Overview of RPSEA Onshore and Offshore Drilling/Completion/Intervention Technologies

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Vice President, Technical Programs

SECURE ENERGY FOR AMERICA
The Energy Policy Act of 2005
And Section 999:

A Industry led Public/Private Partnership for R&D in the Ultra-Deepwater in the Gulf of Mexico and in Unconventional Onshore Natural Gas and Other Petroleum Resources of the United States.

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What is Section 999?

Specifically, the law directs --

- Research, development, demonstration, and commercial application of technologies for ultra-deepwater and unconventional natural gas and other petroleum resource

- Maximize the U.S resource value by:
  - Increasing supply
  - Reducing the cost
  - Increasing E&P efficiency
  - Improving safety and minimizing environmental impacts
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Current Program Structure/Funding

Program Funding From Federal Oil and Gas Royalties

Total Program: $50 M/yr

Department of Energy

Fossil Energy Office

$37.5 M

Program Consortium

Unconventional $16.25 M

Ultra-deepwater $17.5 M

Small Producer Program $3.75 M

$12.5 M

NETL

In-House R&D Program

Designed to be 10 year, $500M directed spending.
Building a Relevant Portfolio

- **Years Five thru Ten**
  - Down-selection, moving to demonstration

- **Year Two**
  - Careful selection of key enabling and cross-cutting technologies that meet multiple objectives or enable the development of a suite of technologies

- **Year One**
  - Development of “low-hanging fruit” or technologies that provide incremental improvements in E&P economics, etc.
  - Smaller more numerous awards towards the basic end of the research spectrum

**Themes**

- **Science Themes**
- **Enabling/Cross-cutting Themes**
- **Enhancing Themes**
Technology has Driven the Growth

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Increased Cost & Risk

Improved Technology

Steve Holditch
Federal R&D Funding Trends

Figure 7: DOE Oil and Gas R&D Budget History

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Where Does R&D Funding Come From?

IOGCC
William Lawson

"Actual" research expenditures have decreased by 44 percent since 1992.

Source: Intek, Inc. study performed for U.S. DOE

Figure from Dr. Scott Tinker, Texas Bureau of Economic Geology, private communication.
** Traditional Oil Field Service companies (Baker Hughes, Halliburton, Schlumberger, Smith, Weatherford); source: company annual reports, CERA analysis.
DeepStar Participants - Industry Funded Joint Effort

Approximately $3 million per year
Norway – Demo2000 Public/Private Effort

The DEMO 2000 program is focused towards three main objectives:
- Continued cost-effective development of the Norwegian Continental Shelf (NCS), using new technology
- Improved confidence in cost and schedule during project execution
- Development of new Norwegian positions for a global offshore market

The DEMO 2000 was initiated jointly by the oil industry and the government, realizing that a major co-operation effort was needed to bring new products and systems into a number of export markets and to maintain the investment into reducing cost of new field developments.

The role of DEMO 2000 is to stimulate the uptake of new technology in the industry by bridging the gap between R&D projects and implementation.

DEMO 2000 focuses on qualifications of new technology and solutions in a close collaboration between suppliers, contractors, research institutions and oil companies through prototype development and testing, deployment and piloting.

Approximately $10 million/year plus ~3:1 cost sharing

The shift of responsibility from operators to suppliers to develop new technology has left a funding gap. Stronger co-operation between programs is needed in order to join forces towards common challenges. DEMO 2000 discusses cooperation with other offshore technology programs - JIP (France), DeepStar (US), Procap 3000 (Brazil) and ITF (UK).

The Research Partnership to Secure Energy for America

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Brazil – 1% of Gross Production to R&D

Petrobras current strategic in-house corporate program dedicated to ultra-deepwater exploitation systems.

