RPSEA Onshore Program
Overview and Research Highlights

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WebEx Meeting
Thursday, September 19, 2013

Mission & Goals

- **Small Producer Mission & Goals**
  - Increase supply from mature resources
    - Reduce cost
    - Increase efficiency
    - Improve safety
    - Minimize environmental impact
- **Unconventional Gas Mission & Goal**
  - *Economically viable* technologies to allow *environmentally acceptable* development of unconventional gas resources
    - Gas Shales
    - Tight Sands
    - Coalbed Methane

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Environmental Issues

- Hydraulic Fracturing
- Land Use
- Air Emissions
- Water Usage
- Water Quality
- Traffic
- Road Damage
- Noise
- Wildlife
- Image Deficit

The New York Times

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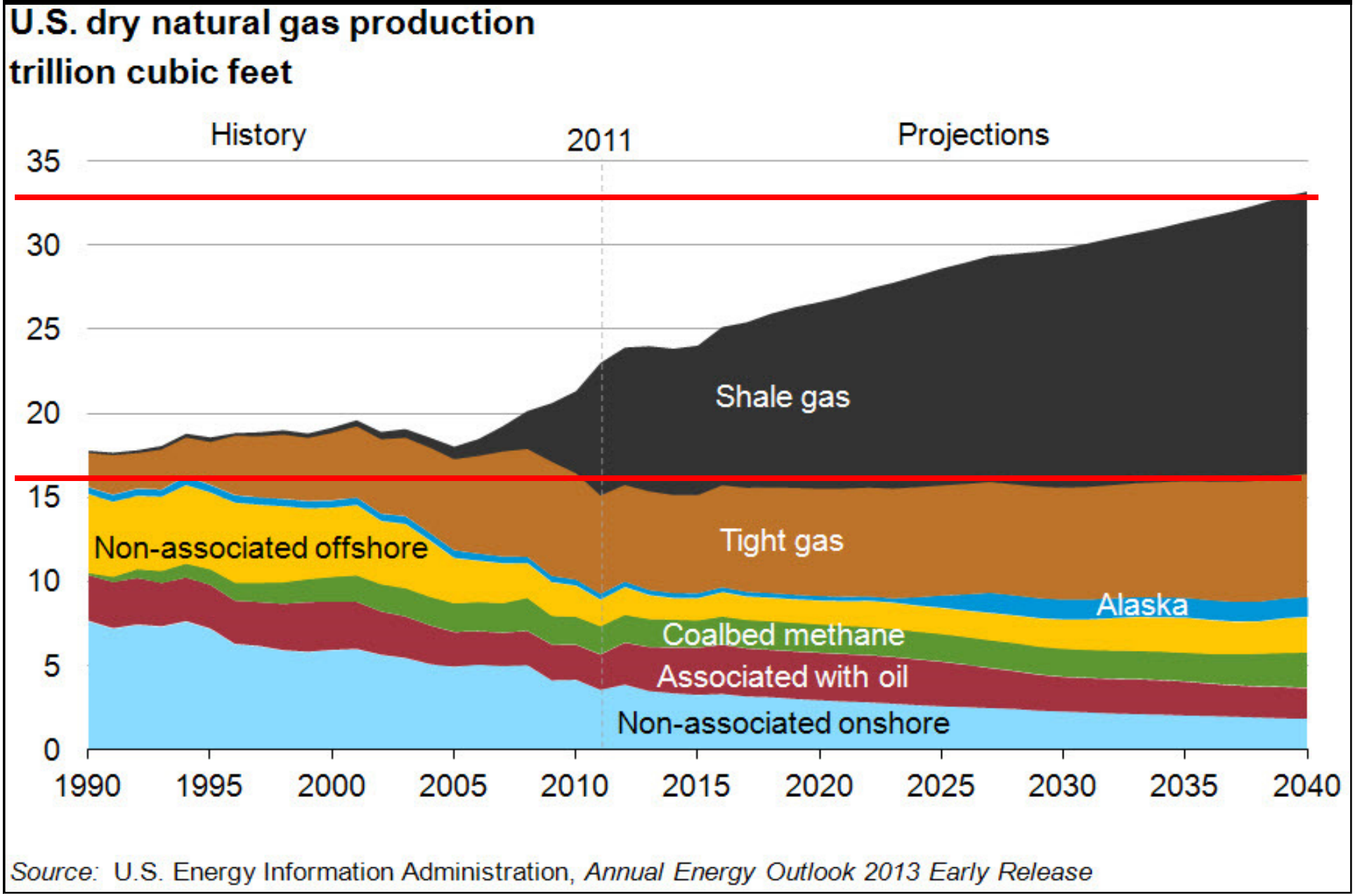
U.S Gas Production



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2013 Early Release*

Onshore Projects

Unconventional Resources

60 Projects
27 Completed

Small Producers

30 Projects
11 Completed

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	Gas Shales		Tight Sands
Integrated Basin Analysis	New Albany (GTI) $3.4 Marcellus (GTI) $3.2 Mancos (UTGS) $1.1 *Technology Integration (HARC) $6.0*		Piceance (CSM) $2.9 *Piceance Permeability Prediction (CSM) $0.5*
Stimulation and Completion	Cutters (Carter) $.09 Frac (UT Austin) $.69 Refrac (UT Austin) $.95 Frac Cond (TEES) $1.6 Stimulation Domains (Higgs-Palmer) $0.39 Fault Reactiviation (WVU) $0.85 *Cryogenic Frac Fluids(CSM) $1.9* *Geomechanical Frac Containment Analysis (TAMU) $0.65* *Frac Diagnostics (TAMU) $0.76* *Conductivity of Complex Fracturing in Unconventional Shale Reservoirs(TAMU) $.88* *Advanced Hydraulic Fracturing (GTI)$6.2*		Gel Damage (TEES) $1.05 Frac Damage (Tulsa) $.22 Foam Flow (Tulsa) $0.57 Petrophysics and Tight Rock Characterization for the Application of Improved Stimulation and Production Technology in Shale (OSU) $1.5
Reservoir Description & Management	Hi Res. Imag. (LBNL) $1.1 Gas Isotope (Caltech) $1.2 Marcellus Nat. Frac./Stress (BEG) $1.0 Frac-Matrix Interaction (UT-Arl) $0.46 Marcellus Geomechanics (PSU) $3.1		Tight Gas Exp. System (LBNL) $1.7 Strat. Controls on Perm. (CSM) $0.1 Fluid Flow in Tight Fms. (MUST) $1.2
Reservoir Engineering	Decision Model (TEES) $.31 Coupled Analysis (LBNL) $2.9 Shale Simulation (OU) $1.05		Wamsutter (Tulsa) $.44 Forecasting (Utah) $1.1 Condensate (Stanford) $.52
Exploration Technologies	Multi-Azimuth Seismic (BEG) $1.1		
Drilling	Drilling Fluids for Shale (UT Austin) $0.6		

