

Natural Gas: Risks and Opportunities

Shale gas, hydraulic fracturing, and other facts

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NY Energy Forum

NYC, December 19, 2011

Overview – Natural Gas Risks and Opportunities:

Shale Gas: Game Changer or Something Else?

- **Context for my comments**
- **What's going on with shale gas**
- **Opportunities and challenges:**
 - New power sector investment cycle
 - Shale gas development
- **What's needed**

Natural Gas: Shale Gas

CONTEXT FOR MY COMMENTS:

Recent Involvement in NPC and SEAB Studies

Overview and background:

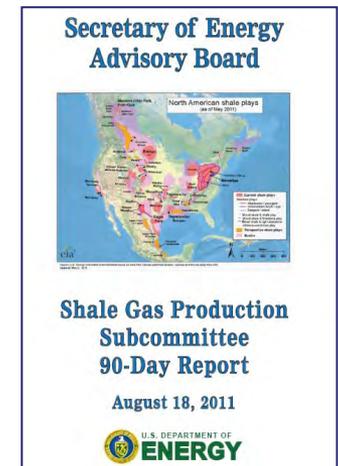
Who: SEAB Board Natural Gas Subcommittee

- Deutch, Holditch, McGinty, Krupp, Yergin, Tierney, Zoback

What: Presidential request to Secretary Chu (Blueprint for Secure Energy Future Charge):

- examine steps to improve the safety and environmental performance of shale gas development
- not regulation, *per se*

When: Initial report: mid-August 2011 Final report: mid-November 2011



Overview and background:

Who: National Petroleum Council

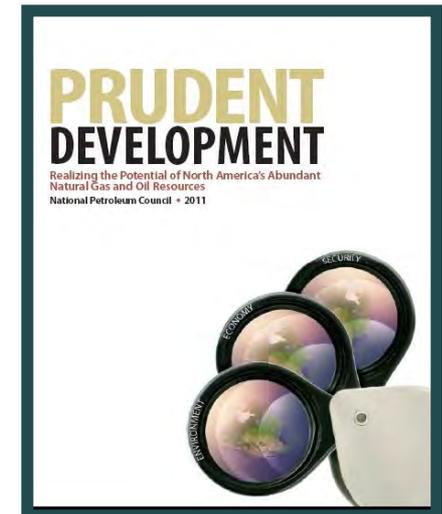
What: Energy Secretary Request to NPC

- Assessment of the size of the oil and natural gas resource base in North America
- Assessment of the role of natural gas in GHG reductions

When: Start – early 2010

Report: September 15, 2011

- “Prudent Development: Realizing the Potential of North America’s Abundant Natural Gas and Oil Resources”



