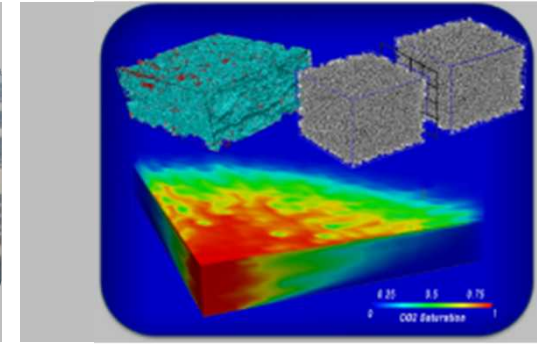
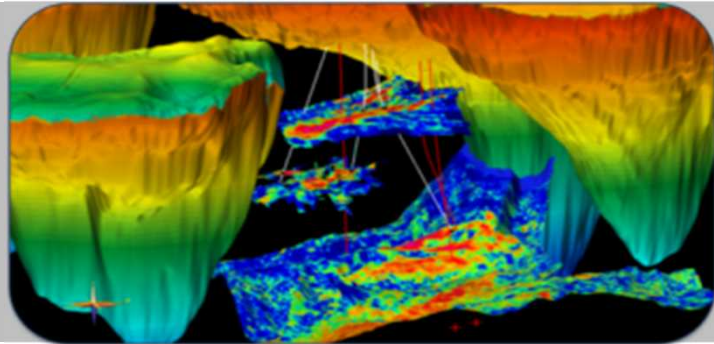