2007 Projects; 2008 Projects; 2009 Projects; 2010 Projects; 2011 Projects

Water Management	**Barnett & Appalachian (GTI) $2.5** **Integrated Treatment Framework (CSM) $1.56** ***NORM Mitigation (GE) $1.6*** ***Water Handling and Enhanced Productivity from Gas Shales; (USC)$1.7*** ***Development of GIS-Based Tool for Optimized Fluid Management in Shale Operations(CSU)$1.1*** ***Advanced Treatment of Shale Gas Frac Water to Produce NPDES Quality Water (SRI)$1.9*** ***Cost-Effective Treatment of Flowback and Produced Waters via an Integrated Precipitative Supercritical Process(OhioU)$1.9*** ***Development of Subsurface Brine Disposal Framework in the Northern Appalachian Basin(Battelle)$1.9*** ***Development of Plasma Technology for the Management of Frac/Produced Water (Drexel)$1.5*** ***Advancing a Web-Based Tool for Unconventional Natural Gas Development with Focus on Flowback and Produced Water Characterization, Treatment and Beneficial Use(CSM)$.28***		**Frac Water Reuse (GE) $1.1** ***Engineered Osmosis Treatment (CSM) $1.3***
Environmental	**Environmentally Friendly Drilling (HARC)* $2.2** ***Zonal Isolation (CSI) $3.0*** ***Understanding and Managing Environmental Roadblocks to Shale Gas Development: An Analysis of Shallow Gas, NORMs, and Trace Metals (UTexas)$1.3*** ***Reducing the Environmental Impact of Gas Shale Development: Advanced Analytical Methods for Air and Stray Gas Emissions and Produced Brine Characterization(GSI Environmental)$3.4*** ***Development of Methods to Prohibit and Remediate Loss of Annular Isolation in Shale Gas Wells: Prevention and Remediation of Sustained Casing Pressure and Other Isolation Breaches(CSI)$4.0*** ***Relationships between Induced Seismicity and Fluid Injection: Development of Strategies to Manage Fluid Disposal in Shale Hydrocarbon Plays(UTexas)$.96***		*
Resource Assessment	**Alabama Shales (AL GS) $.5** **Manning Shales (UT GS) $.43**		**Rockies Gas Comp. (CSM) $.67**

2007 Projects; **2008 Projects;** **2009 Projects;** **2010 Projects;** **2011 Projects**

Selected Program Results

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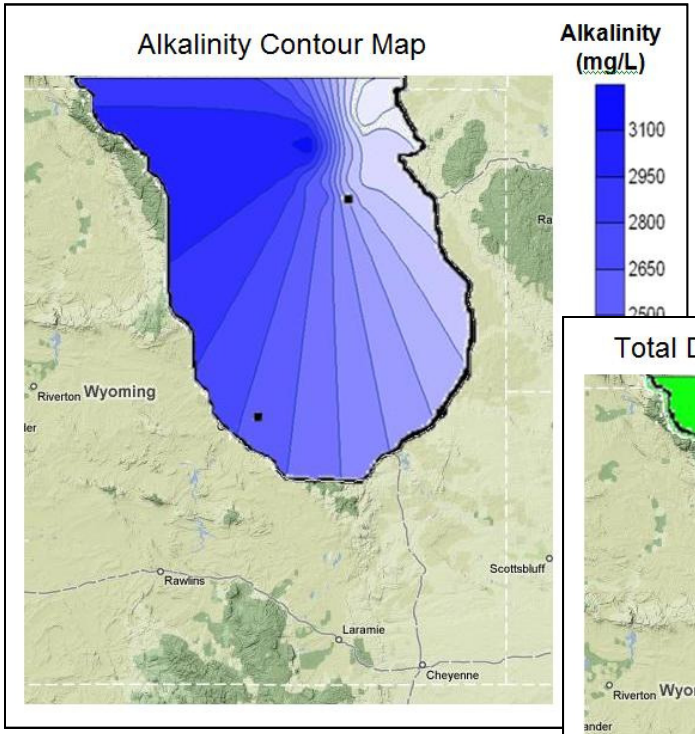
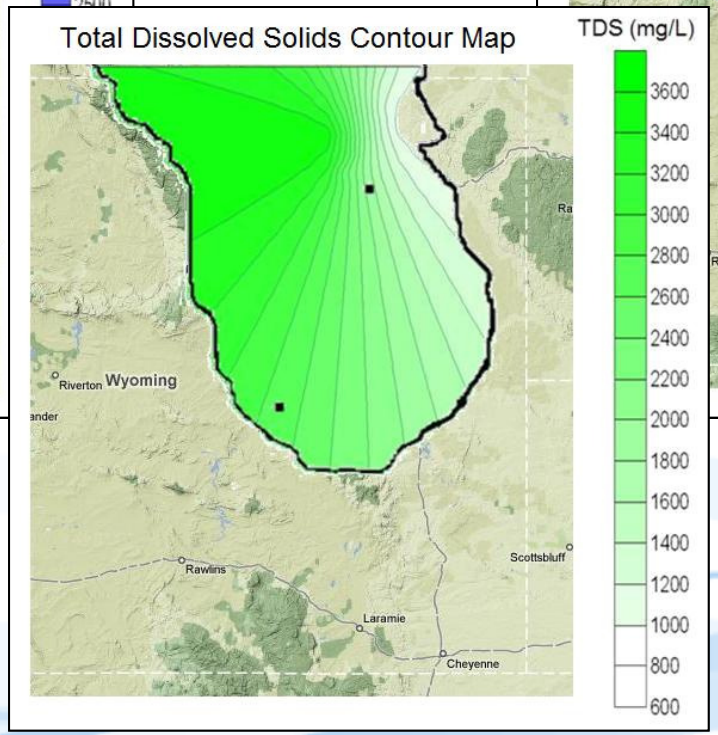
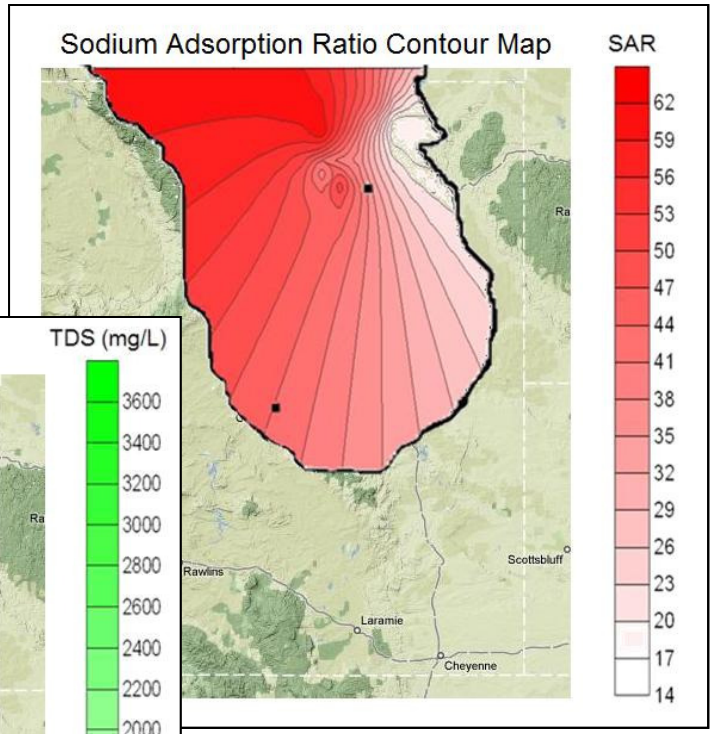
Cable Saw for Well Stimulation

