integrating advanced technologies into systems that significantly reduce the impact of petroleum drilling and production in environmentally sensitive areas.

Drilling Engineering Association

November 19, 2010

Tom Williams
Agenda

• Background of the EFD Program
• Overview of various EFD Projects
• Scorecard
• EFD – Europe
• Outreach and Technology Transfer Efforts
• Opportunities for DEA
Thank you Sponsors!
EFD Program - History

- Formed Team in 2005 (5 years)
- Texas A&M took lead to obtain U.S. Department of Energy Funding
- Formed Joint Industry Partnership to guide and co-fund program
- Phase 2 led by HARC with RPSEA funding
- Formed University National Lab Alliance
- Initiated EFD-EU
From the Past

*(multiple wells at multiple sites)*
To the Present

*multiple wells at single sites*
The team focuses on technologies for **environmentally sensitive development** of **unconventional energy sources** that can be used to maintain our standard of living and preserve our quality of life.

The objective is to identify, develop and transfer critical, **cost effective**, new technologies that can provide policy makers and industry with the ability to develop reserves in a **safe and environmentally friendly** manner.
University/National Laboratories Alliance Overview

- Tap into University and National Laboratories scientific research capabilities by forging a partnership with operators, services companies, environmental organizations and other laboratories.
- Bring highest level research capability to bear on the critical gap and basic research in technology needed.
- Provide fundamental research that can be later incorporated into RPSEA projects.
- Serve as a network link among the regional EFD partners and their constituencies.
2009 – 2012 Plans
University/National Laboratories Alliance

- **Initiated projects:**
  
  - **TAMU - Systems Engineering Design Methodology: Low Impact Well Design Optimization**
    - Engineering study describing a prototype systems model that will be provided to regional centers to use in developing low impact well designs for specific unconventional gas resource plays.
    - Designing a risk-based system selection model that will improve the decision-making for selecting an EFD system for a specific site, by minimizing the environmental impact and by maximizing profit and public perception.
  
  - **University of Colorado – Best Practices Database - Develop a free-access, searchable, database and supporting website for best management practices (BMPs).**
    - [www.oilandgasbmps.org](http://www.oilandgasbmps.org)
  
  - **University of Arkansas – Dissemination and Decisions Support**
    - Commercialize a Fayetteville Shale Play website and expand to the Haynesville Shale. Provides surface and water features, regulatory framework to assist in the proper siting of wells in these plays
  
  - **University of Wyoming – Western Mountain States Studies**
    - Report documenting the development of the prototype lay down road system and documentation of a field test to be performed for sponsors.
2009 – 2012 Plans
University/National Laboratories Alliance

• **Utah State University & Sam Houston State University** – Societal Acceptance
  – Fact-sheets and other outreach educational materials pertaining to the assimilation of environmentally friendly energy exploration and production practices will be developed, printed and disseminated.
  – These materials along with other reports and workshops will be used to inform energy producers, state and federal regulatory agencies, environmental groups, private landowners, and members of the general population about environmentally friendly systems that can be cost effectively used to produce tight sands.
  – Workshops will be held to ensure that the technologies are effectively transferred.

• **West Virginia University** – Eastern Mountain States Studies
  – Workshops will be developed and held to ensure that the technologies are effectively transferred for the Marcellus Shale.

• **Oak Ridge National Lab** – National Lab partnership
  – Provide sensor expertise to allow remote air and water monitoring of oilfield operations
  – Apply water clean-up technologies to allow saline ground water, produced and frac water for re-use

• **Argonne & Los Alamos National Laboratories** – Technology Partnership
  – Provide support to program with a focus on water issues
Texas A&M GPRI Projects (led by Dave Burnett)

• Water Treatment and Re-use.
• Produced water and frac water.
• Waste Management.
• The University Disappearing Roads Competition.
• RPSEA Low Impact Roads Research at the Pecos Test Facility.

This is a photo of the Pecos Test site showing a test road. Newpark Mat and Scott Environmental “Artificial Gravel” Road Connection
Current Membrane Desalination Projects

- Marcellus Shale NY, PA, W. Va (pre-treatment)
- Central Texas (Luling)- Desalination
- Coastal Texas
- South Texas (Eagle Ford Shale) – ground water aquifer protection
A&M All Weather Mobile Unit for Site Treatments - 2011

- Shown in the photograph at left is the mobile training unit used by Texas A&M TEES for water and waste water training for municipal water facility operators.