*Exceptional service in the national interest*



# SubTER: Subsurface Technology & Engineering Research Development, & Demonstration Crosscut

Susan Altman  
March 3, 2015

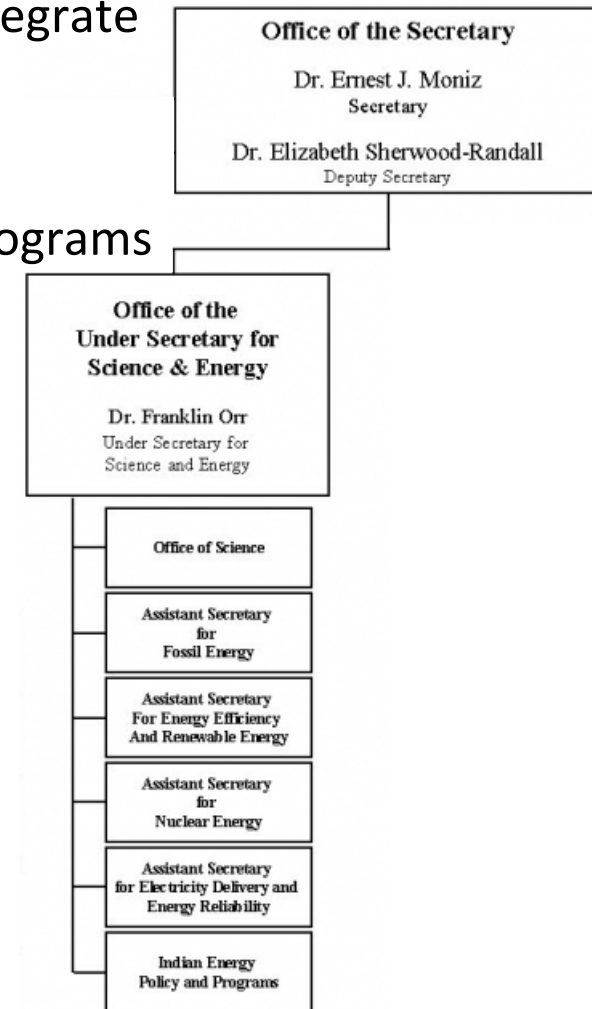


Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

# DOE Secretary Moniz has made a difference!

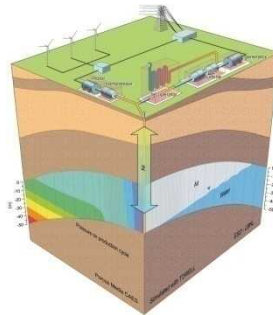
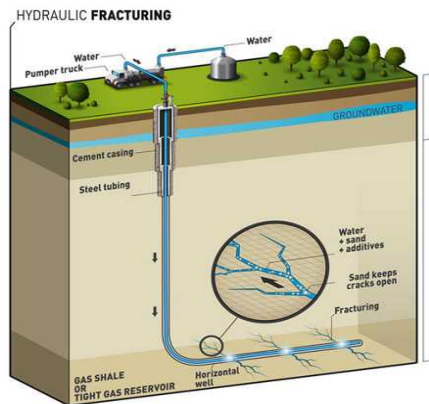
## Secretary Moniz created:

- Undersecretary for Science and Energy to better integrate Energy Technology Programs with basic research
  - Lynn Orr recently confirmed by the Senate
- 6 crosscutting “Tech Teams” : Goal – Large FY16 programs
  - Grid
  - Water-Energy (WETT)
  - Supercritical CO<sub>2</sub> Brayton Cycle
  - Advanced Computing
  - Manufacturing
  - Subsurface Technology and Engineering RD&D (SubTER)

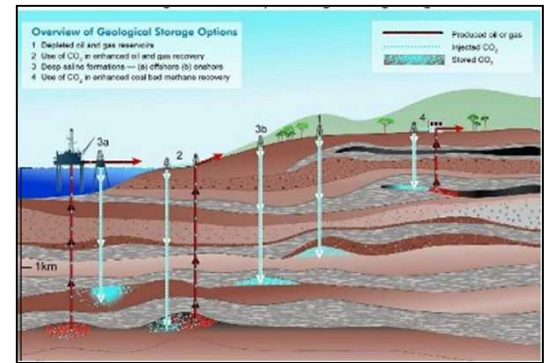


# “Adaptive Control” of subsurface fractures and flow

Ability to adaptively manipulate – rapidly and with confidence - subsurface fracture length, aperture, branching, connectivity and associated reactions and fluid flow.



Compressed Air Energy Storage

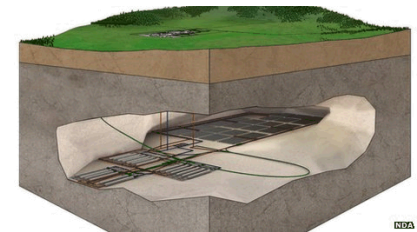
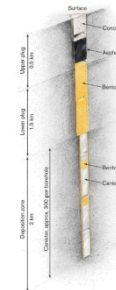
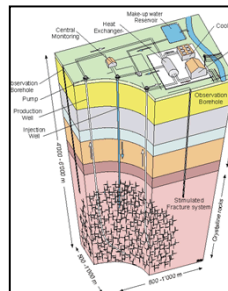


Carbon Sequestration: Enhance injectivity, optimize storage, plug leakage pathways

Fractures by Design: Control fracture length & branching patterns in real-time

Safe subsurface storage of nuclear waste

Enhanced geothermal energy



# Overview of Program Roles

## Energy Policy & Systems Analysis

- Advisement: Secretary of Energy
- Policy: low-carbon and secure energy economy
- Technical assistance: States and local entities