2000 ft² Planar Slots for Enhanced Productivity

Produced Water Quality: Powder River

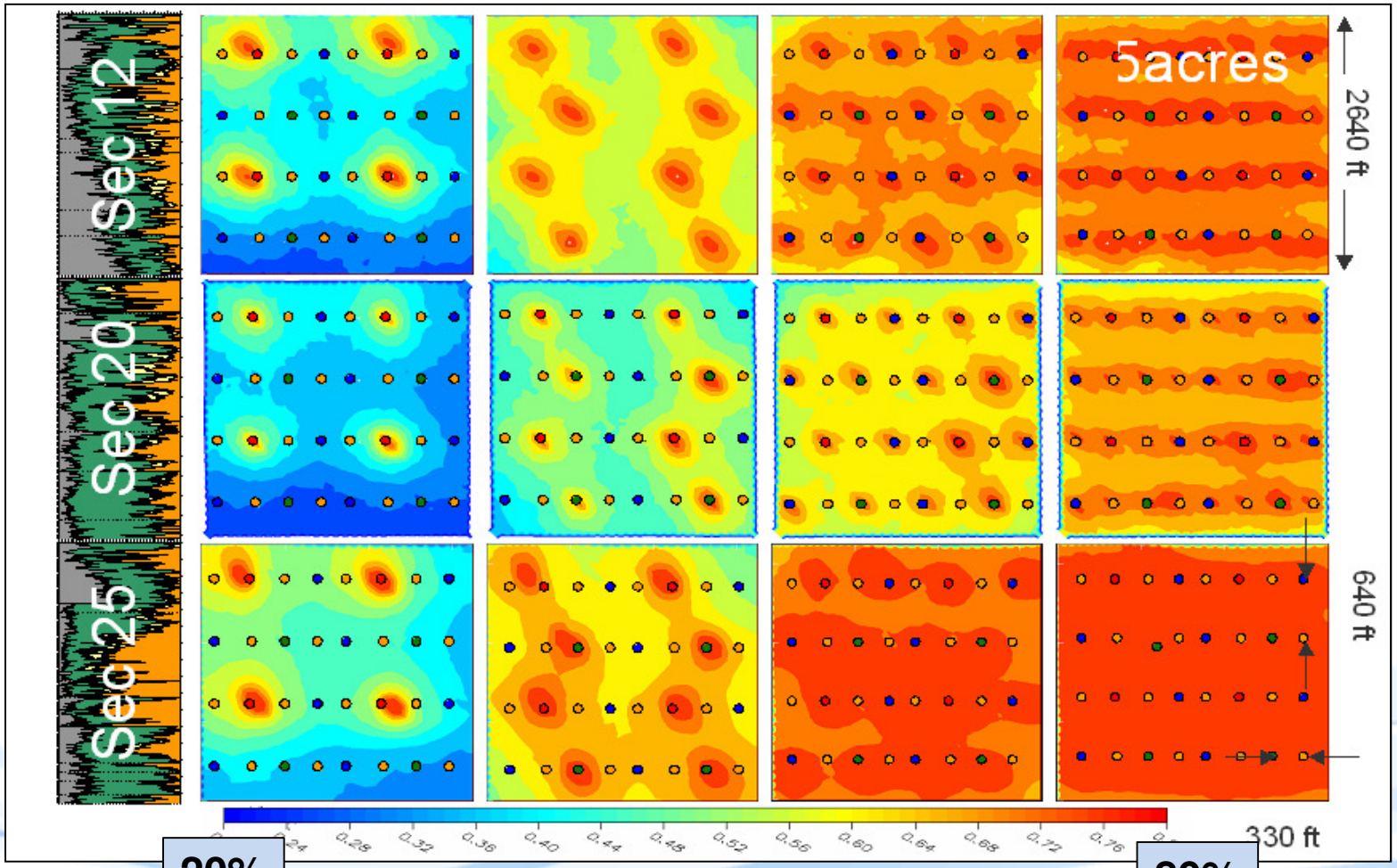






Reservoir Connectivity and Stimulated Gas Flow in Tight Sands "The Piceance Project"