Natural Gas: Shale Gas

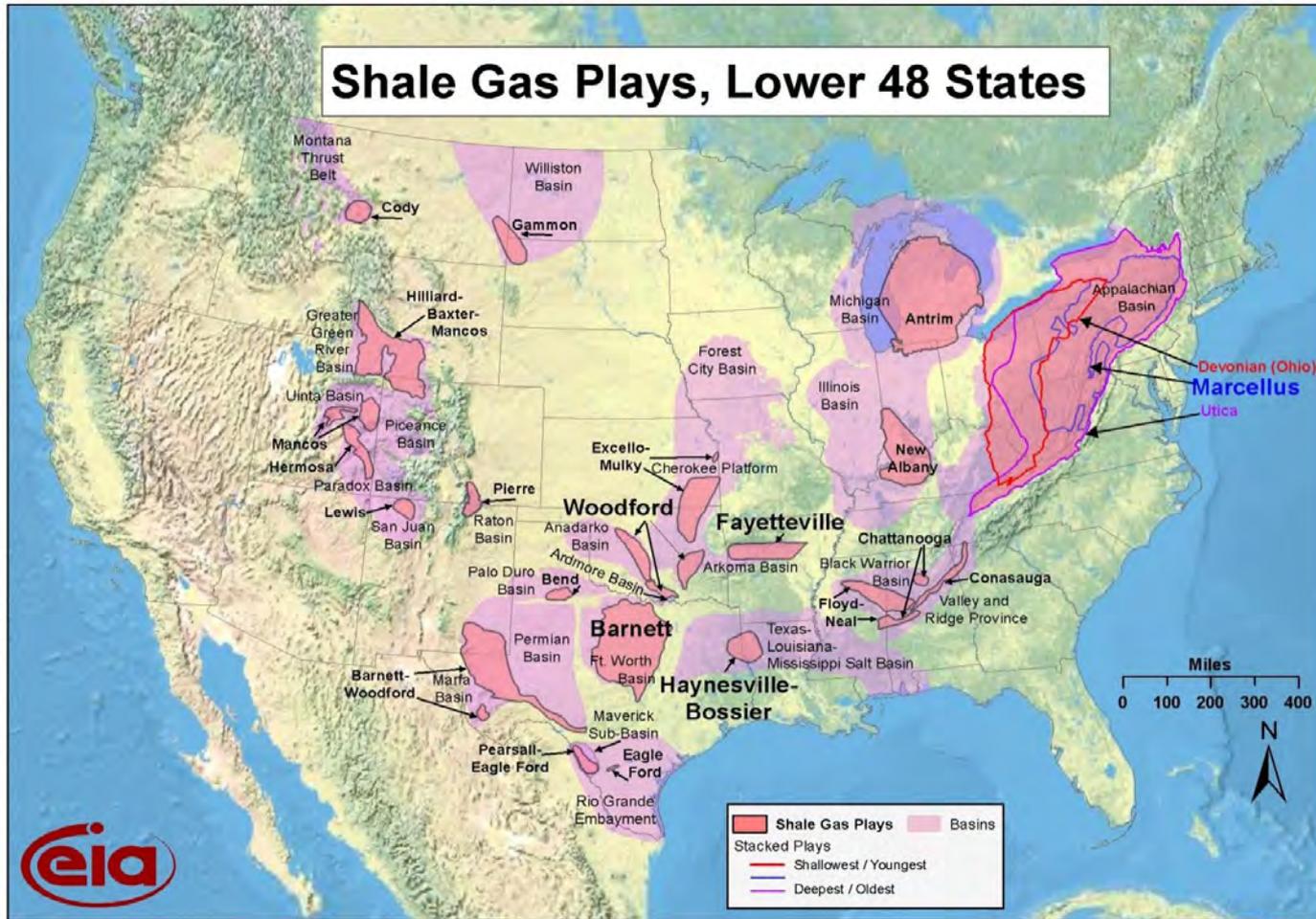
WHAT'S HAPPENING

What does shale gas look like? **ROCK**



**Shale Gas Outcropping –
Marcellus**

What does shale gas look like? REGIONS



Drill site

Stored water

