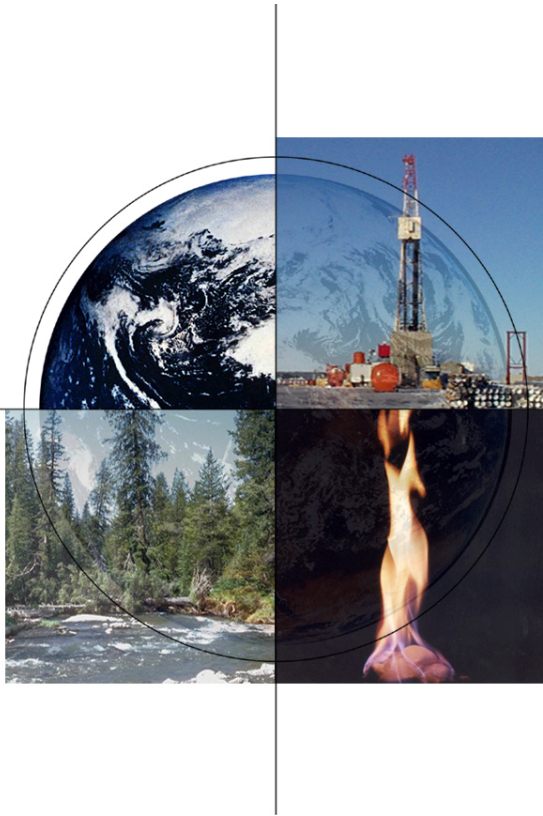


US Dept of Energy Oil & Gas Research



Jamie Brown

*Director, Earth & Mineral
Sciences Division*

*EPAct Complementary Program
Update*

January 25, 2008

National Energy Technology Laboratory

Office of Fossil Energy



Introduction

NETL's EPO Act 999 Complementary R&D Program

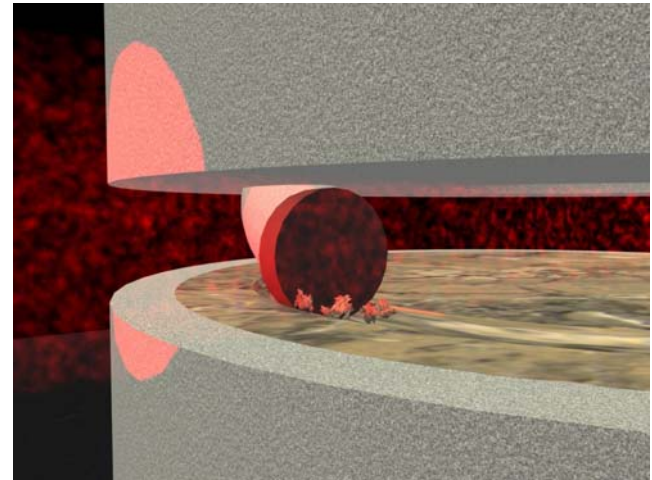
- **Overview of the 4 research areas:**
 - **Drilling Under Extreme Conditions (DUEC)** - *improve the economic viability of drilling for and producing from domestic deep (>15, 000ft) and ultra-deep (>25,000ft) O&G resources.*
 - **Environmental Impacts of O&G (EI)** - *provide unbiased scientific information and analysis of the environmental impacts of O&G, and develop new technology to effectively deal with any negative environmental impacts*
 - **Enhanced and Unconventional Oil Recovery (EUOR)** - *develop advanced technologies that will move the status of known but recoverable oil resources to technologically and economically producible resources*
 - **Resource and Technology Assessment (RTA)** - *provide characterizations of emerging, underutilized, or poorly understood O&G resource elements, and use these assessments to investigate the potential impacts of technology advances on these resources.*
- **Technical Advisory Committees**
- **Budget**



Drilling Under Extreme Conditions

- **Extreme Drilling Laboratory (EDL)**

- One-of-a-kind research facility
- Ultra-deep single cutter Drilling Simulator (UDS) via cooperative agreement with TerraTek
 - recreates bottom-hole drilling environments of ultra-deep wells, mud lab and rock lab
 - operation at up to 30 kpsi and 480 °F
 - operates with “real” drilling fluids
 - sophisticated X-Ray video system that takes images of cutting at down-hole conditions



- **Numerical Modeling**

- Modeling rock and drill cutter behavior under HPHT conditions to explain/predict rock response to various drilling modes
 - rock strain during cutting
 - formation of shear bands
 - influence of fluids in rock pores
- Input to UDS test plans as well as back-analysis of UDS experiments