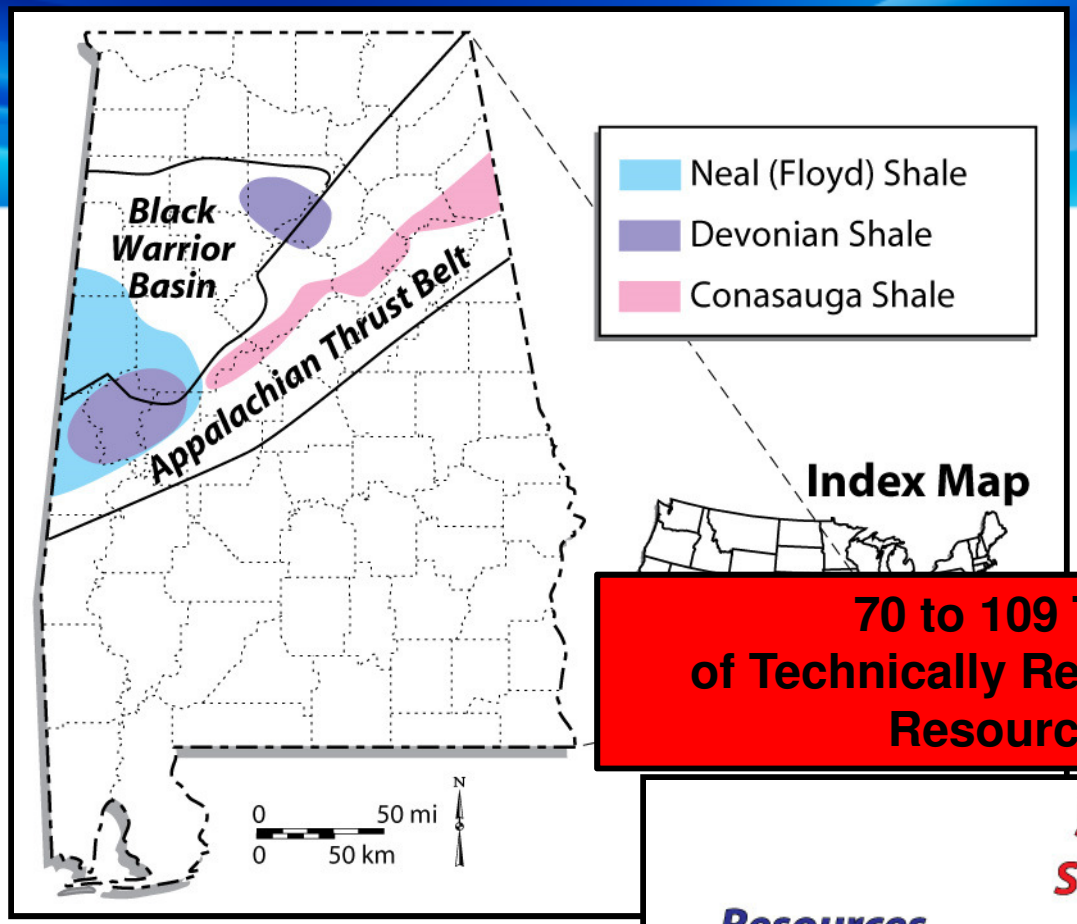
Reservoir Connectivity - Tight Sands



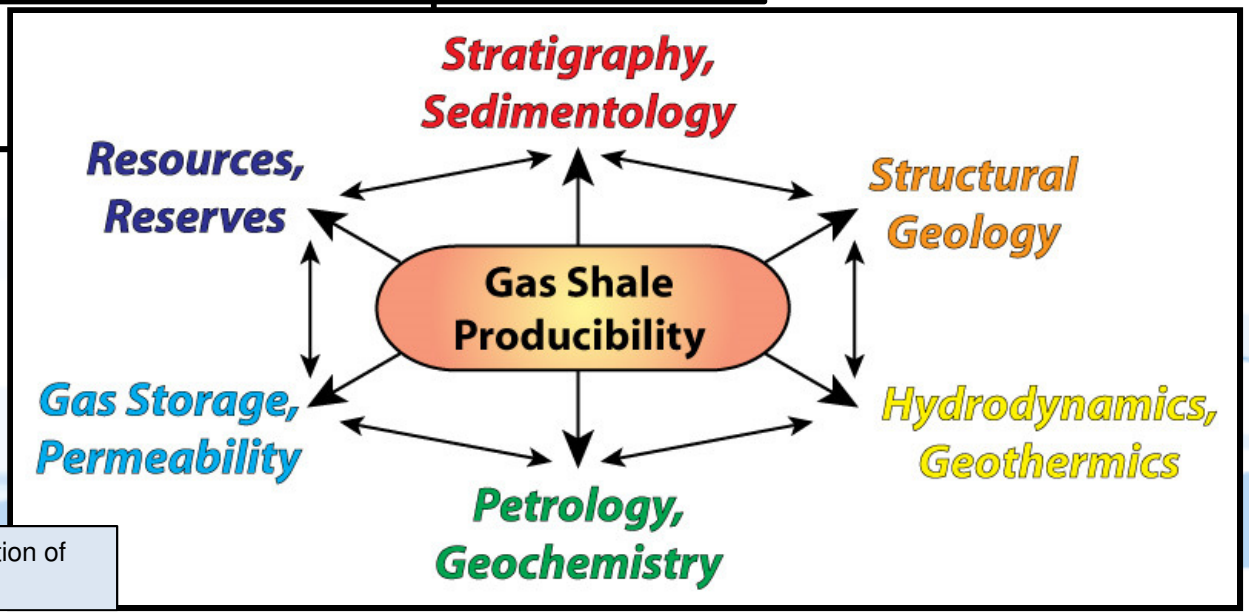
07122-15 Reservoir Connectivity and Stimulated Gas Flow in Tight Sands

Alabama Geologic Survey

Shale Play Concepts
Alabama
Black Warrior Basin



70 to 109 Tcf of Technically Recoverable Resource



GEOLOGICAL SURVEY OF ALABAMA · Founded 1848

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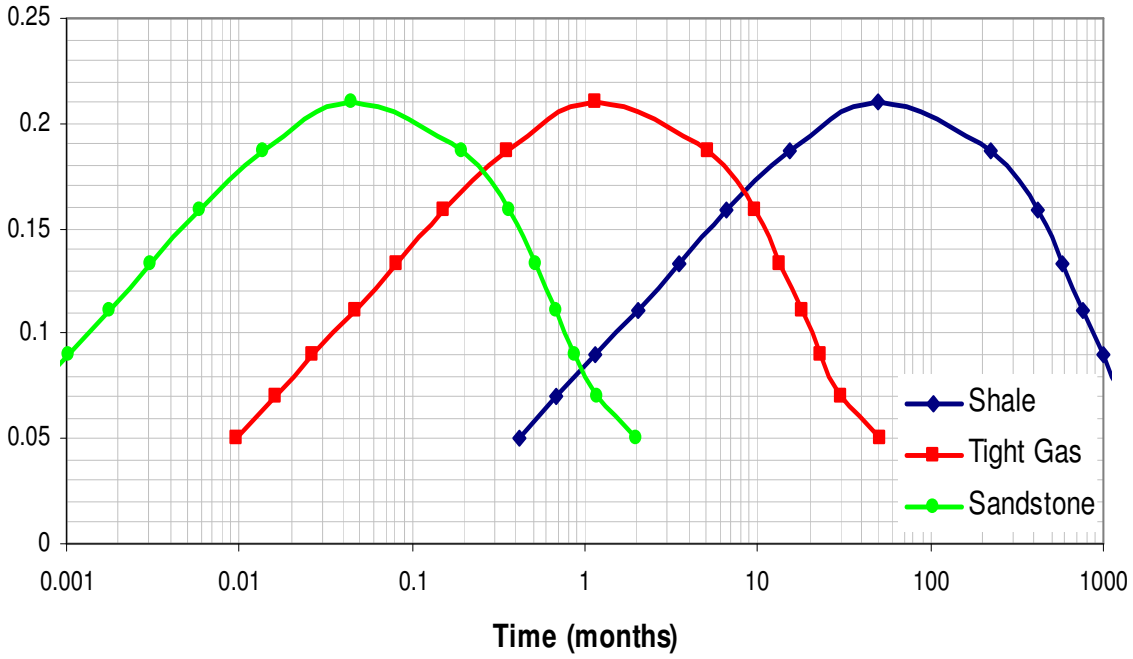
07122-17 Geological Foundation for Production of Natural Gas from Diverse Shale Formations

Identification of Refracturing Opportunities

- Methodology for candidate selection based on poro-elastic models and analysis of field data.
- Recommendations for the time window most suitable for re-fracturing
- Re-fracture treatment design for horizontal and deviated wellbores



Optimum time for re-fracturing

07122-41 Improved Reservoir Access through Refracture Treatments in Tight Gas Sands and Gas Shales

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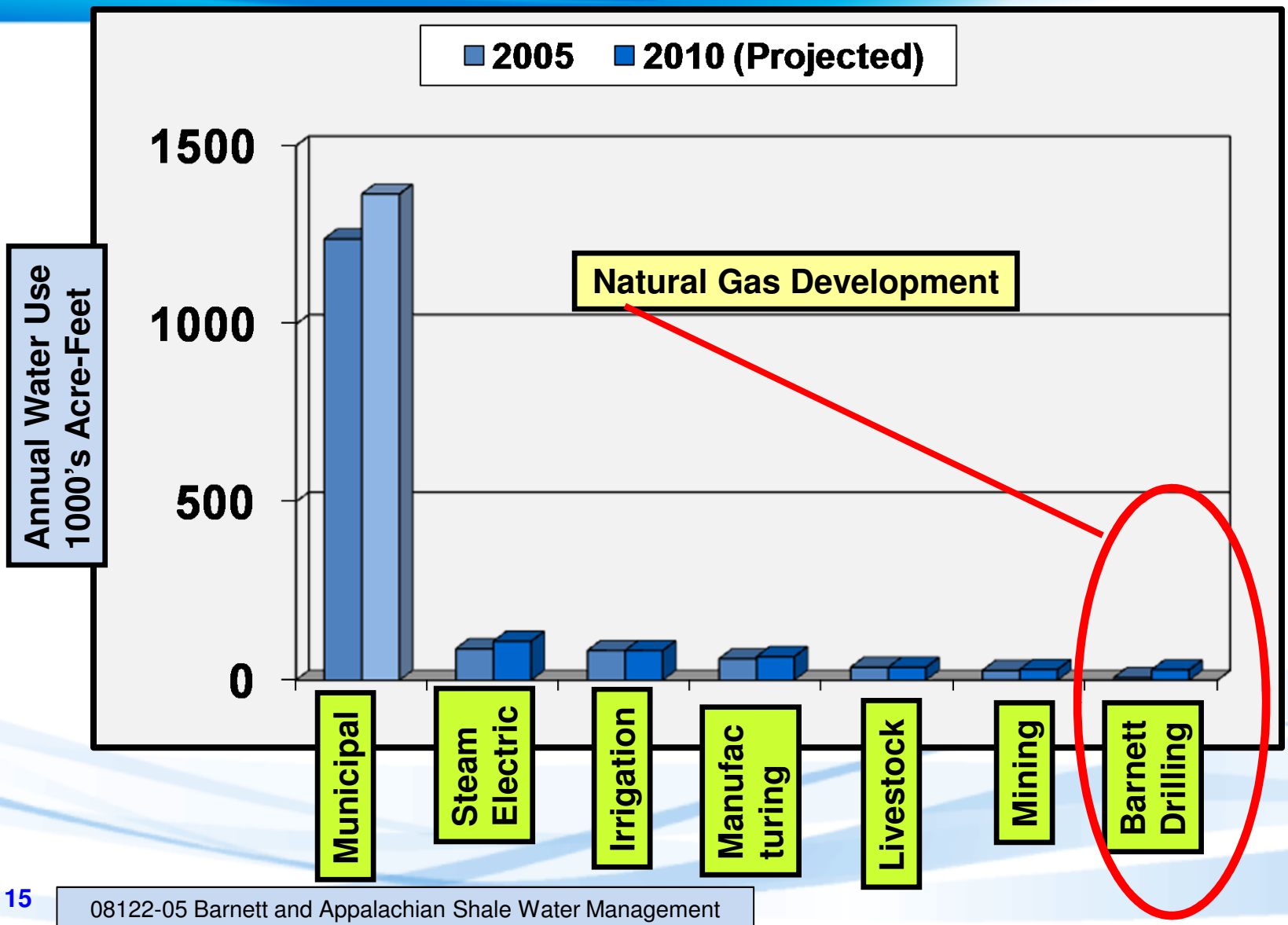
Freshwater Users in the Barnett Shale Region