Steel casing
and cement

Drinking water

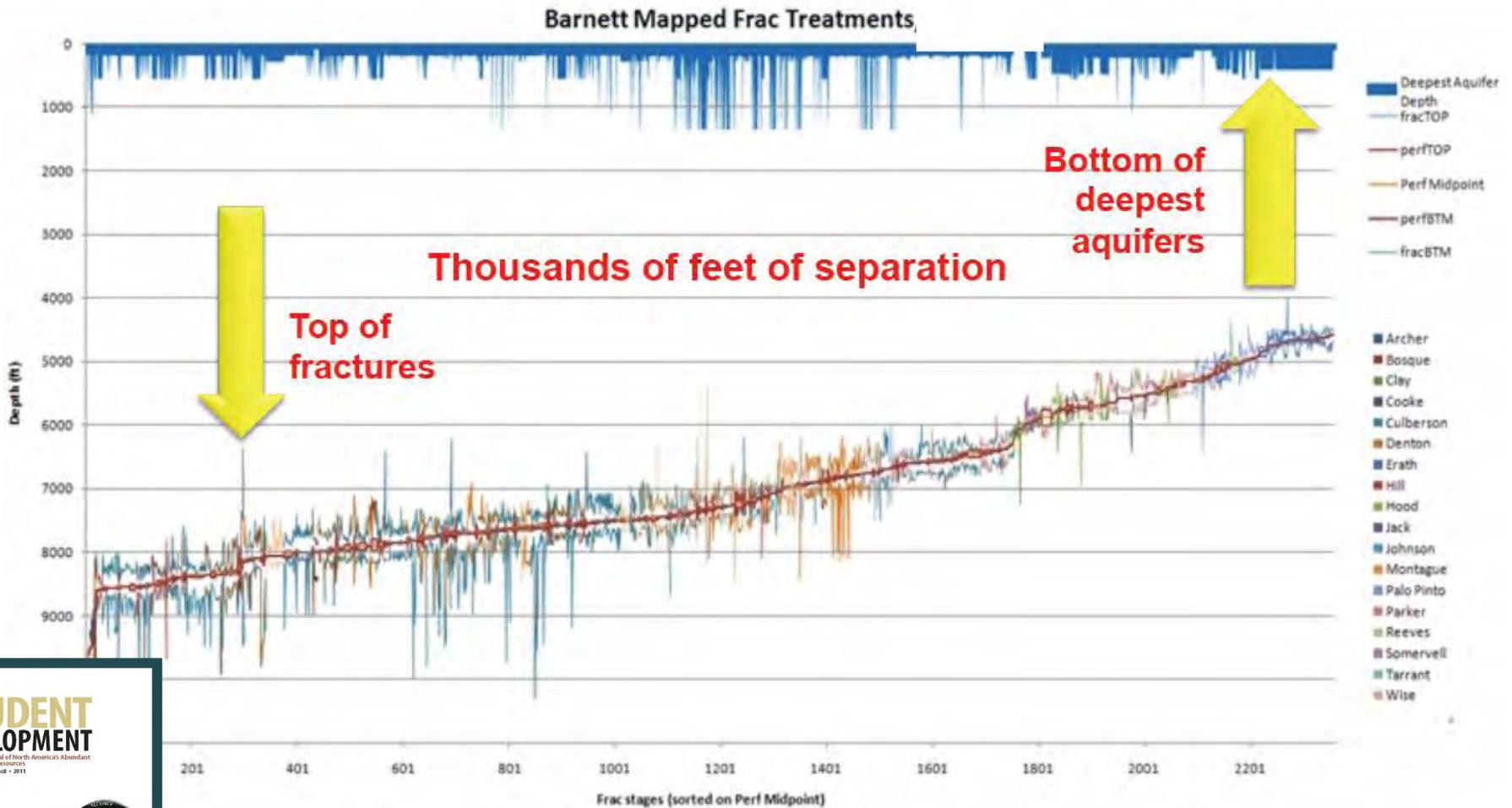
Borehole

**What does
shale gas
look like?
TECHNOLOGY**

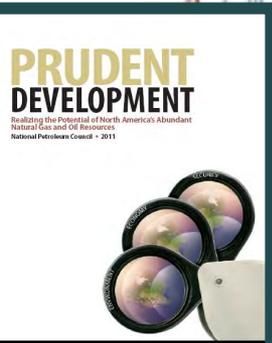
Hydraulic fracturing

Horizontal drilling