Application Scenarios:

- Roncador (1.500 – 2.000m), Mód 2, Mód 3, Mod 4
- Marlim Sul Mod 2 (1.100 – 1.500m)
- Marlim Leste (1.100 – 1.700m)
- Alba cora Leste (800 – 2.100m)
- Jubarte I, II (1.300-1.500m)
- Golfinho I, II (1.300-1.500m)
- Prospects at 3,000m WD
- West Africa & GoM

José Formigli
E&P
Production Engineering
September 2005
Focus Leads to Steady Progress

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NPC 2007 Priorities/Potential

The amount of research and development needed to fully develop a given technology is described ... as follows:

- Incremental—research and development as usual
- Accelerated—research and development as usual, but with a major increase in funding (factors of 3 to 5)
- Breakthrough—substantial increase in funding (factors of 10 to 100) and more use of consortia.
A Proven Model for Development

Technology Dissemination

GTI Project Management
75 Advisors
20 Companies

Idea Generation

200 Papers
Methane from Coal Seams
Publication
100 Reports

Cost: $140 M over 10 yrs
CBM now 10% of domestic production

Workshops, Forums, Symposia
12,000 Attendees

Demonstration

3 Major Field Experiments
50 Research Wells

Proof of Concept

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The Technology Challenges of Small Producers

Focus Area – Advancing Technology for Mature Fields

Target – Existing/Mature Oil & Gas Accumulations

- Maximize the value of small producers’ existing asset base
- Leverage existing infrastructure
- Return to production of older assets
- Minimal additional surface impact
- Minimize and reduce the existing environmental impact

- Lower cost and maximize production
# Unconventional Resources
## 2007 Program

<table>
<thead>
<tr>
<th>Category</th>
<th>CBM (10%)</th>
<th>Gas Shales (45%)</th>
<th>Tight Sands (45%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Basin Analysis</td>
<td></td>
<td>$3.4M (GTI)</td>
<td>$2.9M (CSM)</td>
<td>$6.30</td>
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<tr>
<td>Drilling</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Stimulation and Completion</td>
<td>$0.08M (Penn St.) Microwave CBM</td>
<td>$0.09M - Carter -Cutters $0.69M (U.Houston) $0.95M UT-Refrac</td>
<td>$1.05M (TEES) Gel Damage $0.22M (Tulsa) Frac Damage</td>
<td>$5.08</td>
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<tr>
<td>Water Management</td>
<td>$1.56M (CSM) Integrated Treatment Framework</td>
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<td></td>
<td>$1.56</td>
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<tr>
<td>Environmental</td>
<td></td>
<td><strong>⭐️</strong></td>
<td><strong>⭐️</strong></td>
<td></td>
</tr>
<tr>
<td>Reservoir Description &amp; Management</td>
<td><strong>⭐️</strong></td>
<td>$1.07M (LBNL) High Resolution Imaging</td>
<td>$1.7M (LBNL) Expert Teaching System Tgas</td>
<td>$2.77</td>
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<tr>
<td>Reservoir Engineering</td>
<td><strong>⭐️</strong></td>
<td>$0.31M (TEES) Dev. Strategy/Decision Model</td>
<td>$0.44M (Tulsa) Wamsutter $1.07M (UofUtah) Forecasting TGas $0.52M (Stanford) Condensate</td>
<td>$2.34</td>
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<tr>
<td>Resource Assessment</td>
<td>$0.50M (Geo Surv)Alabama Shales $0.43M (Utah Geo)Manning Shales</td>
<td>$0.67M (CSM) Gas Comp. Rockies</td>
<td></td>
<td>$1.60</td>
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<td>Exploration Technologies</td>
<td>$0.86M (CSM) Coal &amp;Bugs</td>
<td></td>
<td></td>
<td>$0.86</td>
</tr>
</tbody>
</table>

**Total: $18.51**

- **H**: High Priority
- **M**: Medium Priority
- **L**: Low Priority
- **⭐️**: Resource Focus
- **⭐️**: Technology Focus

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**Current Portfolio**
Drilling, Completions, & Interventions Projects
Unconventional Resources Program

• 2007
  – 7122-16 New Albany Shale Gas – Texas A&M University
  – 7122-33 Advanced Hydraulic Fracturing Technology for Unconventional Tight Gas Reservoirs – Texas A&M University
  – 7122-35 Optimizing Development Strategies to Increase Reserves in Unconventional Gas Reservoirs – Texas Engineering Experiment Station
  – 7122-36 Novel Fluids for Gas Productivity Enhancement in Tight Gas Formations – University of Tulsa
  – 7122-38 Improvement of Fracturing for Gas Shales – The University of Texas at Austin
  – 7122-41 Improved Reservoir Access Through Refracture Treatments in Tight Gas Sands and Gas Shales – The University of Texas at Austin
7122-07 Novel Concepts for Unconventional Gas Development in Shales, Tight Sands, and Coalbeds – Carter Technology