What Flows Out – Is it a Witch's Brew of Toxins?

Sampling and Analysis of Flow back Water

- Sampling from 19 Marcellus Locations.
- Includes Chemistry and Analysis of Constituents of Interest.
- Lists of Constituents Provided by USEPA, WV-DEP and PA-DEP.
- Over 250 Determinations Performed on Samples.

08122-05 Barnett and Appalachian Shale Water Management and Reuse Technologies

http://www.rpsea.org/attachments/contentmanagers/5820/08122-05-FR-Barnett_Appalachian_Shale_Water_Management_Reuse-Technologies-03-30-12_P.pdf

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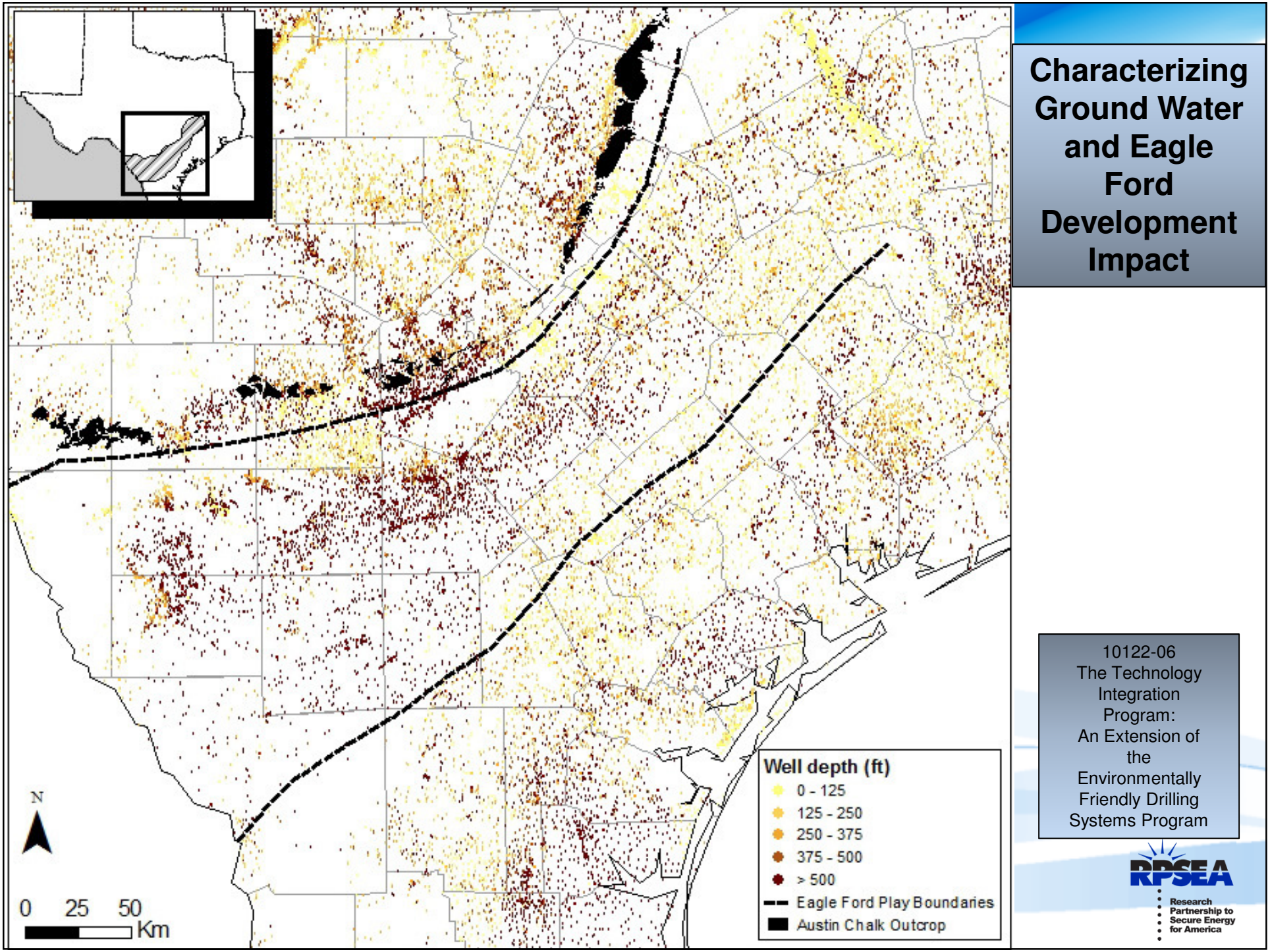

Characterizing Ground Water and Eagle Ford Development Impact

10122-06
The Technology Integration Program:
An Extension of the Environmentally Friendly Drilling Systems Program