- A similar unit is being constructed for oil field well site brine treatment.
MI-SWACO Environmental Solutions

Applied Research Mobile Water Treatment Units 2009

Haynesville Shale – June 2010
Prototype Small Footprint Drilling Rig

Perform a prototype testing of a small footprint drilling rig to investigate how environmental tradeoffs are reduced.

**Deliverables**
- Reports documenting low impact rig advances. Fuel savings/reduced emissions, footprint, efficiency (get in drill and get out), noise, and to document advances in rig and drilling technologies.
Air Emissions Studies

Develop guidelines concerning the measurement of NOx, (possibly expand to include PM, VOC) for a drilling site and work with operating company personnel to plan an investigation at a location.

**Deliverables**

- Plans for an emissions study.

- Guidelines for emissions reduction at oil and gas operations.
Reduced Fracturing Footprints

Identify alternatives to reduce the footprint including offsite operations and innovative fracturing technologies such as a novel process involving: minimal pumping equipment, low volumes of frac fluid and materials that are environmentally green and non-damaging.

**Deliverables**
- Report documenting alternatives to reduce the footprint of hydraulic fracturing operations.

Courtesy Williams Bros. Company
Our big challenge: Core Values

Industry’s progress to improve their safety performance is remarkable
Our big challenge: Core Values

- Companies successfully made safety a core value.

- Accomplished by corporate leadership, documenting, measuring and training.

- If we are to achieve the same success in environmental performance, it will require the leaders in the industry to also make this a core value.
Tradeoffs

Human Culture

All Living Systems

Ecosystem Provinces

- Polar Ice
- Arctic Tundra
- Taiga
- Mountain Zones
- Temperate Deciduous Forest
- Chaparral
- Temperate Evergreen Forest
- Warm, Moist Evergreen Forest
- Tropical Monsoon Forest
- Tropical Evergreen Rain Forest
- Desert
- Savanna
- Semidesert
- Temperate Grassland
Scorecard Concepts
Focus Scorecard on Operation

Concept – USGBC LEED Program

Energy Production

Oil and Gas Operations

Upstream

Downstream

- Exploration
- Drilling
- Completions
- Field Operations
- Processing
- Refining
- Transportation
- Distribution
Measuring Effectiveness of EFD

Ecosystem Provinces

EFD Facts

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th>Max</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIR</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>WATER</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>SITE</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>WASTE MANAGEMENT</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>BIODIVERSITY/HABITAT</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>SOCIETAL</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

Deliverables

- Scorecards for various ecosystems.
- Reference guidebook.
- Case studies

Document effectiveness of using environmentally friendly drilling and production systems.
Tradeoff Scorecard Development

### Tradeoff Facts

**Project:**

**Location:**

**Ecosystem:**

<table>
<thead>
<tr>
<th>Max Score</th>
<th>AIR</th>
<th>WATER</th>
<th>SITE</th>
<th>BIODIVERSITY</th>
<th>SOCIETAL</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Tradeoff Scorecard

<table>
<thead>
<tr>
<th>Environmentally Friendly Drilling Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project:</strong></td>
</tr>
<tr>
<td><strong>Location:</strong></td>
</tr>
<tr>
<td><strong>Ecosystem:</strong></td>
</tr>
</tbody>
</table>

#### Scorecard Details

**Max Score**

<table>
<thead>
<tr>
<th>Category</th>
<th>Score Points</th>
<th>Points Achieved</th>
<th>Credit 1</th>
<th>Credit 2</th>
<th>Credit 3</th>
<th>Credit 4</th>
<th>Credit 5</th>
<th>Credit 6</th>
<th>Credit 7</th>
<th>Credit 8</th>
<th>Credit 9</th>
<th>Credit 10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WATER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SITE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIODIVERSITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOCIETAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Credits**

- Credit 1: Site Emissions - Stationary
- Credit 2: Site Emissions - Temporary
- Credit 3: Title
- Credit 4: Title
- Credit 5: Title
- Credit 6: Title
- Credit 7: Title
- Credit 8: Title
- Credit 9: Title
- Credit 10: Title

**Score**

- Points Achieved: 20
- Possible Points: 100

---

**Tradeoff Facts**

**Project:**

**Location:**

**Ecosystem:**
Stakeholder Engagement is Important!

Stakeholders are all those who are affected, interested in or have the capacity to influence a project.

