

Shale Gas: Energy and Environmental Issues

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OUTLINE OF TALK

- (1) Why is shale gas important**
- (2) How is shale gas produced?**
- (3) What are the impacts of shale gas water usage?**
- (4) What are the issues associated with produced water from shale gas wells?**
- (5) What other environmental issues have been raised regarding shale gas production?**
- (6) What is the historical environmental and regulatory track record of hydraulic fracturing and of shale gas production?**
- (7) What are the public policy implications of the above issues?**

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Why is Shale Gas Important?

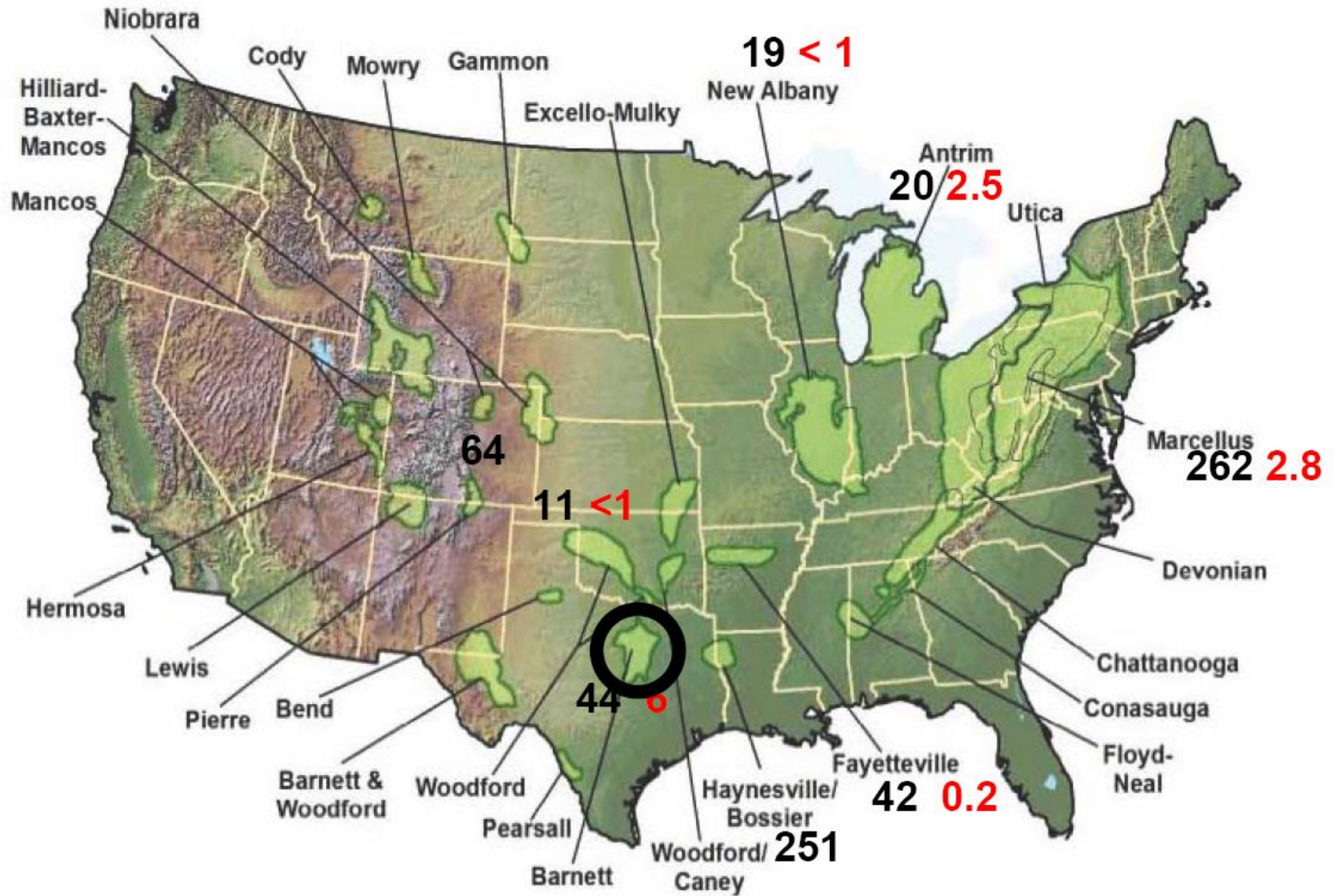
- Shale gas has solved the gas availability issue in the US
- Shale gas is a low carbon, relatively low polluting alternative to coal for electric power generation
- Shale gas can play a key role in Energy Security for the US