## Nuclear Energy

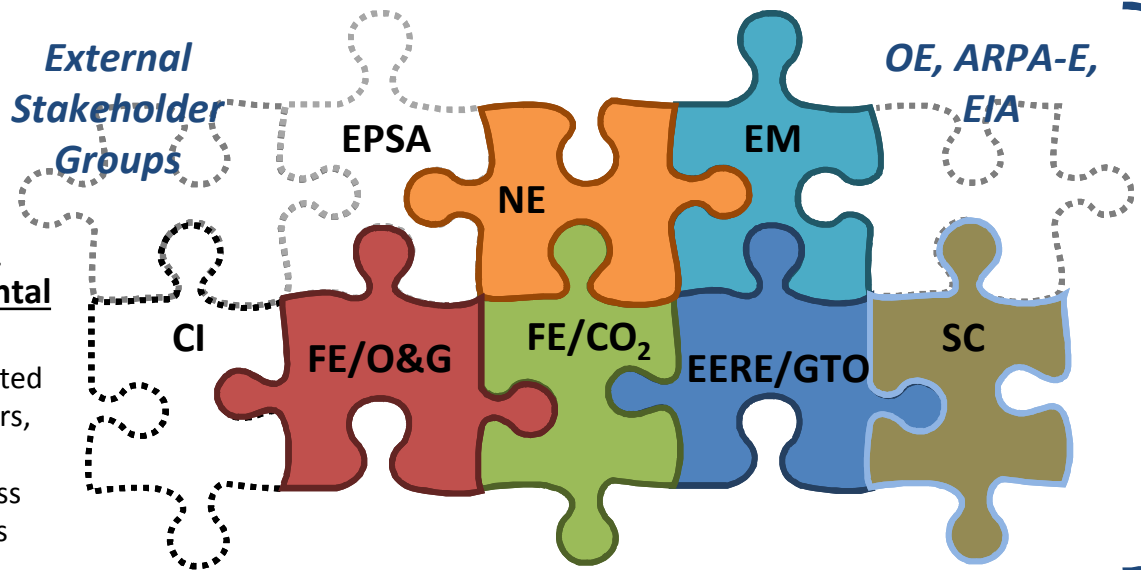
- Policy and technology: disposition of used nuclear fuel and waste
- R&D: deep borehole disposal concept

## Environmental Management

- Modeling and tools: subsurface evaluation and characterization
- Cleanup: nuclear weapons legacy

## Congressional & Inter-governmental Affairs

- Interactions: elected officials, regulators, and stakeholders
- Information access for change agents



## SubTER Tech Team

- Encompasses relevant offices
- Reports to Under Secretary for Energy and Science
- Identifies and facilitates crosscutting subsurface R&D and policy priorities for DOE
- Develops collaborative spend plan and funding scenarios

## Fossil Energy/Oil & Gas

- R&D and access: clean, affordable traditional fuel sources
- R&D: drilling, well construction and integrity, and hydraulic fracturing technologies

## Fossil Energy/Carbon Storage

- Policy and technology: challenges of CO<sub>2</sub> storage to inform regulators, industry, and the public
- R&D: CO<sub>2</sub> offshore and onshore storage

## Energy Efficiency & Renewable Energy/Geothermal Technologies Office

- R&D: locate, access, and develop geothermal resources
- R&D: access, create, and sustain enhanced geothermal systems (EGS)

## Science

- Basic research: geology, geophysics, and biogeochemistry
- Expertise: subsurface chemistry, complex fluid flow

# Common Subsurface Energy Challenges

## Discovering, Characterizing, and Predicting

Efficiently and accurately locate target geophysical and geochemical responses, finding more viable and low-risk resource, and quantitatively infer their evolution under future engineered conditions