Pictures of UDS Assembly

Starting Point:
Assembly of the support stand on the bottom platen. Bottom Platen shown with legs upside-down, resting on top of top platen. **September 2007**



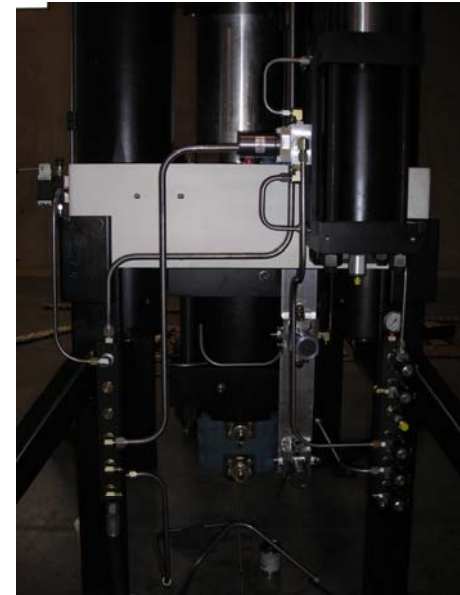
Prime Mover:
The UDS is controlled, hydraulically. This requires a single electric motor to pump hydraulic pressure to a moderate pressure. This hydraulic fluid powers other pumps and actuators.