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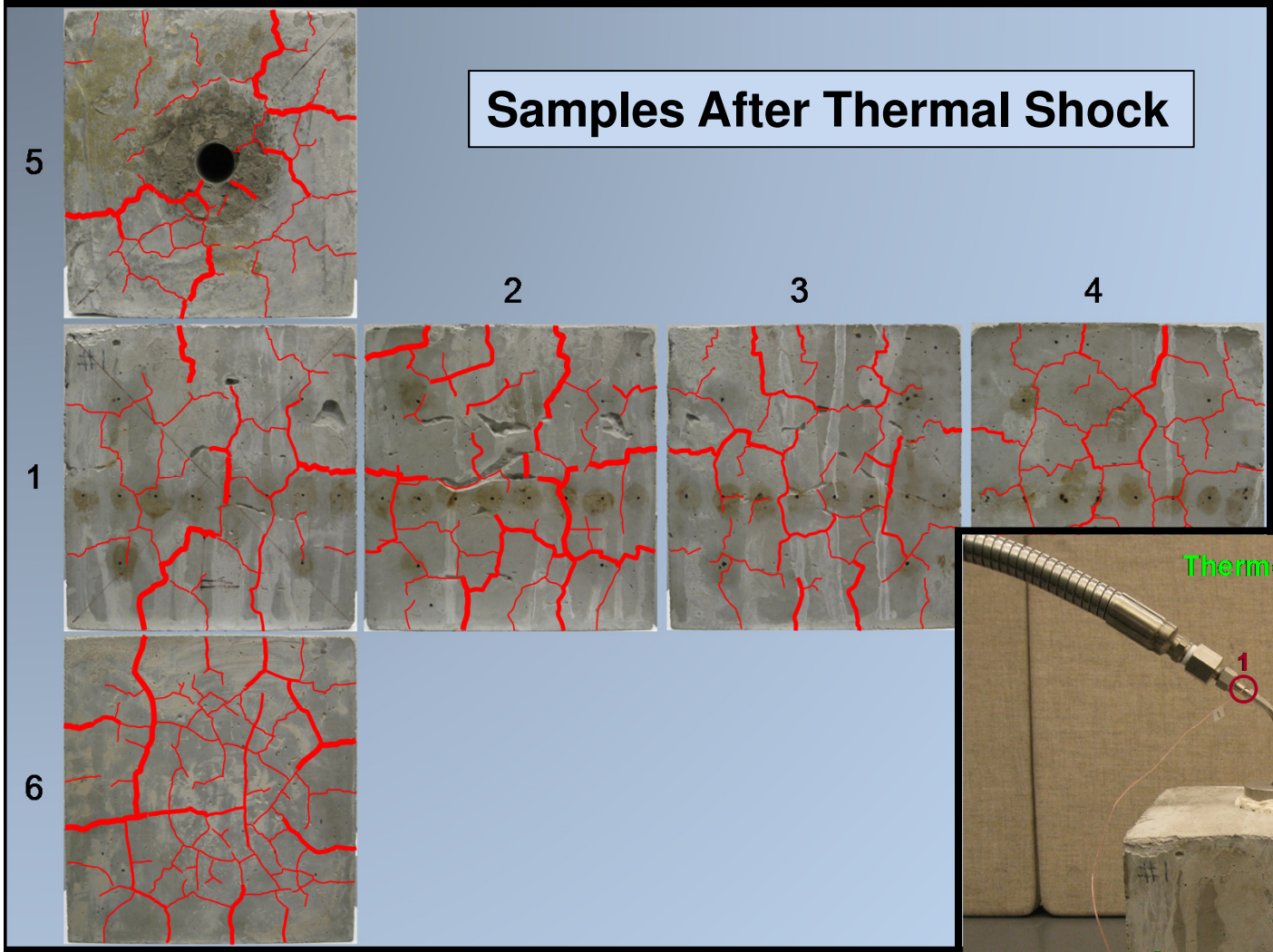
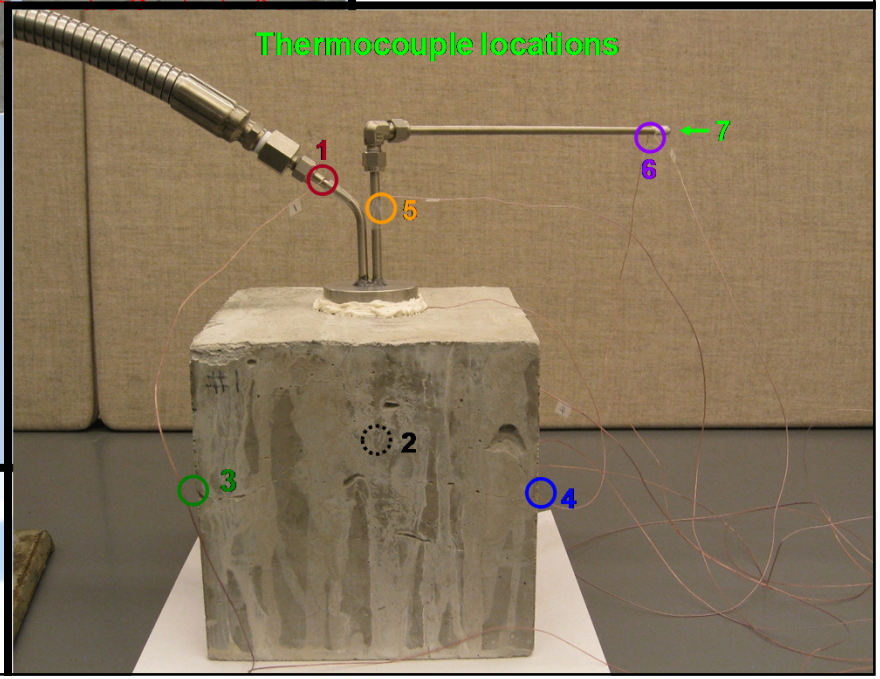
Cryogenic Fracturing Fluids