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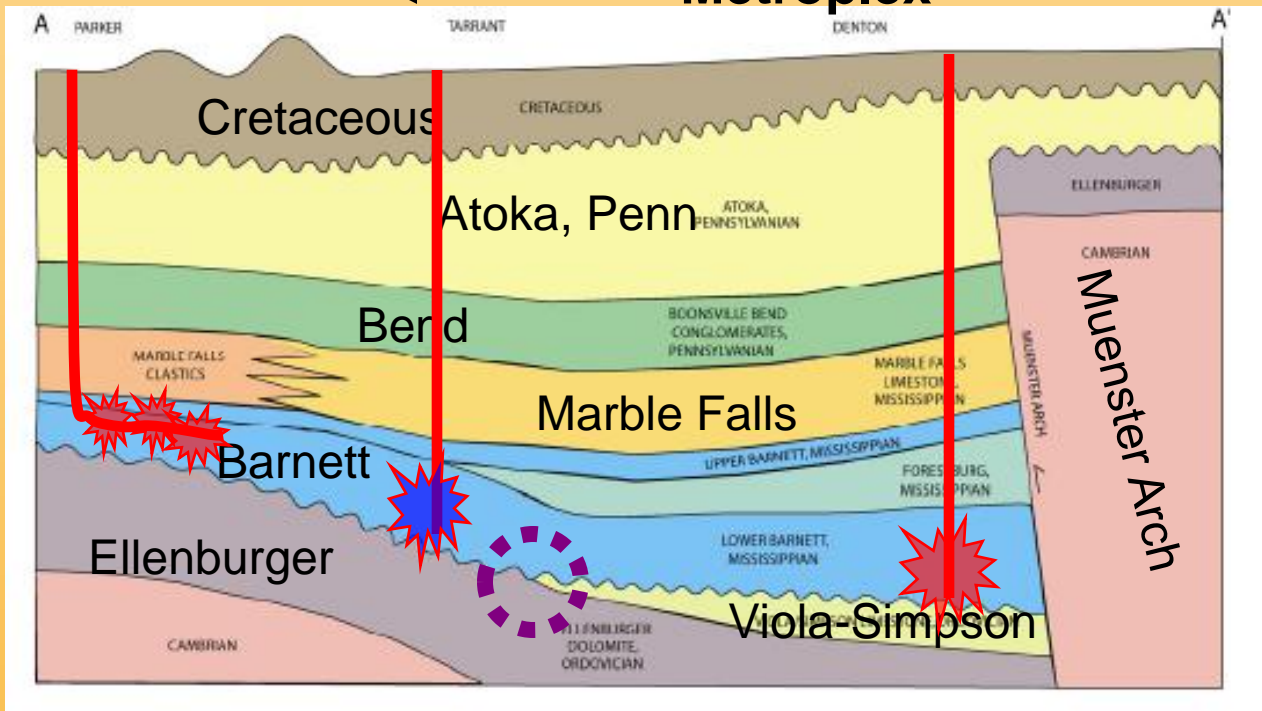
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US Shale Gas Plays



Map: DOE Shale Gas Primer, 2009

Black = Resource values in Tcf, DOE Shale Gas Primer (Rockies PGC); Clean Skies, 2008
Red = cumulative production, Texas RRC, Curtis 2009, Ark Geol Surv 2007, Andrews 2007