• **Cost:**
  – Total Estimated Cost: $114,600
  – RPSEA Maximum Share: $91,680
  – Carter Technology: $22,920
Objectives:

- Prepare preliminary study of novel methods of formation stimulation
- Increase production of large amounts of gas in shale, coal, and tight sandstone formations
- Methods will differ significantly from traditional drilling and stimulation methodologies

Basis:

- Methods of mechanically or hydraulically cutting large infiltration galleries connected to wellbore evaluated & numerically modeled.
- Slots similar to steerable fractures, only larger
- Best concepts will be integrated with advanced fracture propagation & propping concepts for hybrid stimulation technique.
- Concept & design drawings; cost estimates developed
7122-07 Novel Concepts for Unconventional Gas Development in Shales, Tight Sands, and Coalbeds – Carter Technology

- **Potential Impacts:**
  - No reliance on detailed knowledge of natural fracture systems
  - May be applicable to formations with limited data
  - If successful, will allow more efficient drainage fields with higher recovery rates
Drilling, Completions, & Interventions Projects
Unconventional Resources Program

• 2008
  – 8122-35 The Environmentally Friendly Drilling Systems Program – Houston Advanced Research Center

  – 8122-36 Pretreatment and Water Management for Frac Water Reuse and Salt Production – GE Global Research

  – 8122-48 Sustaining Fracture Area and Conductivity of Gas Shale Reservoirs for Enhancing Long-Term Production and Recovery – Texas A&M University and TerraTek
8122-35 The Environmentally Friendly Drilling Systems Program
– Houston Advanced Research Center

• Objectives:
  – Previous work ID’ed EFD technologies and gaps
  – Included many US operating companies as partners
  – Regional partners to manage program
  – Optimize technologies to fit regional needs
  – Partners in each region to incorporate such systems into operations (Rockies, Southwest desert, & Appalachia)
  – Collaborate & present work progress to each other & to sponsors/advisors
8122-35 The Environmentally Friendly Drilling Systems Program
– Houston Advanced Research Center

• Potential Impacts:
  – Similar to earlier program, identify critical technologies appropriate for low impact systems
  – Create industry-led research projects
  – Develop techniques to select low impact systems for a given project site.
  – Possibly achieve more than 90% reduction in impact on the environment if low impact technology is implemented into a complete system
Drilling, Completions, & Interventions Projects
Small Producer Program

• 2007
  – 07123-01 Field Site Testing of Low Impact Oil Field Access Roads: Reducing the Footprint in Desert Ecosystems – Texas A&M University


  – 07123-07 Reducing Impacts of New Pit Rules on Small Producers – New Mexico Institute of Mining and Technology

- Total Estimated Cost: $519,441
- RPSEA Maximum Share: $248,385
- University of Kansas: $271,056
Objectives:

- New cost-effective, energy efficient technologies will be applied in Hillsboro Field, Marion County, Kansas
- Radial-jetted laterals to be used
- Increase drainage area & enhance oil production from a Viola production well pumped by an efficient high-volume progressive cavity pump
- Move higher fluid volumes at no incremental cost
- Increased volumes of produced water economically disposed by deepened Arbuckle injection well whose injectivity will be enhanced by targeted jetted laterals
Potential Impacts:

- Successful demonstration of this production-injection pair will be followed by application of methodology to multiple producing wells in (nearby) Durham Center Field

- This study will be the first publicly available scientific evaluation of the use of radially jetted laterals in both production and injection wells
Summary - Companies

- Acute Technological Services, LLC
- Advanced Resources International, Inc.
- AeroVironment, Inc.
- Altira Group LLC
- American Gas Association
- Anadarko Petroleum Corporation
- Apache Corporation
- APS Technology, Inc.
- Baker Hughes Incorporated
- Big Cat Energy Corp. (pending)
- Bill Barrett Corporation
- BJ Services Company
- BlueView Technologies Inc. (pending)
- BP America, Inc.
- Brownstein Hyatt Farber Schreck, LLP
- Cameron/Curtiss-Wright EMD
- Campbell Applied Physics
- Capstone Turbine Corporation
- CARBO Ceramics, Inc.
- Centre for Marine CNG, Inc.
- Chesapeake Energy Corporation
- Chevron Corporation
- City of Sugar Land
- Colorado School of Mines
- Colorado Oil & Gas Association
- ConocoPhillips Company
- Conservation Committee of California Oil & Gas Producers
- Correlations Company
- CSI Technologies, Inc.
Summary - Companies