## Accessing

Safe and cost-effective drilling, with reservoir integrity

## Engineering

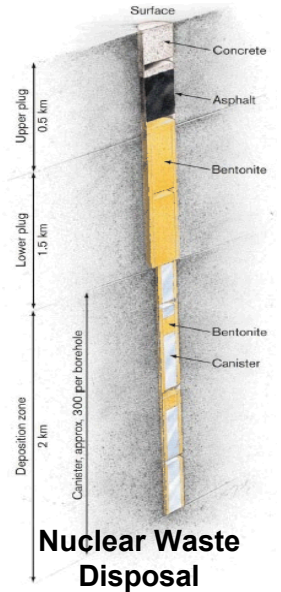
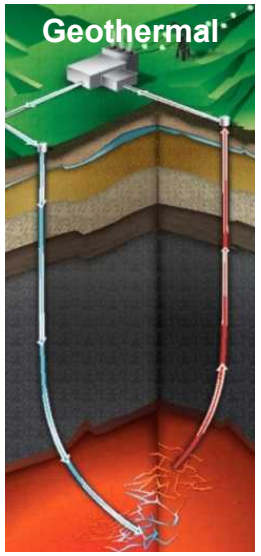
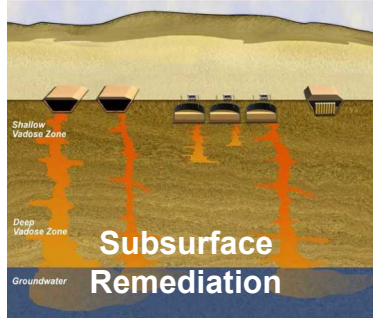
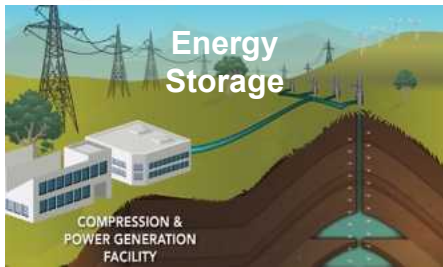
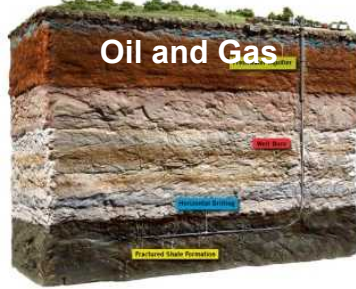
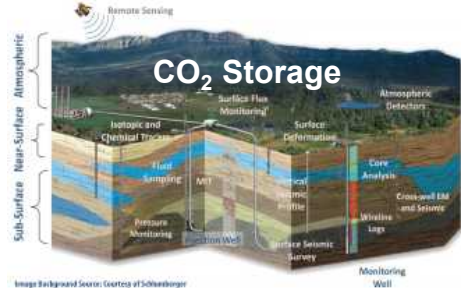
Create/construct desired subsurface conditions in challenging high-pressure/high-temperature environments

## Sustaining

Maintain optimal subsurface conditions over multi-decadal or longer time frames through complex system evolution

## Monitoring

Improve observational methods and advance understanding of multi-scale complexities through system lifetimes



# FY15 Example Priority Aligned Activities Within Offices

## Energy Efficiency and Renewable Energy

- FORGE (Frontier Observatory for Research in Geothermal Energy)

## Nuclear Energy, Office of Used Nuclear Fuel Disposition

- Activities related to initiating the Deep Borehole Field Test in FY16, which is a high priority item for the Office of Nuclear Energy

## Fossil Energy, Oil & Gas and Carbon Storage

- NRAP
- Unconventional Resources Field Laboratories

## Science, Basic Energy Science (BES)

- Foundational Research
- EFRCs: Centers for Geologic Storage of CO<sub>2</sub>, Frontiers of Subsurface Energy Security, and Nanoscale Controls on Geologic CO<sub>2</sub>

## Environmental Management

- Investigate the use and development of universal canisters for EM waste disposal in borehole

# How Can the Academic Community Be Involved?



- Your input now can contribute to shaping the scope of SubTER.
- Funding opportunities will be announced leading up to and/or after the full launch of this initiative in FY16 (pending appropriations).
- Partnerships with National Labs can facilitate involvement in other aspects of the Subsurface Crosscut starting in FY15.

## Subsurface Working Team: 13 Laboratories



# The Quadrennial Technology Review (QTR)

The 2015 Quadrennial Technology Review (QTR 2015) will examine the most promising research, development, demonstration, and deployment (RDD&D) opportunities across energy technologies to effectively address the nation's energy needs. The insight gained from this analysis will provide essential information for decision-makers as they develop funding decisions, approaches to public-private partnerships, and other strategic actions over the next five years.



