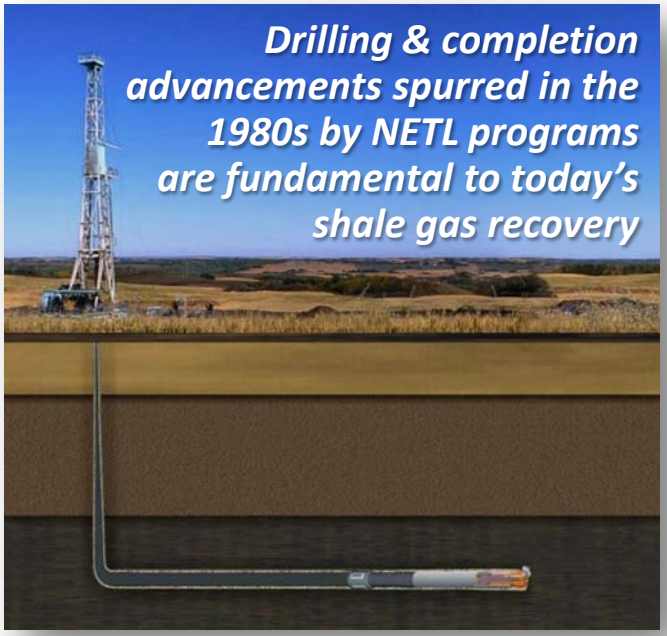
Potentially thousands of trillion cubic feet of natural gas from methane hydrate in Alaska and the Gulf of Mexico

Hundreds of trillion cubic feet of natural gas in shales and tight gas sands across the country

Shales photo courtesy of Statoil

Tapping Unconventional Natural Gas

- **Shale gas contributes 14% of today's domestic natural gas supply, could supply 45% by 2035**
  - Employed resource characterization and technology development to match technology to geology to chart path for resource development
  - NETL programs developed technologies that increased per-well gas-recovery efficiencies and reduced unit development costs



- **Coalbed methane recovery rose from <100 Bcf in 1989 to ~2 Tcf in 2009**
  - Today, coalbed methane accounts for ~8% of U.S. natural gas produced *and* increases safety by reducing methane concentrations ahead of mining operations

Early Involvement of Public Research Proves Beneficial

The Future of Natural Gas: An Interdisciplinary MIT Study (Interim Report), MIT Energy Initiative, 2010.
Energy Research at DOE: Was It Worth It? Energy Efficiency and Fossil Energy Research 1978 to 2000, National Research Council , 2001

Shale Gas

A Potential Paradigm Shift in Energy

- **New technology opening the door on a significant domestic resource**
- **Prospect of large quantities of secure, affordable, and available domestic natural gas offers potential multi-sector applications—power, fuels, chemicals**
- **Environmental concerns with wide-scale shale gas development must be addressed—real potential for fatal flaw**
- **Significant export potential with large balance-of-trade ramifications—prospect of the U.S. being an energy export nation**
- **Shale gas development potentially a world-wide energy sector "game-changer" playing out in the immediate 10-year horizon**
- **Three agency framework to guide research: DOE, DOI (USGS), EPA**
  - Characterization/technology development, air quality, water sourcing/quality, induced seismicity, ecological effects

Photo of shale deposit courtesy of Lvklock, http://en.wikipedia.org/wiki/File:MarcellusShaleCloseUp.jpg

NETL's Project Management Center

NETL Expertise Used to Help Other Government Organizations

- **Helping to implement other DOE, government programs for 25+ years**
  - Office of Engineering and Construction Management
  - Environmental Management
  - Legacy Management
  - Department of Homeland Security
  - Department of Defense
- **Non-FE extramural RD&D**
- **Technical, administrative, and project management support**
  - Documented procedures/policies
  - Disciplined process with tracking
- **Implementation activities**
  - Acquisition (contracts)
  - Financial Assistance (can only be awarded by Federal personnel)

Electricity Delivery & Energy Reliability

- *Grid modernization*
- *Reliable & secure energy supplies*
- *Disaster response*

Energy Efficiency & Renewable Energy

- *Vehicle Technologies*
- *Solid State Lighting*
- *Advanced Manufacturing*

Office of Research and Development

Innovating Energy Technologies

Computational & Basic Sciences

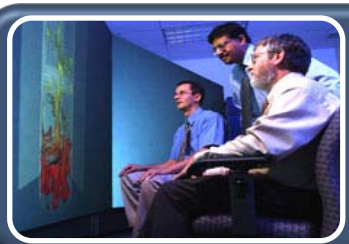
- Integrate computation with experimental research
- Model from atomic- to device- to facility-scale

Geological & Environmental Sciences

- Investigate clean power generation and gas & oil technologies
- Enhance proven, unconventional, new, and renewable resources

Materials Science & Engineering

- Seek new and improved materials
- Design and fabricate metals, alloys, and ceramics



Energy Systems Dynamics

- Conceive and develop pre-commercial technologies
- Improve in-plant devices and processes

NETL-Regional University Alliance

R&D for Energy Innovation

WVU

Carnegie Mellon

Penn State

Virginia Tech

Pitt

NETL-RUA
Regional University Alliance

NETL, URS Corporation, and five regional universities working to advance energy science & technology, train the next generation of energy researchers, and help grow the energy technology market

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