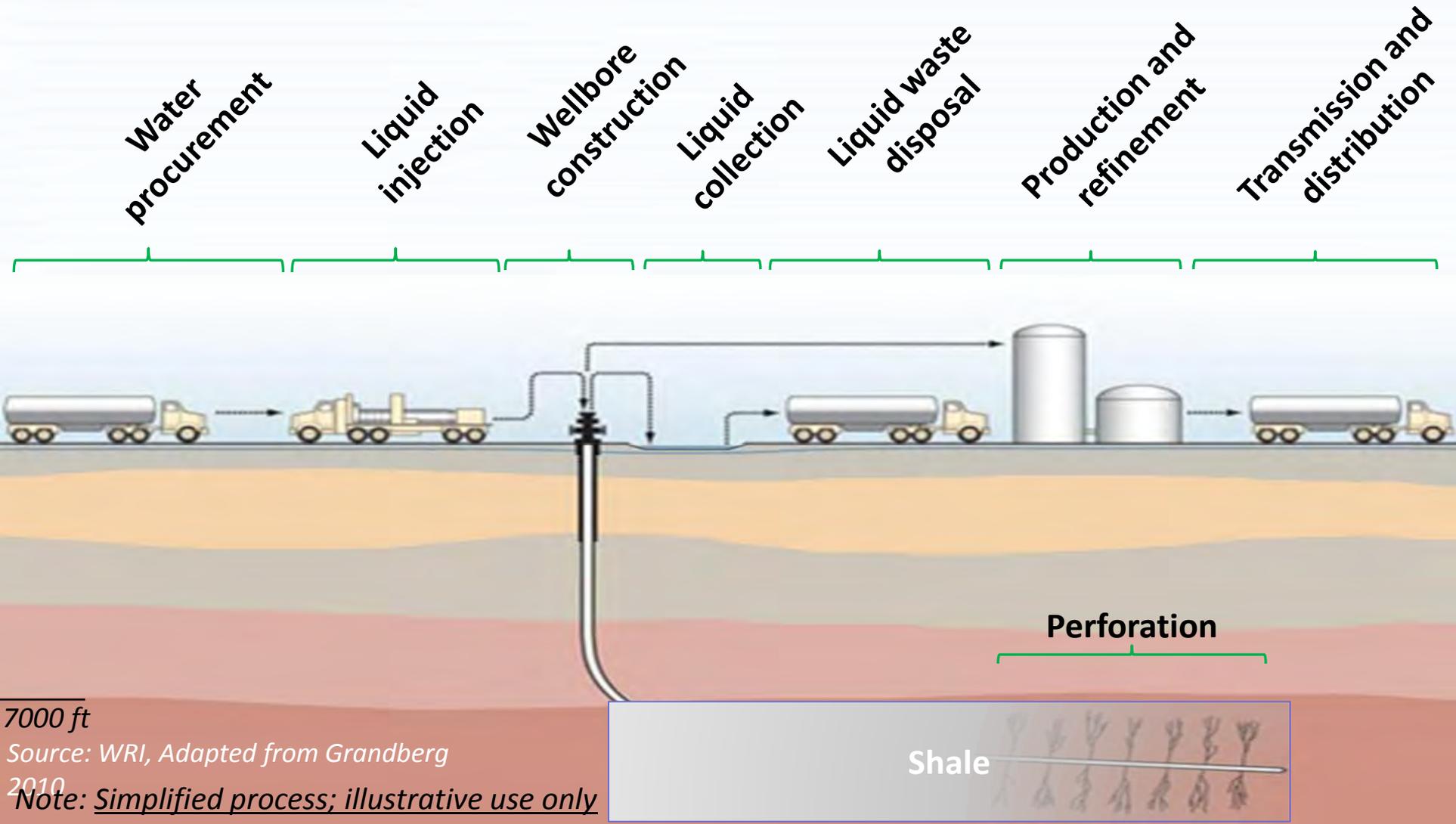
What does shale gas look like? FRACTURING DEPTH



Fracture Height Determination – Microseismic



What does shale gas look like? SURFACE ACTIVITIES



What does shale gas look like? SURFACE ACTIVITIES