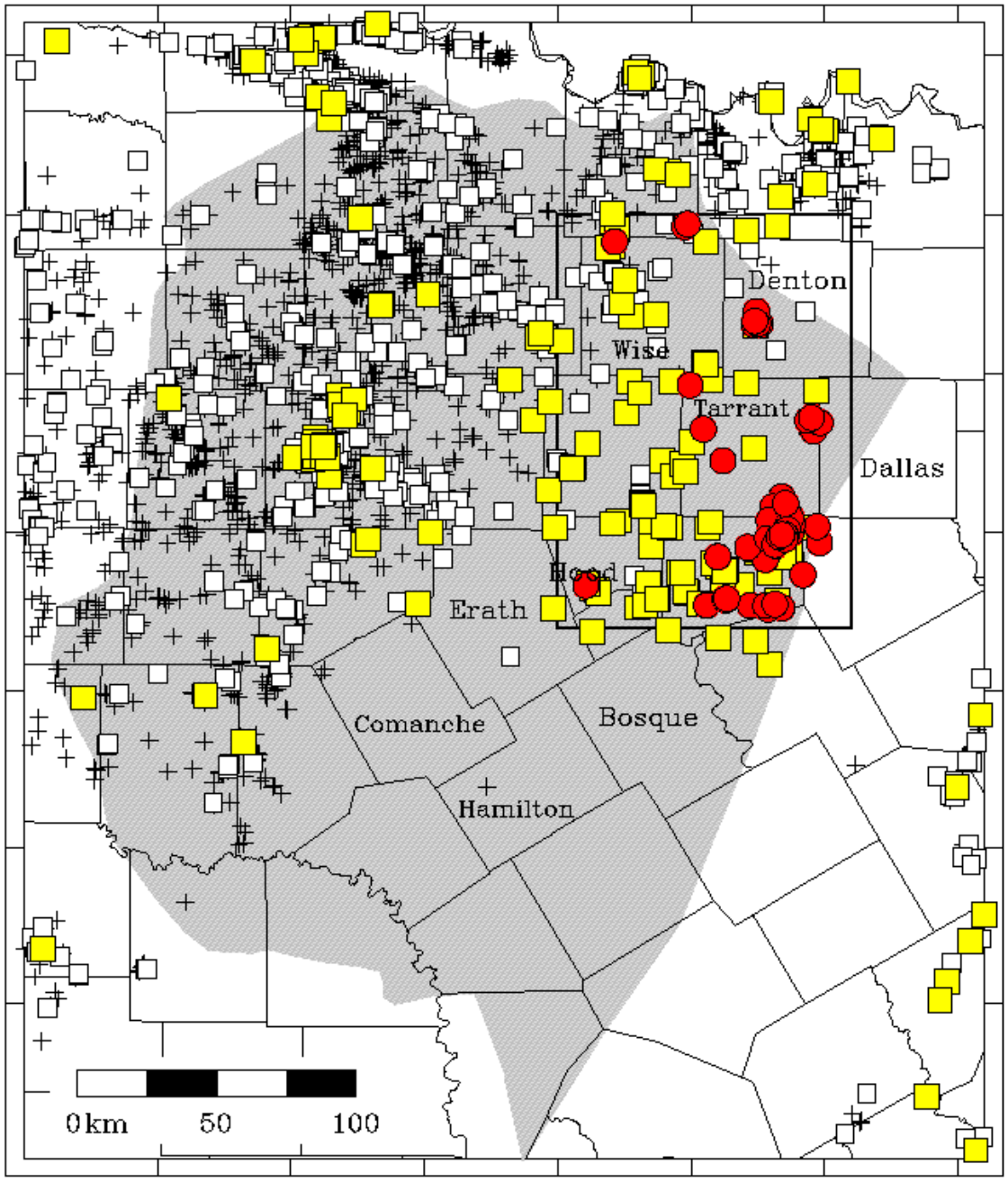
Samples After Thermal Shock



Apparatus



10122-20 Development of Non- Contaminating Cryogenic Fracturing Technology for Shale and Tight Gas Reservoirs



NE Texas Survey

- Red Circles: Seismic Events
- Yellow Squares: High-Volume Wells

Events are near wells…
e.g., Johnson County

But many wells/counties have no events…
e.g., Parker County
Stephens County

Will events occur near high-volume injection wells elsewhere?

11122-27-UT-Frohlich

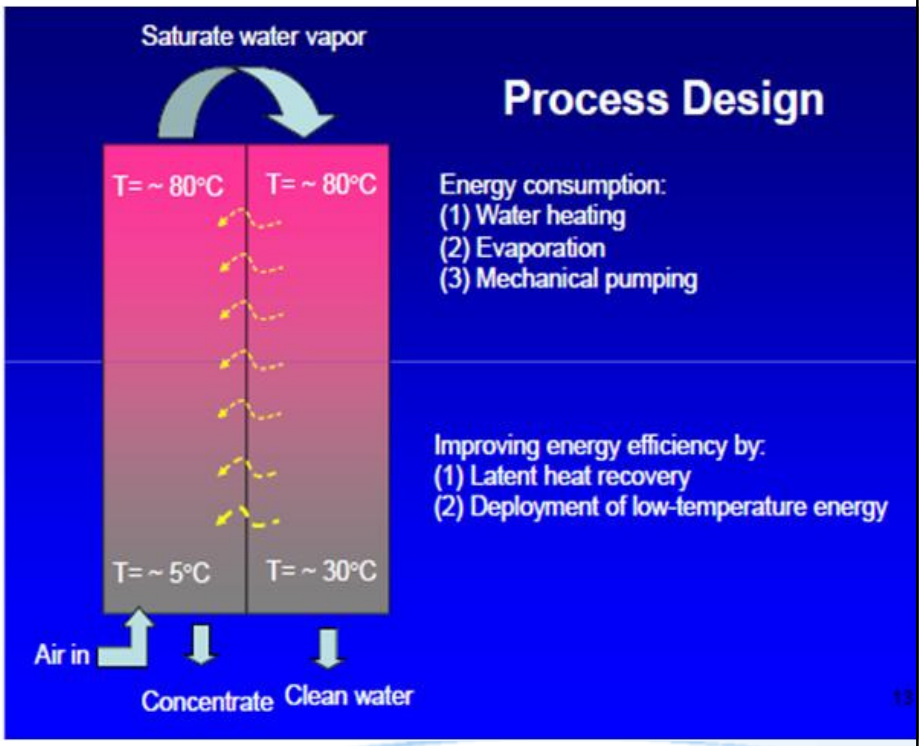
Cost-Effective Treatment of Produced Water Using Co-Produced Energy Sources for Small Producers

Environmental, Safety and Regulatory

Development of distillation for produced water purification at wellhead.

Prototype design capacity 20 bbl/day

Purified produced water is suitable for alternative uses, such as agriculture, irrigation and industrial processing.



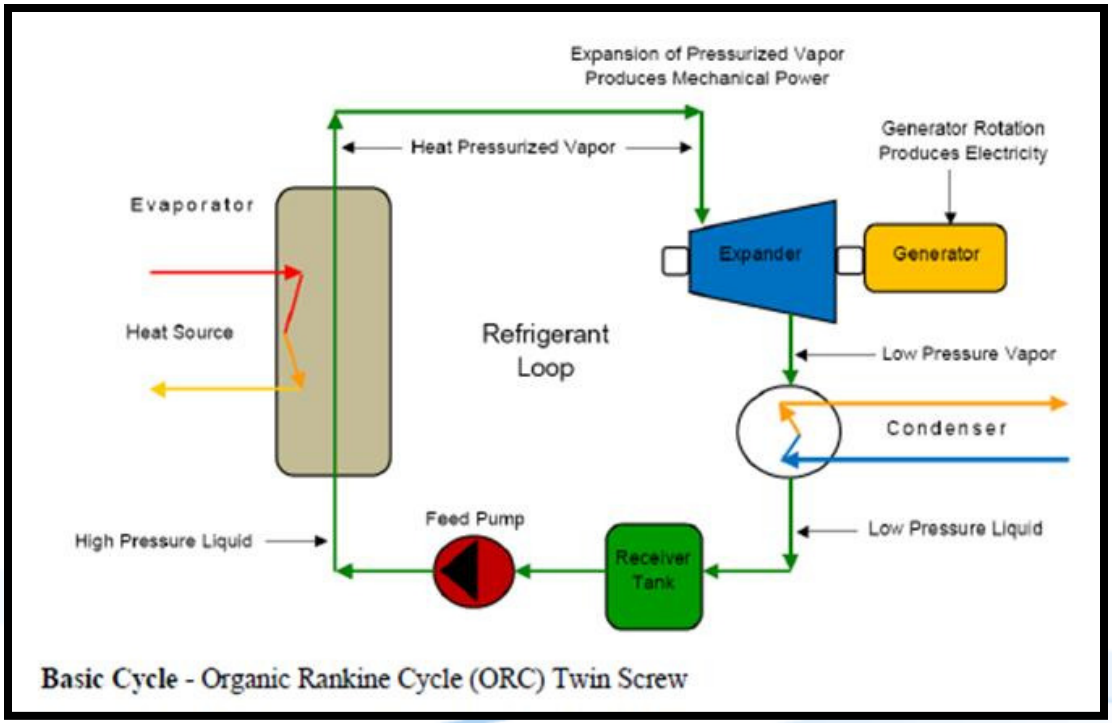
Harvard Petroleum Company

New Mexico Institute of Mining & Technology

Electrical Power Generation from Produced Water

Project Goal: using heat in produced water to create electricity.

Minimize the environmental impact by creating green electricity using produced water and no additional fossil fuel.



