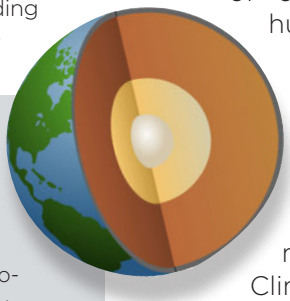
U.S. DEPARTMENT OF ENERGY | Office of the Under Secretary for Science and Energy

Energy Department Subsurface Crosscut

Addressing Common Subsurface Challenges

Mastering the subsurface for energy production and storage and for the management of energy waste streams constitutes an energy "grand challenge." To meet this challenge, the Department of Energy (DOE) is implementing a new collaborative model to address the following common subsurface challenges:

1. Discovering, Characterizing, and Predicting
   - accurately characterizing the subsurface using integrated geophysical and geochemical technologies
   - quantitatively inferring subsurface evolution under current and future engineered conditions
   - finding viable, low-risk resources
2. Accessing
   - safe, cost-effective reservoir integrity
3. Engineering
   - creating/constructing desired subsurface conditions in challenging high-pressure/high-temperature environments
4. Sustaining
   - maintaining optimal subsurface conditions over multi-decadal or longer time frames through complex system evolution
5. Monitoring
   - improving observational methods to advance the understanding of multi-scale complexities through system lifetimes



The SubTER Crosscut identifies common research, development, and demonstration (RD&D) and policy challenges across DOE and enables programs to work together toward solutions. The SubTER Crosscut reports to the Under Secretary for Science and Energy and leverages program budget priorities to better plan for investment and assistance. While each of the offices brings new activities to the table, the subsurface energy sector benefits as a whole from crosscutting solutions. SubTER partners include DOE programs and national labs, academia, industry, and other federal agencies.

Learn more about SubTER at www.energy.gov/subsurface-tech-team.

Subsurface Technology and Engineering Research, Development, and Demonstration (SubTER) Crosscut

Why is the SubTER Crosscut Important?

Subsurface energy sources satisfy over 80% of total U.S. energy needs. Finding and effectively exploiting these resources while mitigating impacts of their use constitute major technical and socio-political challenges. Still, the opportunities are vast. Next generation advances in subsurface technologies will enable increases in domestic natural gas supplies, as well as 100+ GWe of clean, renewable geothermal energy. The subsurface provides hundreds of years of safe storage capacity for carbon dioxide (CO_2), and opportunities for environmentally responsible management and disposal of hazardous materials and other energy waste streams. The subsurface can also serve as a reservoir for energy storage for power produced from intermittent generation sources. These opportunities have immediate connection to societal needs and administration priorities. Clean energy deployment and CO_2 storage are critical components of the President's Climate Action Plan, necessary to meet the 2050 greenhouse gas (GHG) emissions reduction target. Increasing domestic energy supply from greater hydrocarbon resource recovery, in a sustainable and environmentally sound manner, is also an Administration goal that enhances national security and fuels economic growth.

Who's Involved?

Representing the geosciences, research, modeling, technology development, policy, and stakeholders, the participating DOE program and staff offices include:

Fossil Energy
Energy Efficiency & Renewable Energy
Nuclear Energy
Environmental Management
Science
ARPA-E
Electricity Delivery & Energy Reliability
Energy Policy & Systems Analysis
Congressional & Intergovernmental Affairs
Energy Information Administration

Crosscutting RD&D Strategy

Through ongoing engagement with key stakeholders to help identify high priority technology areas for federal advancement, DOE has developed a comprehensive RD&D strategy focused around four core pillars:

Intelligent Wellbores – New sensors and adaptive materials are needed to ensure sustained integrity of the wellbore environment.

Subsurface Stress & Induced Seismicity – Radically new approaches are needed to guide and optimize sustainable energy strategies and reduce the risks associated with subsurface injection.

Permeability Manipulation – Greater knowledge of coupled processes will lead to imroved methods of enhancing, impeding, and eliminating fluid flow.

New Subsurface Signals – DOE seeks to transform our ability to characterize subsurface systems by focusing on four areas of research: new signals, integration of multiple data sets, identification of critical system transitions, and automation.

A critical component of all pillars will be R&D testing at **Energy Field Observatories.** Field tests are critical to the validation of new results and approaches at commercial scale to validate tools, technologies, and methodologies and measure progress.

Events

UPCOMING

DOE Crosscutting Subsurface Initiative: *Adaptive Control of Subsurface Fractures and Flow*
Town Hall, **December 15, 2014, 6:15-7:15 pm**
American Geophysical Union Fall Meeting
San Francisco, CA

Informational Briefing on Subsurface Technology and Engineering Challenges and R&D Opportunities: *Stress State and Induced Seismicity*
Public workshop hosted by the United States Energy Association, **October 30, 2014,** Washington, DC

National Research Council Joint Committee Meeting: *Critical Issues in the Subsurface: Using Field Observatories and Data to Advance Understanding of Rock Behavior*
October 23, 2014, Washington, DC

PAST

U.S. DOE Subsurface Technology & Engineering Challenges and R&D Opportunities: *Control of Fracture Propagation & Fluid Flow*
Public workshop hosted by the United States Energy Association, **July 22, 2014,** Washington, DC
http://usea.org/event/us-doe-subsurface-technology-engineering-challenges-and-rd-opportunities-control-fracture

National Research Council Committee on Geological and Geotechnical Engineering Meeting, May 29, 2014, Washington, DC
http://dels.nas.edu/global/besr/COGGE-Events

SubTER Workshop with National Lab Partners, March 14, 2014, Washington, DC

With nearly 100 Quadrillion Btu of energy generated by oil, natural gas, coal, nuclear, and geothermal, the Earth's crust affects the greater part of all domestic energy supplies.

Current Activities

JASON Letter Report on State of Stress in Engineered Subsurface Systems

A new report prepared for SubTER by the independent JASON advisory group recommends that **"DOE take a leadership role in the science and technology for improved measurement, characterization, and understanding of the state of stress of engineered subsurface systems in order to address major energy and security challenges of the nation."** JASON recommends coordinated research and technology development at dedicated field sites to connect insights from laboratory scales and models to operational environments.

National Laboratory Early-Phase Research

Approximately $1.6M has been awarded by the EERE-Geothermal Technologies Office and Office of Fossil Energy to national laboratory teams to begin work on crosscutting topics. These projects are envisioned to feed into broader program efforts in upcoming years:

Lawrence Berkeley National Laboratory: Intermediate-Scale Hydraulic Fracture and Stimulation Field Laboratory in a Deep Mine for the Investigation of Induced Seismicity and Fracture Flow. **PILLAR: Permeability Manipulation, Subsurface Stress & Induced Seismicity**

Los Alamos National Laboratory: Development of Novel 3D Acoustic Borehole Integrity Monitoring System. **PILLAR: Intelligent Wellbores**

Los Alamos National Laboratory: Evaluating the State of Stress Away from the Borehole. **PILLAR: Subsurface Stress & Induced Seismicity**

National Energy Technology Laboratory: Big Data and Analytics for Induced Seismicity. **PILLAR: Subsurface Stress & Induced Seismicity**

Oak Ridge National Laboratory: Photo-stimulated luminescence spectroscopy stress sensor for in-situ stress measurement. **PILLAR: Subsurface Stress & Induced Seismicity**

Pacific Northwest National Laboratory: Borehole muon detector for 4D density tomography of subsurface reservoirs, geophysics, hydrology, geochemistry, and biochemistry. **PILLAR: New Subsurface Signals**

Read the JASON Report at www.energy.gov/articles/2014-jason-report-state-stress-engineered-subsurface-systems