Assembly of the Load Frame
October 2007



Assembly of Load Frame and Pressure Vessel
November 2007



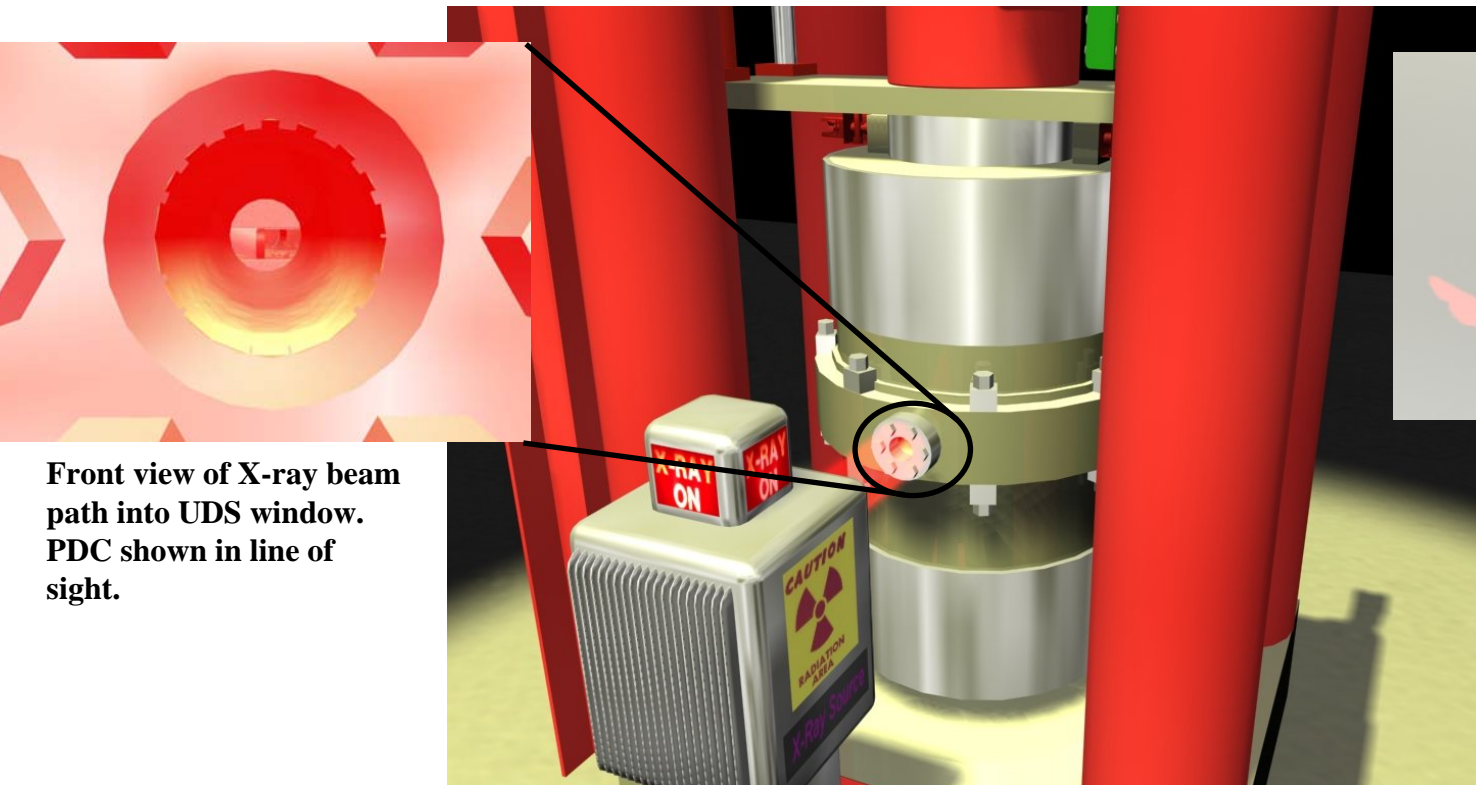
Close-up of piping
December 2007



Role of X-Ray Visualization

- **Visualization provides**

- Specifics on rock deformation & strain as cuttings form
- Shape of rock cutting as it forms
- Evidence of how test parameters (e.g. fluid properties) change cutting process



Front view of X-ray beam path into UDS window. PDC shown in line of sight.

Shadow image on UDS Back side. Image shown is an artist's conception of cutter interface with rock surface and generated cuttings.

Drilling Under Extreme Conditions

- **Nanofluids for HPHT Drilling**

- Develop multifunctional, smart nanofluids with controllable rheological and thermal conductivity properties
 - unique chemical techniques and laser ablation to develop nanofluid
 - characterize thermal, rheological and magnetic properties, stability and controlability
 - scale up



- **HP/HT materials**

- Identify technology gaps in materials performance for tubular alloys
 - environmental-induced cracking: stress corrosion cracking, sulfur stress corrosion, and hydrogen embrittlement
 - wear-corrosion
 - fatigue - modeling fatigue for HPHT applications.
- Develop benchmark testing for quantifying susceptibility of new tubular materials against commercial materials to corrosion and wear



Environmental Impacts of O&G Development

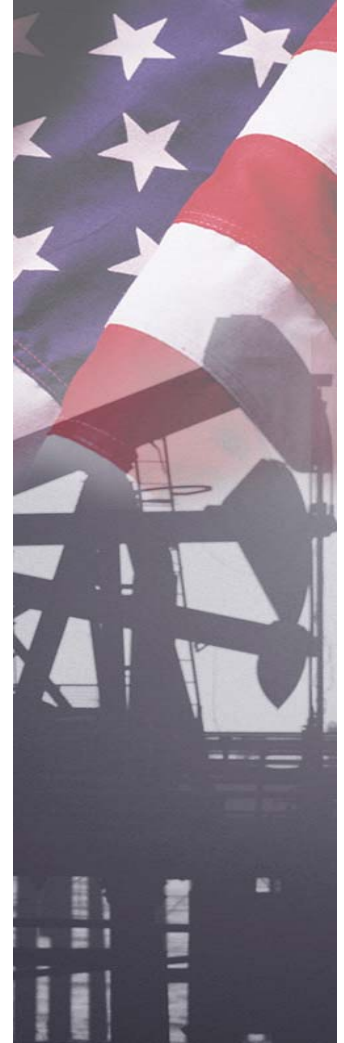
- **Unbiased information for sound policy**
 - Identify, collect, manage and disseminate data pertaining to environmental impacts of O&G exploration and production
 - Catalog regulatory barriers relating to gas development
 - Assess the impacts of O&G E&P activities on air quality
- **Managing produced water (PW)**
 - Evaluate subsurface drip irrigation as a beneficial use for CBNG PWs
 - Rapid assessment of watersheds for PW disposal according to Wyoming Section
 - Cataloging effort to identify technology barriers and PW technologies
 - PWMIS as building block; upgrade to expert system
 - Modeling high-resolution topographical data to estimate the amount of PW that can be discharged to stream channels before significant flooding or erosion occurs
- **Oil Shale water-use minimization**
 - Initiate environmental assessment of next generation oil shale retort technologies