Diagrammatic figure; no scale

General Stratigraphy and Barnett completion strategies, Ft. Worth Basin

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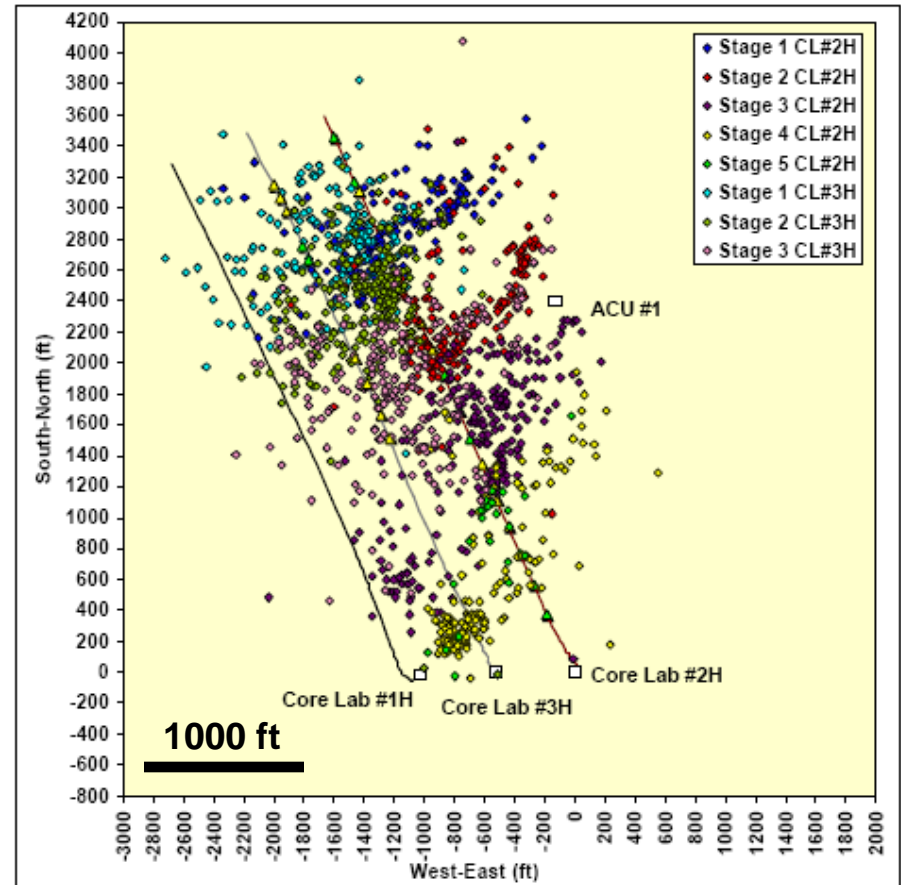
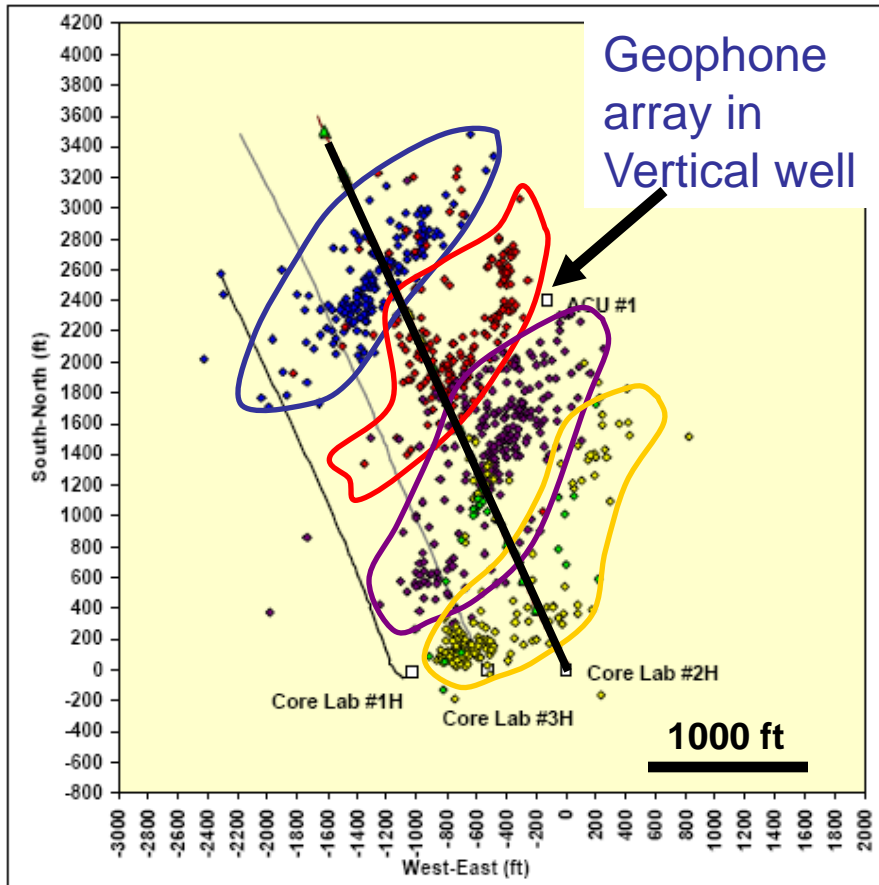
Stratigraphy from Bowker, 2003, and poster by Givens & Zhao, 2005