Contributions are encouraged for identifying key RDD&D opportunities, approaches to analysis of the RDD&D portfolio, and means for accelerating the RDD&D process. Your comments are welcome and can be sent to: [DOE-QTR2015@Hq.Doe.Gov](mailto:DOE-QTR2015@Hq.Doe.Gov)

<http://energy.gov/qtr>

# Subsurface Control for a Safe and Effective Energy Future

## Adaptive Control of Subsurface Fractures and Fluid Flow

### Wellbore Integrity & Drilling Technologies

Improved well construction materials and techniques

Autonomous completions for well integrity modeling

New diagnostics for wellbore integrity

Remediation tools and technologies

Fit-for-purpose drilling and completion tools (e.g. anticipative drilling, centralizers, monitoring)

HT/HP well construction / completion technologies

### Subsurface Stress & Induced Seismicity

Measurement of stress and induced seismicity

Manipulation of stress and induced seismicity

Relating stress manipulation and induced seismicity to permeability

Applied risk analysis of subsurface manipulation

### Permeability Manipulation

Physicochemical fluid-rock interactions

Manipulating flowpaths

Characterizing fractures, dynamics, and flows

Novel stimulation methods

### New Subsurface Signals

New sensing approaches

Integration of multi-scale, multi-type data

Adaptive control processes

Diagnostic signatures and critical thresholds

Energy Field Observatories

Fit For Purpose Simulation Capabilities

# Funding Potential

## Adaptive Control of Subsurface Fractures and Fluid Flow

Intelligent Wellbore  
Systems

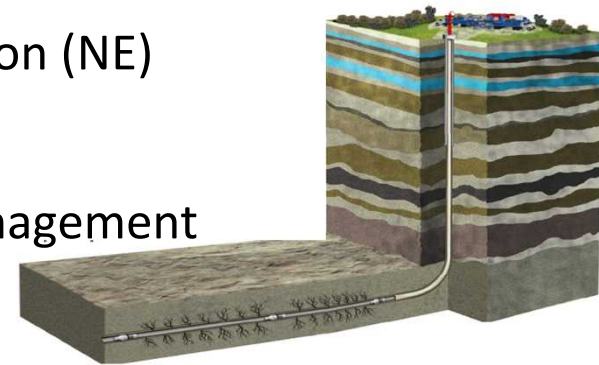
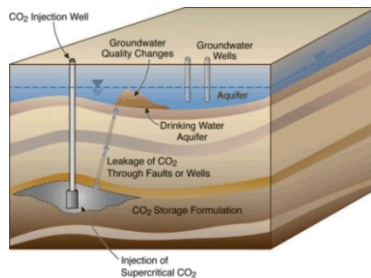
Subsurface Stress &  
Induced Seismicity

Permeability  
Manipulation

New Subsurface  
Signals

### Energy Field Observatories

- \$2M FY14 funding
  - Geothermal (EERE)
  - Clean Coal (FE)
- \$6M FY15 funding
  - Geothermal (EERE)
  - Clean Coal (FE)
- \$244M - FY 16 President's Budget Request
  - \$102M new funds
    - Geothermal (EERE)
    - Clean Coal (FE)
    - Used Fuel Disposition (NE)
  - \$142M ongoing
    - Environmental Management
    - Science



# FY15 request for expanded FWP for the following projects:

- **Wellbore** – LANL: 3D acoustic borehole integrity monitoring system
- **Stress, Permeability** – LBNL: Field Laboratory in a Deep Mine for the Investigation of Induced Seismicity and Fracture Flow
- **Stress** – LANL: Evaluating the State of Stress Away from the Borehole
- **Stress** – ORNL: Luminescence spectroscopy stress sensor for in-situ stress measurement
- **Stress** – NETL: Big Data and Analytics for Induced Seismicity
- **New Signals** – PNNL: Borehole muon detector for 4D density tomography of subsurface reservoirs
- **Wellbore** – ORNL: Nondestructive Inspection of Injection and Production Wells
- **Stress and New Signals** - LLNL: Development of microBayesloc Location Method
- **New Signals / Permeability**- SNL: Imaging fracture networks using crosshole seismic logging and advanced change detection
- **Permeability** – SNL: In situ control of fracture toughness