Enhanced and Unconventional Oil Recovery

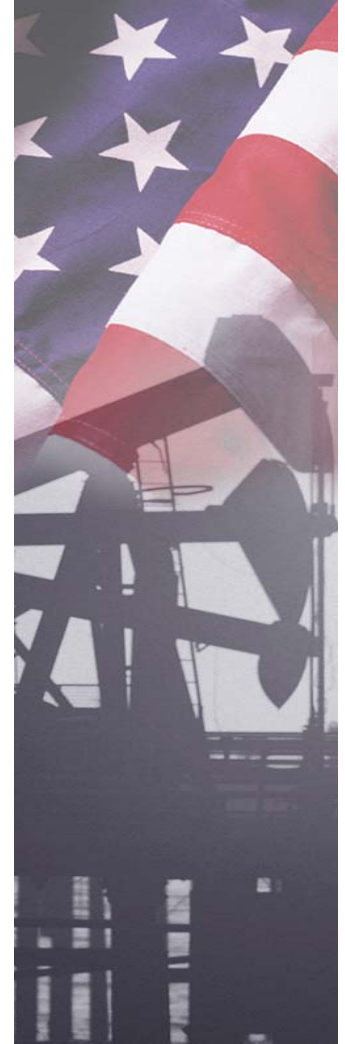
- **New EOR Technologies**

- Improve accuracy and reliability of reservoir simulations of oil recovery from fractured reservoirs
 - update simulation code with two-phase flow capability to simulate CO₂ and/or water flood
 - test FRACGEN/NFFLOW
 - perform laboratory tests (CT scans of core samples) to study the effectiveness of CO₂-EOR
- Novel surfactant-based concepts for improved mobility CO₂ floods
 - follow-on of UPitt work on thickeners
 - develop CO₂-soluble surfactants to decrease mobility and increase viscosity of CO₂.
- Microwave conversion for EOR study
 - literature review of current state of microwave conversion
 - study kerogen structure and CO₂-enhanced in situ oil shale conversion.
 - study physical properties of kerogen
 - conduct laboratory experiments to prove concept



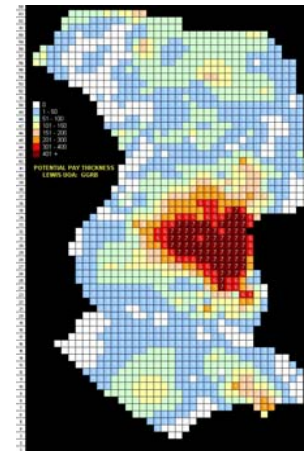
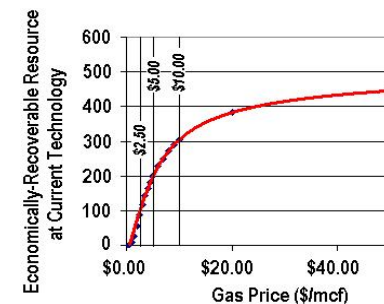
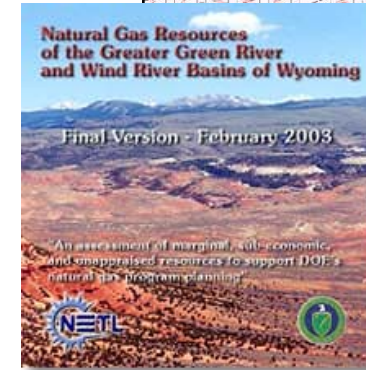
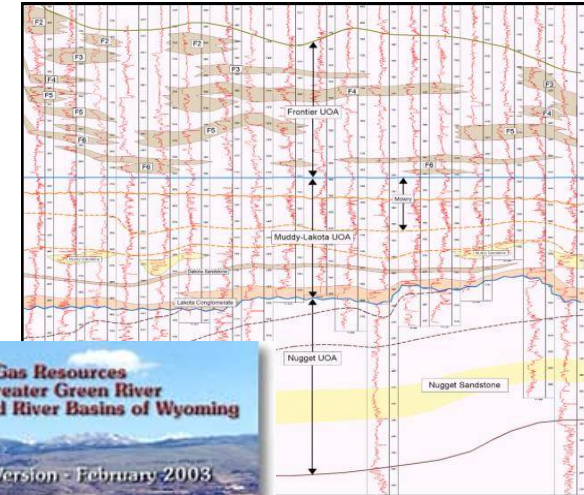
Enhanced and Unconventional Oil Recovery

- **Reservoir Characterization**
 - Create reservoir characterization data archives from historic EOR and oil shale projects
- **Catalyst Development**
 - Initiate the development of an inexpensive, disposable, and readily dispersed catalytic agent for in situ production of oil from oil shale
 - study literature
 - define test plan
 - perform laboratory experiments



Resource and Technology Assessments

- Resource Assessment
 - Identify the most-promising resource elements for characterization within the Appalachian and/or other mature basins.
 - build on previous work that focused on Upper Devonian Reservoirs
 - Design and initiate a research effort in geologically-based resource assessments targeting the key plays identified above.
 - update USDOE 1992 Appalachian Assessment
 - final products (maps; cross-sections) will be available free on CD.