EOG Resources Micro Seismic Frac Mapping

Map view of multiple frac stages in horizontal wells

Core Lab #2H Stimulation Stages

Core Lab #2H and #3H Stimulation Stages



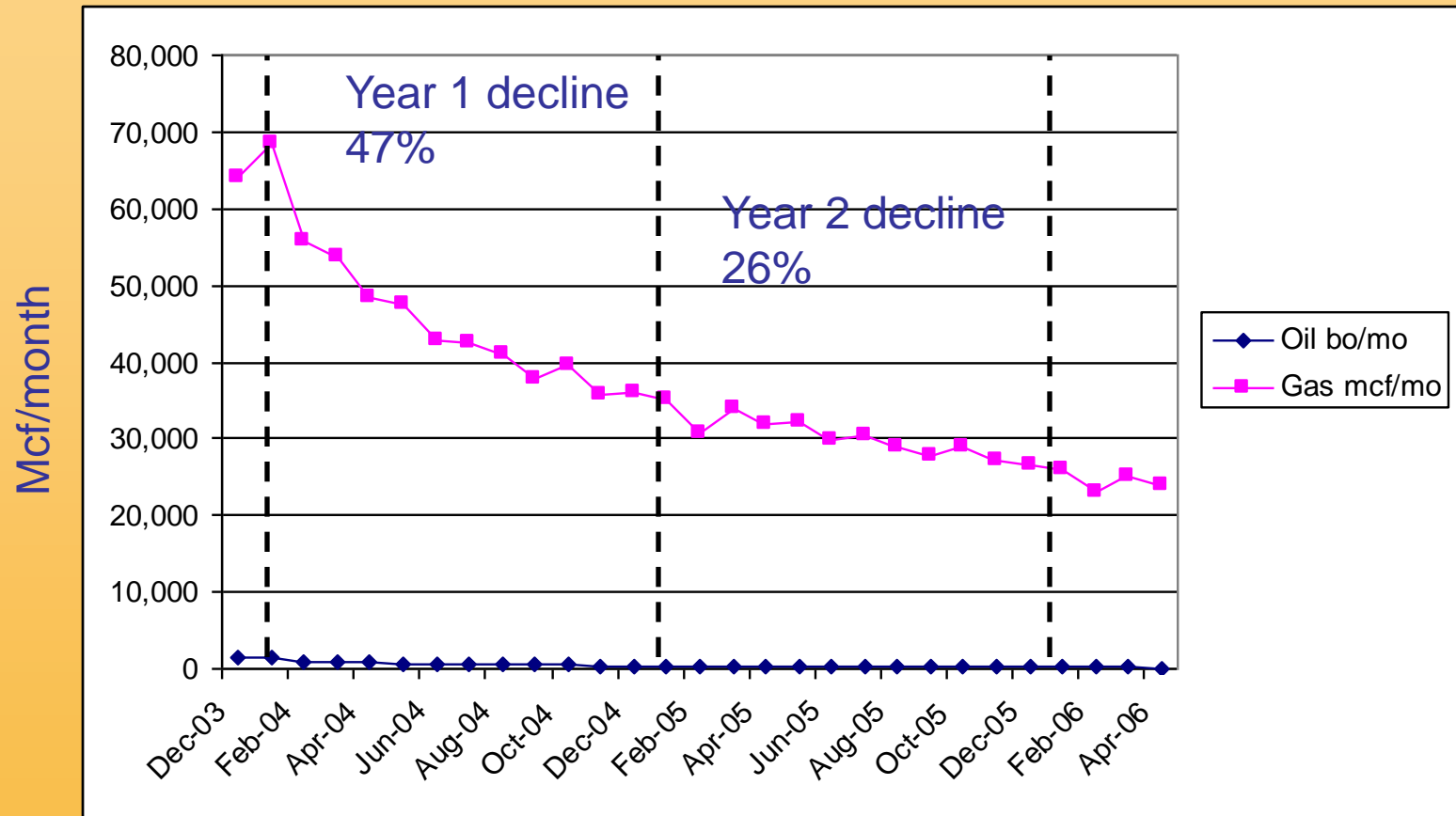
Barnett frac job in progress

From Devon Energy, 2006



Horizontal well example, Wise Co

Devon James D. Bentley #4H



Overview of Shale Gas Plays

- Marginal-quality reservoir covering large area
- Horizontal wells and multiple “frac jobs”; expensive completions
- Per-well reserves and economic life span are relatively low Overall play production rate is very sensitive to drilling rate... large numbers of wells compared to conventional gas fields

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Water for Well Completions

Some Barnett Shale water facts:

- 1.2 to 3.5 million gallons per frac (4 to 11 acre-feet)
- Total water demand for Barnett Shale was about 7,200 acre-feet in 2005
- <1% of total water use
- About 60% (4,300 acre-feet) from groundwater
- ~3% of total groundwater use



Overall Shale Gas has very low Water Usage

- Shale Gas Total water 1.25 Gals per MBTU
- Corn Ethanol 2,500 to 29,000 Gals per MBTU



Issues Associated with Injected (Frac) Water

Frac water has a few percent total of an array of fracture enhancers and biocides

Under pressure from environmental groups companies have released lists of the components of Frac water ... many chemicals some carcinogenic

Frac additives are being reformulated to produce “green fracs”

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Issues Associated with Produced Water

Produced water is a combination of Frac water and in-situ formation water

Formation water typically very saline (3 times as salty as seawater) so disposal is an issue

Shale formation water can have significant levels of Benzene and other light hydrocarbons

What is the Environmental Impact of Shale Gas on Groundwater?

Shale gas production has a relatively short track record so we may not have all the answers.