- DCP Midstream, LLC
- Deepwater Structures, Inc
- Deepwater XLP Technology, LLP
- Delco Oheb Energy, LLC
- Det Norske Veritas (USA)
- Devon Energy Corporation
- Drilling & Production Company
- EnCana Corporation
- EnerCrest, Inc.
- Energy Corporation of America
- Energy Valley, Inc.
- ExxonMobil Corporation
- Florida International University
- Gas Technology Institute
- GE Oil and Gas
- Granherne, Inc.
- Greater Fort Bend Economic Development Council
- GSI Environmental, Inc.
- Gunnison Energy Corporation
- Halliburton
- Harvard Petroleum Corporation
- Houston Advanced Research Center
- Houston Offshore Engineering, LLC
- Houston Technology Center
- HW Process Technologies, Inc.
- Idaho National Laboratory
- Independent Petroleum Association of America
- Independent Petroleum
- Association of Mountain States
- Independent Petroleum Association of New Mexico
- Integrated Ocean Drilling Program
- Intelligent Agent Corporation
- Interstate Oil and Gas Compact Commission
- Jackson State University
- K. Stewart Energy Group
- Knowledge Reservoir, LLC

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Summary - Companies

- Lawrence Berkeley National Laboratory
- Lawrence Livermore National Laboratory
- Leede Operating Company
- Los Alamos National Laboratory
- Lousiana State University
- Map Royalty Inc. (pending)
- Marathon Oil Company
- Massachusetts Institute of Technology
- Merrick Systems, Inc.
- Mississippi State University
- M&H Energy Services (pending)
- Nalco Company
- Nance Resources
- NanoRidge Materials, Inc.
- National Oilwell Varco, Inc.
- Natural Carbon, LLC
- Nautilus International, LLC
- New England Research, Inc.
- New Mexico Institute of Mining and Technology
- NGAS Resources, Inc.
- NGO Development Corporation (Pending)
- NiCo Resources
- Noble Energy, Inc
- Novatek, LLC
- Oklahoma Independent Petroleum Association
- OTM Consulting Limited
- Oxane Materials, Inc.
Summary - Companies

- Paulsson Inc. (pending)
- Petris Technology, Inc.
- Petrobras America, Inc.
- Petroleum Technology Transfer Council
- Pioneer Natural Resources Company
- QO, Inc.
- Quanelle, LLC
- Quest Integrated, Inc.
- Rice University
- Robert L. Bayless, Producer LLC
- Rock Solid Images
- RTI Energy Systems
- Sandia National Laboratories
- Schlumberger Limited
- Shell International Exploration & Production
- Simmons & Company International
- SiteLark, LLC
- Southern Methodist University
- Southwest Research Institute
- Spatial Energy
- Stanford University
- StatoilHydro
- Strata Production Company
- Stress Engineering Services, Inc.
Summary - Companies

- Technip
- Technology International
- Tejas Research & Engineering, LP
- Tenaris
- Texas Energy Center
- Texas A&M University
- Texas Independent Producers and Royalty Owners Association
- Texas Tech University
- The Discovery Group, Inc.
- The Fleischaker Companies
- The Ohio State University
- The Pennsylvania State University
- The University of Kansas
- The University of Oklahoma
- The University of Texas at Austin
- The University of Tulsa
- The University of Utah
- Titanium Engineers, Inc.
- TOTAL Exploration Production USA
- Tubel Energy LLC (pending)
Summary - Companies

- University of Alaska Fairbanks
- University of Colorado at Boulder
- University of Houston
- University of Michigan
- University of South Carolina
- University of Southern California
- Vista Resources, Inc. (pending)
- VersaMarine Engineering, LLC
- Watt Mineral Holdings, LLC
- Weatherford International Ltd.
- WellDog, Inc.
- Western Standard Energy Corp.
- West Virginia University
- Williams Companies, Inc.
- Woods Hole Oceanographic Institution
- Wright State University
- Ziebel (pending)
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