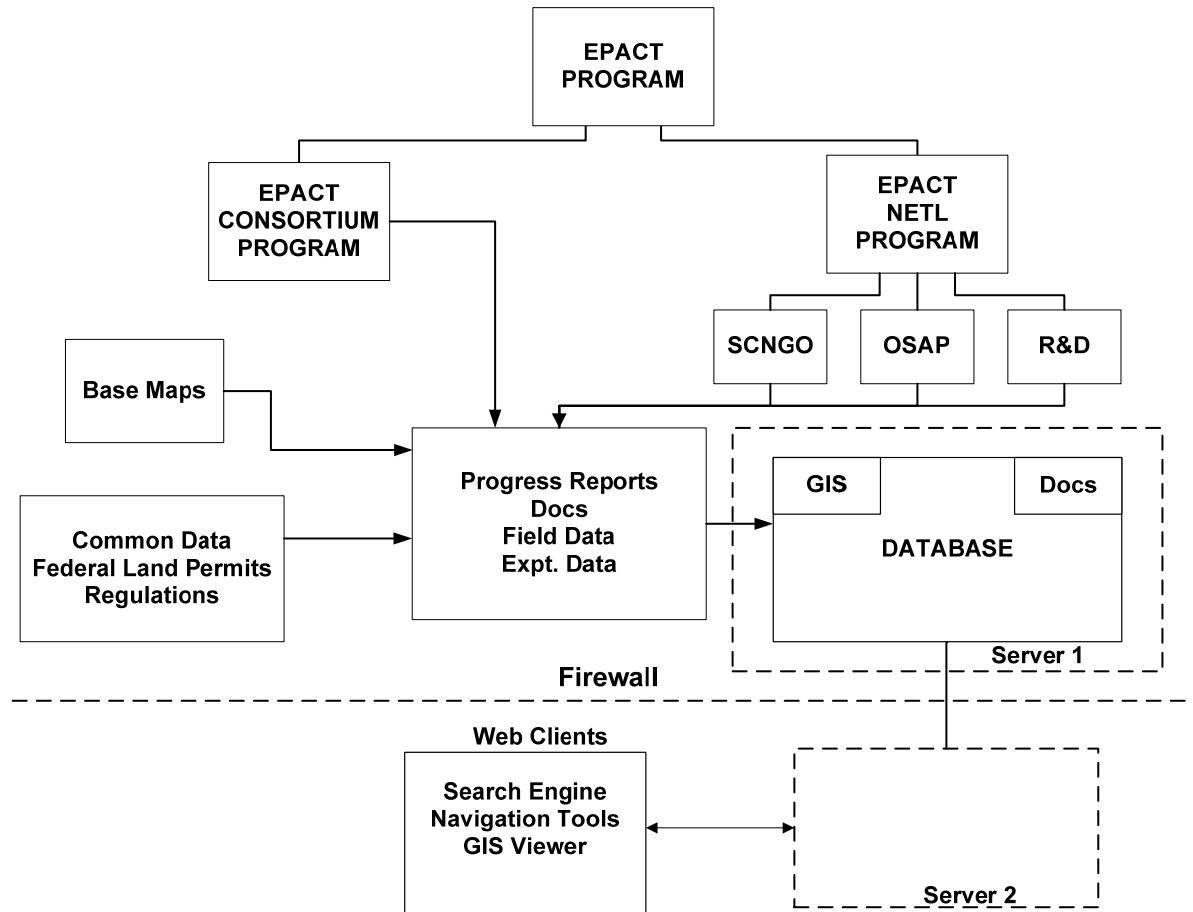


Resource and Technology Assessments

- Knowledge Management Database (KMD)
 - Recommended by the Federal Advisory Committee
 - Central repository for output generated from the Consortium, NETL Complementary R&D Programs, and other ongoing DOE O&G programs
 - Current effort is the design phase of the KMD
 - Example of data/dataset to be housed: project reports, test results, and spatial data
 - End user web interface
 - search engine
 - interactive map viewing of spatial data
 - expert systems