All reported groundwater impact appear to have been caused by poor well completions

So it seems shale gas is a win-win for the environment.....

Why then are some environmental groups talking about:

“dire impacts of hydraulic fracturing”

“significant risk of water pollution [is] **endemic to the fracing process**”.

But what is the environmental community saying about Shale Gas?

Hazen and Sawyer (2009) asserts that “extensive hydraulic fracturing will present subsurface contamination risks via naturally occurring faults and fracture systems”.



But what is the environmental community saying about Shale Gas?

Hazen and Sawyer (2009): “any individual hydraulic fracturing operation poses a relatively small risk to the water supply”.

However because of the large number of wells drilled in the Marcellus that “the likelihood of negative impacts and the subsequent risk” is “substantially higher”.

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But what is the environmental community saying about Shale Gas?

Yale Environment 360 (www.e360.yale.edu)

“the **possibly dire** impacts of hydraulic fracturing has now become primary source material for a growing **environmental backlash** to the gas industry’s rapid assault on ... the Marcellus Shale”.

“the city’s study raised a **large red flag** as scientists argued that **significant risk** of water pollution was **endemic to the fracing process**”.

But what is the environmental community saying about Shale Gas?

The Yale article quotes Wes Gillingham, program director of Catskill Mountainkeeper, as saying

“One of the reasons industry could get away with these incidents is that there was a lack of science. New York City used reputable geologists and came up with the science.”



Our Proposed research Looks at Some of the Science

Some problems may not be tractable ...
such as trying to establish the probability of a frac intersecting an open natural fracture resulting in leakage to potable groundwater....