What does shale gas look like? LAND USES



<http://news.nationalgeographic.com/news/energy/2010/10/101022-energy-marcellus-shale-gas-rush/>

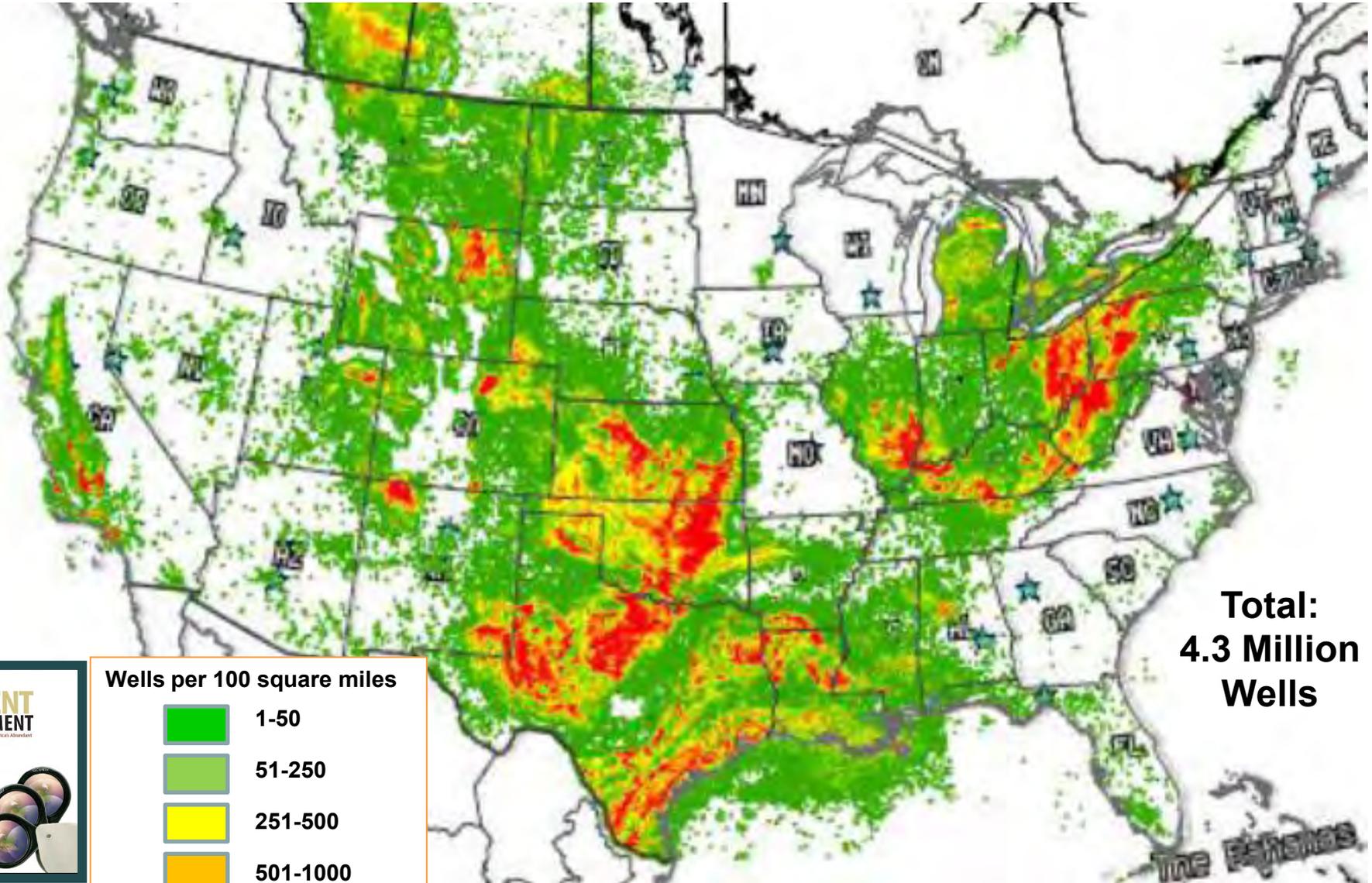
What does shale gas look like? ENVIRONMENTAL RISKS