**Academia**
- Texas A&M University College Station
- Texas A&M University Kingsville
- University of New Hampshire
- UT Medical Center
- Mississippi State University
- Sam Houston State
- University of South Alabama
- John Hopkins University
- University of Arizona
- University of Texas
- University of Houston

**Environmental Organizations**
- Natural Resources Defense Council
- Environmental Defense Fund
- The Nature Conservancy
- Conservation International
- Mercer Arboretum
- Bureau of Applied Anthropology/Arizona
- Clinton Climate Initiative
- Rocky Mountain Clean Air
- McFaddin Ranch

**Industry**
- API
- Ballard Exploration
- BP
- Shell
- Chevron
- StatoilHydro
- ConocoPhillips
- Devon
- King Exploration
- Halliburton
- Husman
- National Oil Well – Varco
- MI Swaco
- TerraPlatform
- T. Baker Smith
- Weatherford
- Derrick Equipment
- Composite Mats
- Ecology and Environmental Inc.
- PTTC
- IADC

**State/Federal Agencies**
- US Department of Energy
- Bureau of Land Management
- US Park Service
- Texas Railroad Commission
- Texas General Land Office
- Texas Dept. of Agriculture
- Texas Dept. of Transportation
- US Minerals Management Services
- Texas Parks & Wildlife
- Texas Water Board
- Texas Commission on Env. Quality
- US Environmental Protection Agency
- US Fish and Wildlife
- Argonne National Laboratory
- Big Thicket Preserve
- Idaho National Laboratory

Source: Connor Development Services Ltd
Outreach and Technology Transfer

Publications/Articles

Exhibits

Presentations
Outreach & Technology Transfer

• Following the direction of industry sponsors and stakeholders
  – Industry advisors lined to key program elements
• Work with RPSEA, DOE NETL, PTTC, NGOs
• Open Communication
  – Environmental forums
  – Conferences
  – Workshops
  – Bringing parties together
  – Special studies
• Addressing public perception
Pending Project: Evolution of Rig

Start with this. Then, replace/add, for example:
- Mats
- Emission controls
- Pitless drilling
- Small rig
- Coiled tubing rig/drilling
- Multiple wells/rig skidding
- Zero spill system
- Heat to electricity recovery
- Tie to grid
- Other technologies
EFD EU Initiative

- Identify and Transfer Innovation and (Cost Effective) Best Practices in US and Europe
  - Technology Transfer opportunity
  - Identify applicable and cost effective practices (US and Europe)
  - Inform respective regulators about certain requirements that have not worked well
- Establish a non-government, (thus less bureaucratic) dialogue, work with various EU R&D organizations
- Gas Shale Play issues are of keen interest
- First International Workshop was in September 2010 – Report is posted on website
- Led by G. Thonhauser, U. of Leoben
EFD Sponsor Benefits

- Access to EFD Alliance
- Leverage funding
- Quarterly Advisors Meetings
- Engagement in EFD Projects
- Voice in Program Direction
- Joint publishing of articles and technical reports
- Access to Reports, Review Meetings, etc.
- Networking with Environmental Organizations
- Networking with Community Groups
- Communication via EFD Team with Regulators, Legislators, Government Agencies
- Direct Focus of Sponsorship
Workshops

Each Quarter we hold at least one workshop with a focus on regional issues.

One of the program participants is the host.

2010: Colorado, Utah, Pennsylvania, S. Texas (water) & Arkansas (all have had a large turn-out)

2011: Eagle Ford area - focus on low impact drilling technologies (DEA interest in joint sponsoring?)
What to Remember

www.efdsystems.com

Environmentally Friendly Drilling Systems Program
- Joint industry, academia, government, non-profit program
- Focused on current and emerging technologies
- Demonstrates technologies and measures tradeoffs

Measuring Environmental Tradeoffs
- Key component of the Program
- What gets measured, gets done.
- What gets identified, gets dealt with.
- What gets expected, gets respected.

Environmental Stewardship as a Core Value
- Different Scorecards for Different Ecosystems
- Six Attributes: Air, Water, Waste Management, Site, Biodiversity, Societal
It’s not so hard to be green

Contact:
www.efdsystems.com

Rich Haut
Tom Williams
David Burnett