So BEG has developed a research plan to model consequences if some leakage occurs...
subrtion by shale, bacterial breakdown etc



Regulatory Issues

- Shale Gas has expanded into states with little previous gas production
- Some States have an antiquated regulatory system
- Shortage of trained state regulators?
- Disposal wells for produced water lacking in many states



Summing Up: Public Policy Issues

- Shale Gas is a key source of relatively low carbon, clean burning fossil fuel for electric power production in US and globally
- Shale gas production presents a intertwined array of environmental, regulatory and policy issues

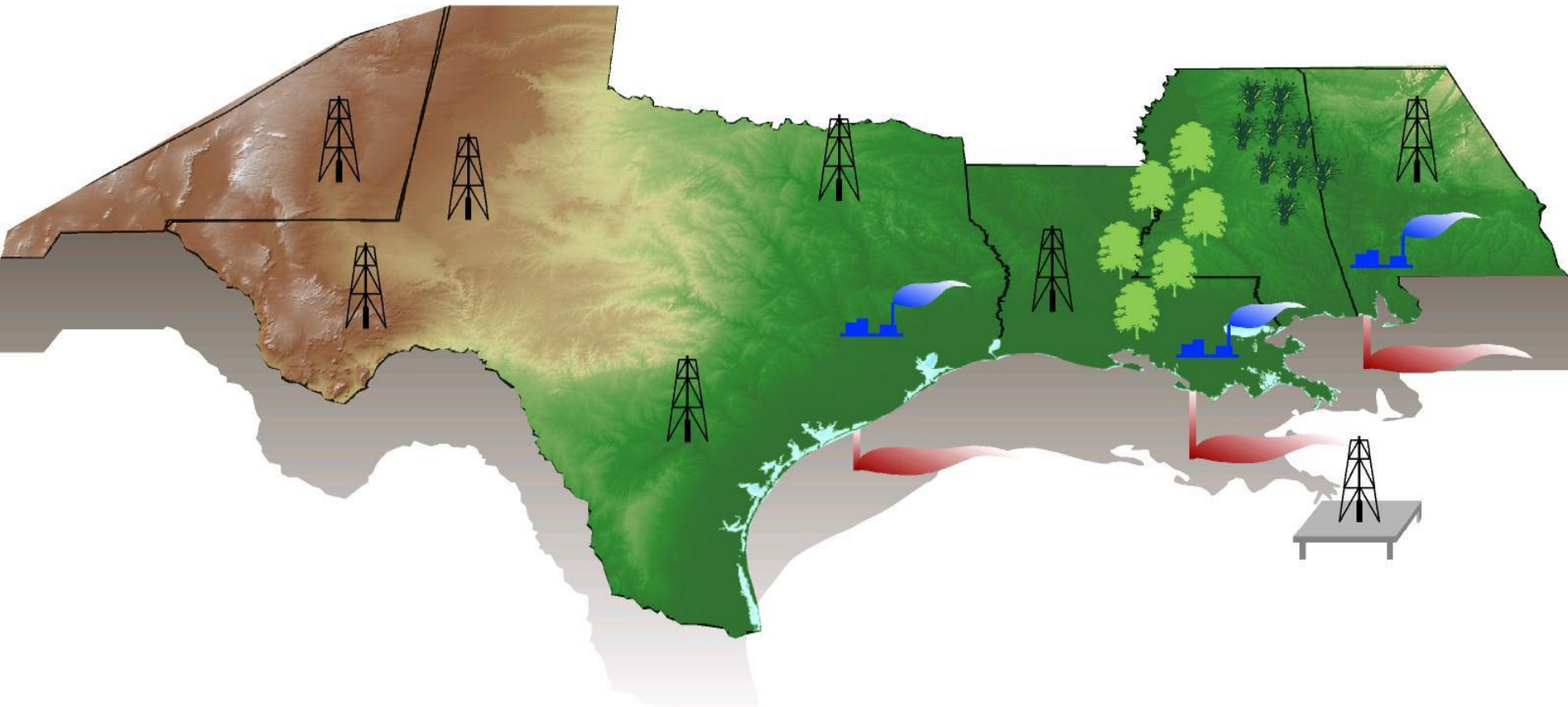


Summing Up

- Shale Gas has a short track record so the long term environmental impact must be inferred from geologic insights and modeling
- Recently announced EPA study and our proposed research can address issues being raised by the environmental community



Thanks!



For more information: www.beg.utexas.edu

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