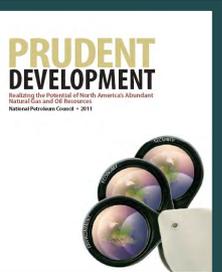
Risks from past practices and events

Phil Nguyen, Regulatory Options and Challenges in Hydraulic Fracturing, WISE, 2010

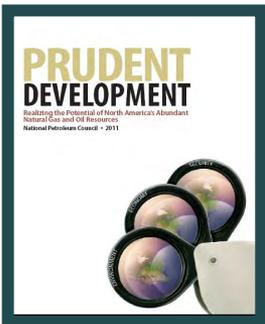
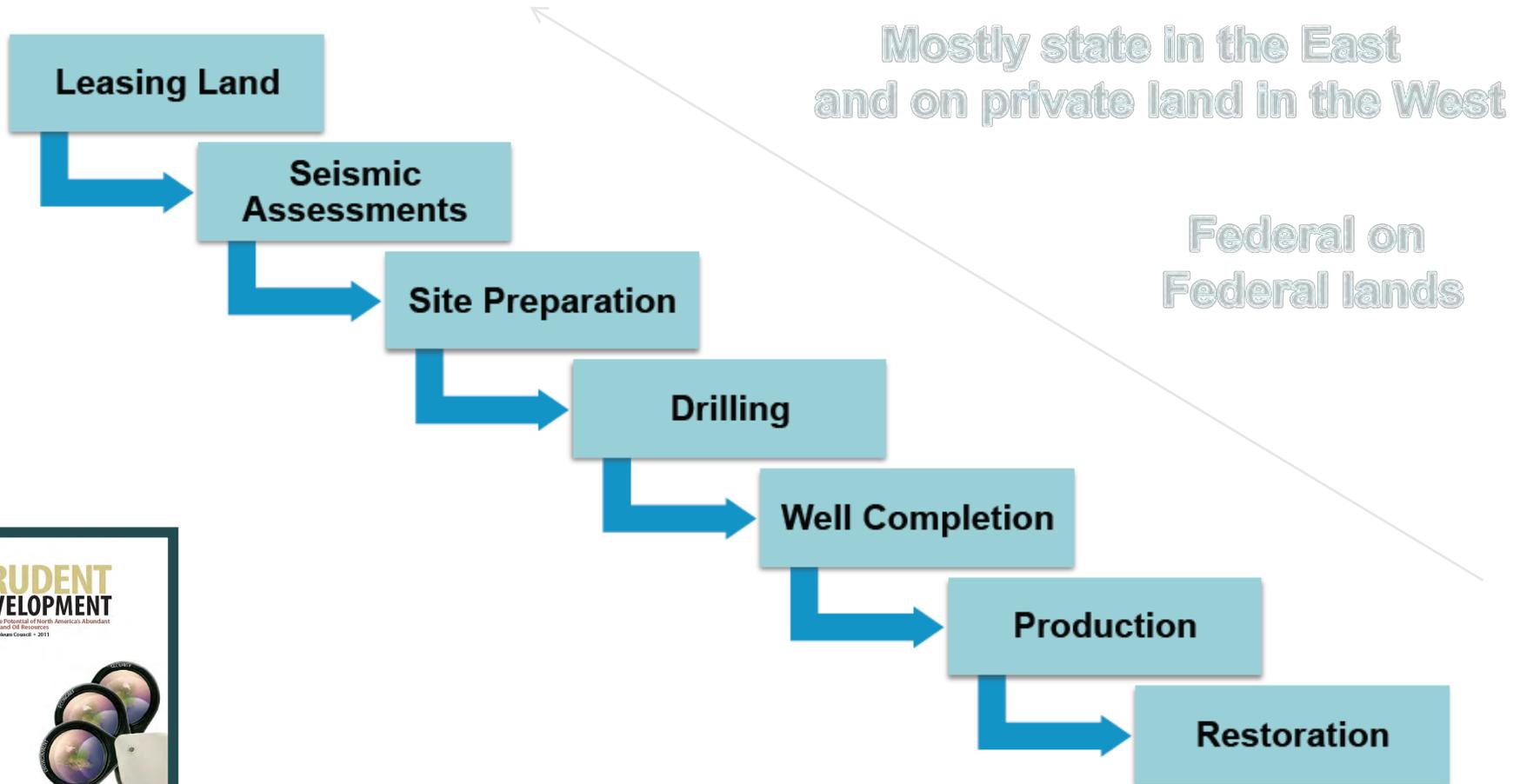
What does shale gas development look like? PAST, PRESENT WELLS