Basic Cycle - Organic Rankine Cycle (ORC) Twin Screw

Denbury Resources, Inc.,

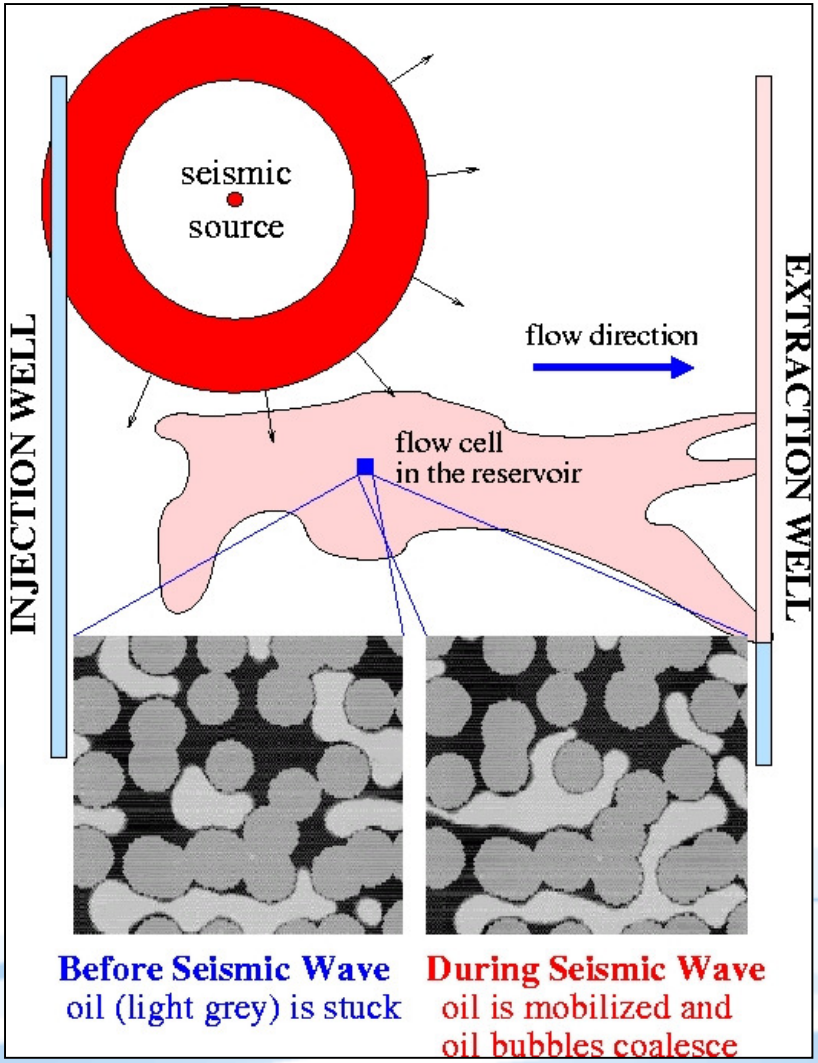
Gulf Coast Green Energy

Seismic Stimulation to Enhance Oil Recovery

Increased Recovery

Test seismic stimulation in EOR

A seismic wave is to "***shake the stuck oil loose***" and get it flowing again toward a production well.



SandRidge to Field Test

Lawrence Berkeley National Laboratory

2102 Request for Proposals

Status

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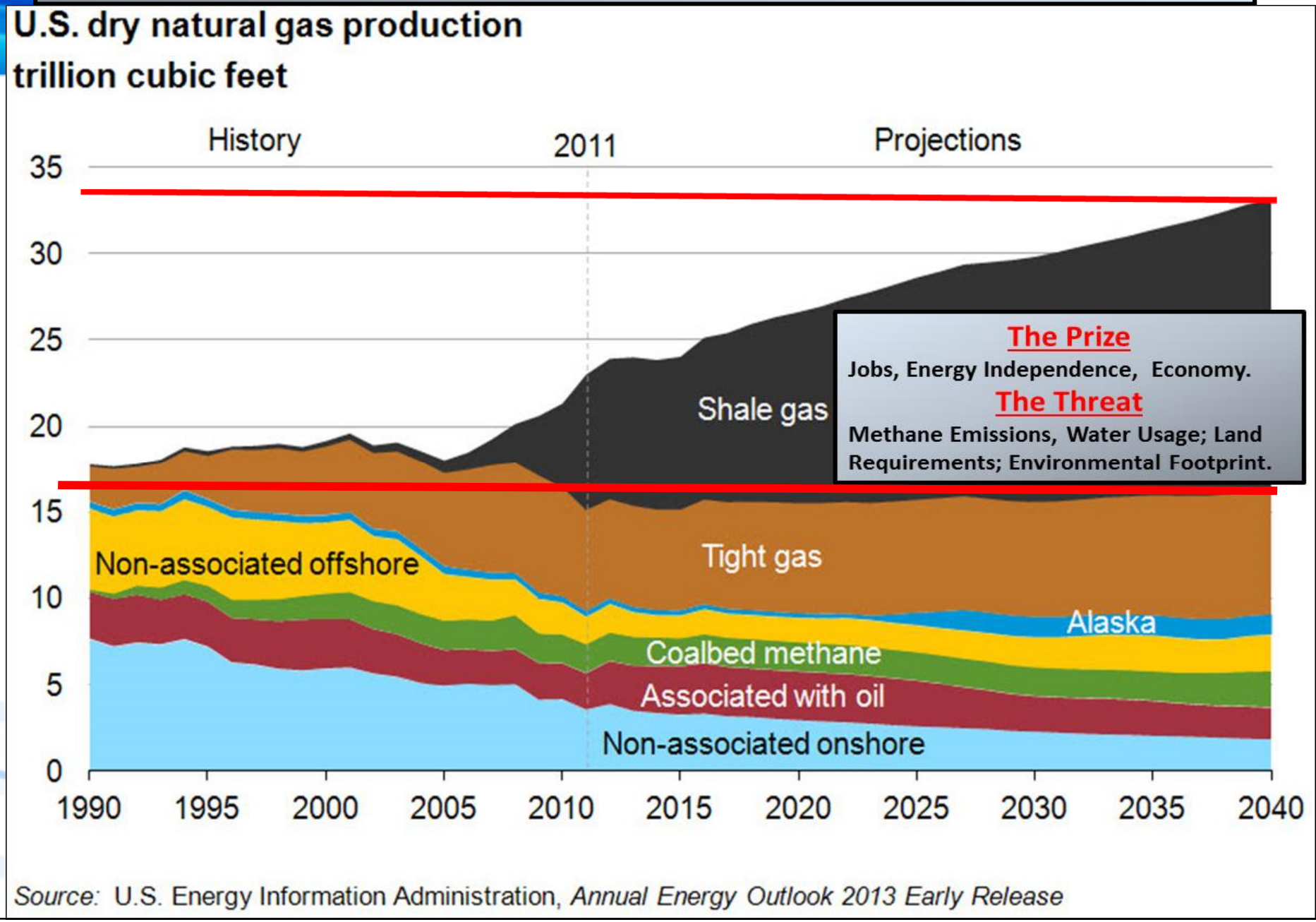
"Specific URTAC Topical Recommendations"

- *"Refocus the R&D component of the Subtitle J program to include other unconventional resources such as tight oil, and oil shale."*

- *"Research should be conducted to improve well construction that ensures long-term wellbore integrity during and beyond the operational life of the well."*

- *"Pursue research and communication among multiple government agencies and industry that addresses air quality concerns specific to the exploration and production of natural gas from shale deposits and other unconventional resources."*

U. S. Gas Production- Tcf



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2013 Early Release*

Thank You

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