KMD

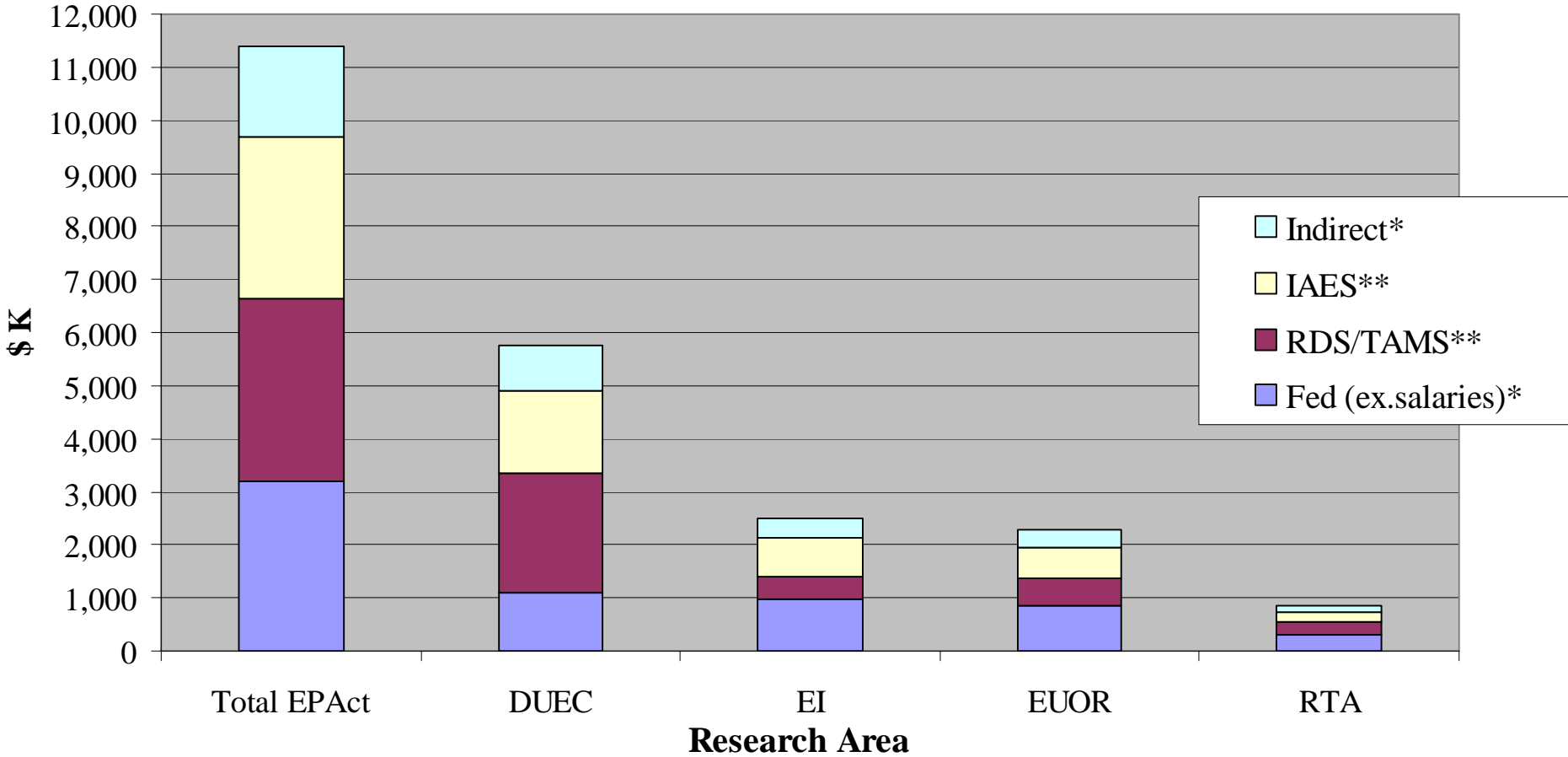


Technical Advisory Committee

- Assist NETL with planning and implementation of R&D program
 - Review progress, provide input to Annual Plan, and participate in annual merit reviews
 - Provide assessment of the complementary nature of the R&D program with the Consortium, the traditional program and OSAP
- Made up of four subcommittees
 - one for each research area
 - 3 to 4 members including industry and academia
 - The objectives of the subcommittees are to gather data, conduct analyses and develop recommendations for consideration by the full committee
- Status
 - Draft charter
 - Draft list of proposed members
 - Draft email to proposed members



Distribution of FY07 EPAct Complementary Program Funds



* Funds received by ORD on 12/21/07

** Funds received by ORD on 9/22/07