**Total:
4.3 Million
Wells**



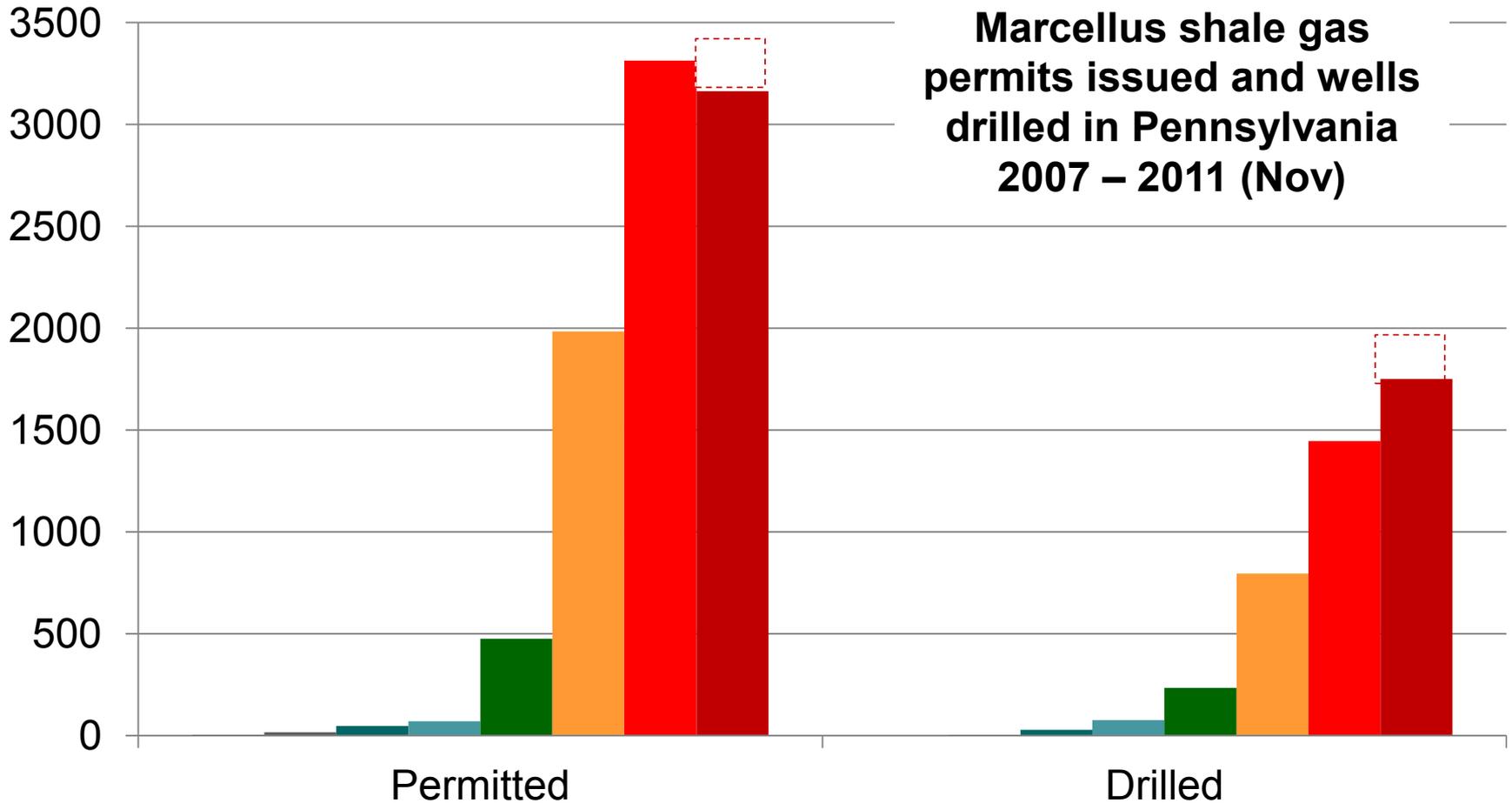
What does shale gas look like? **SIGNIFICANT REGULATION**



NPC Study, Prudent Development, 2011

What does shale gas look like?

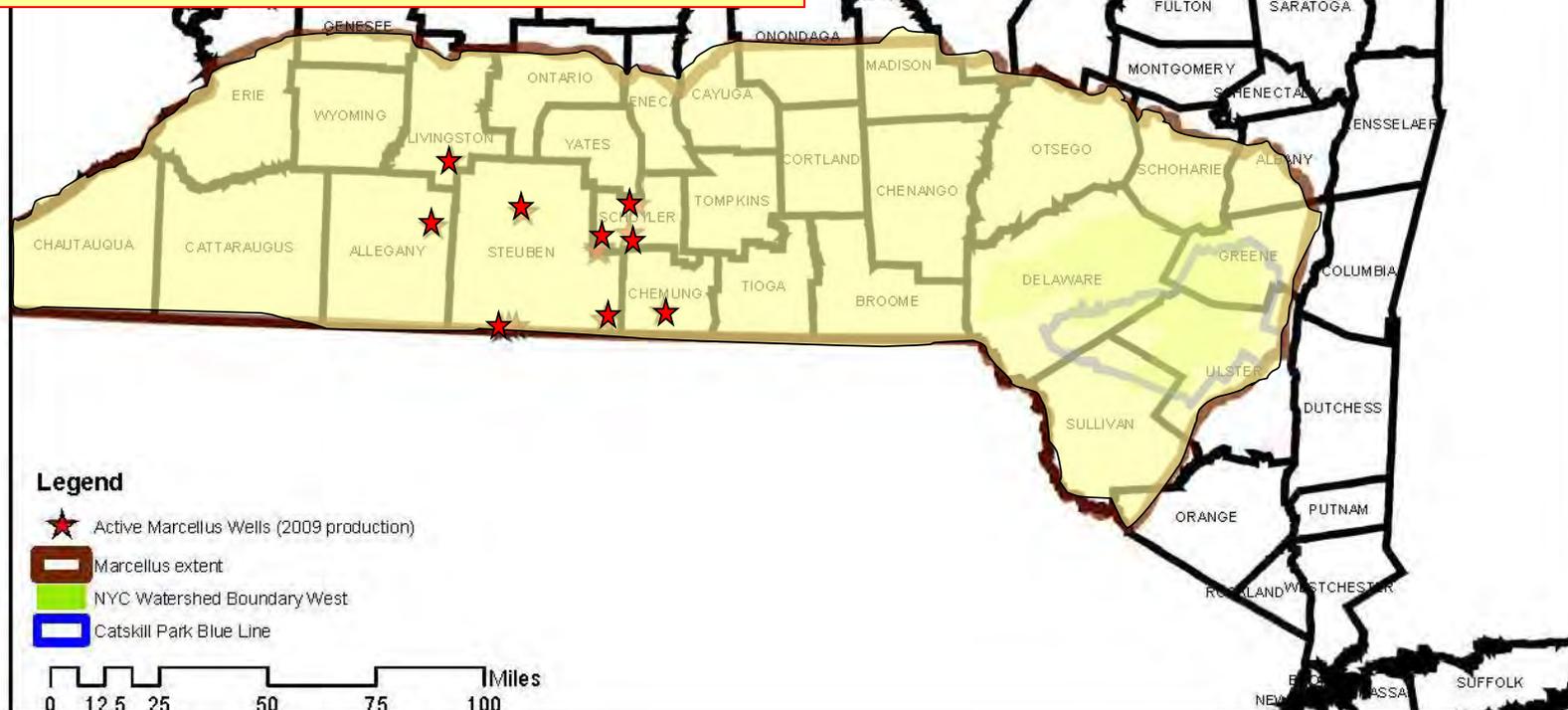
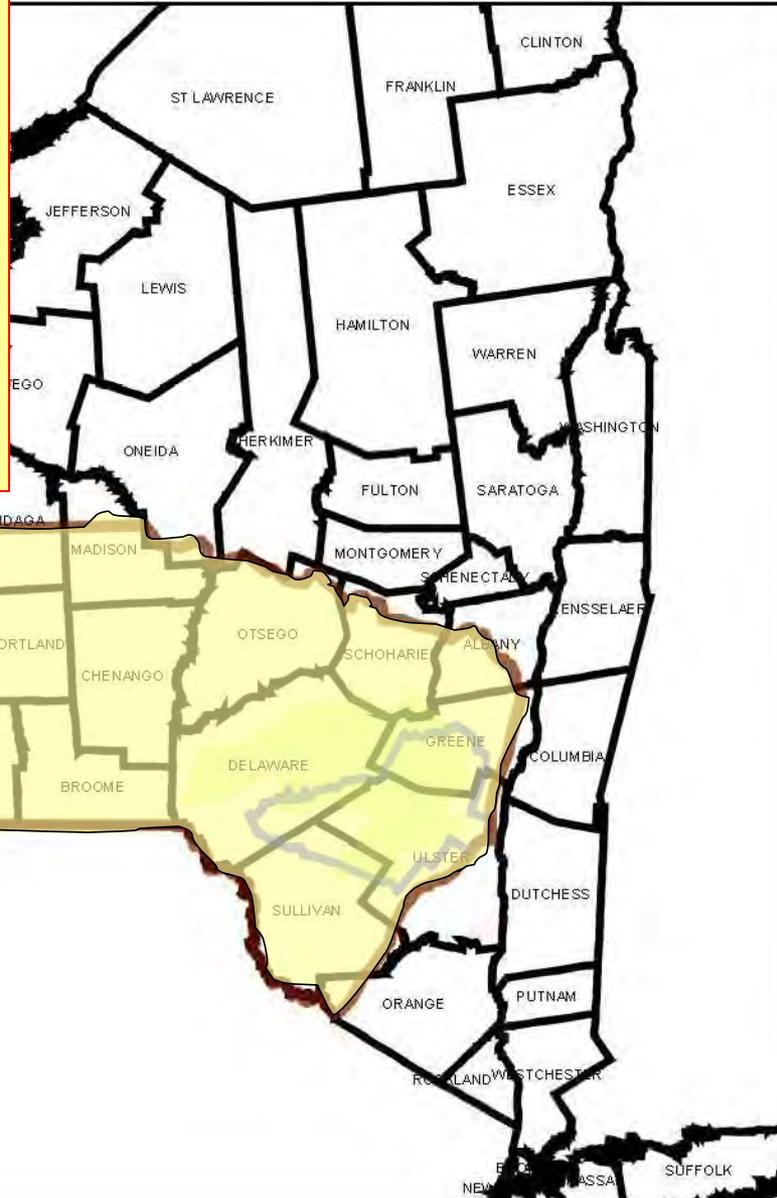
PACE OF DEVELOPMENT



Marcellus Shale Gas Commission, July 2011, Figures 22 and 23;
<http://www.dep.state.pa.us/dep/deputate/minres/oilgas/Marcellus%20Wells%20permitted-drilled%20NOVEMBER%202011.gif>

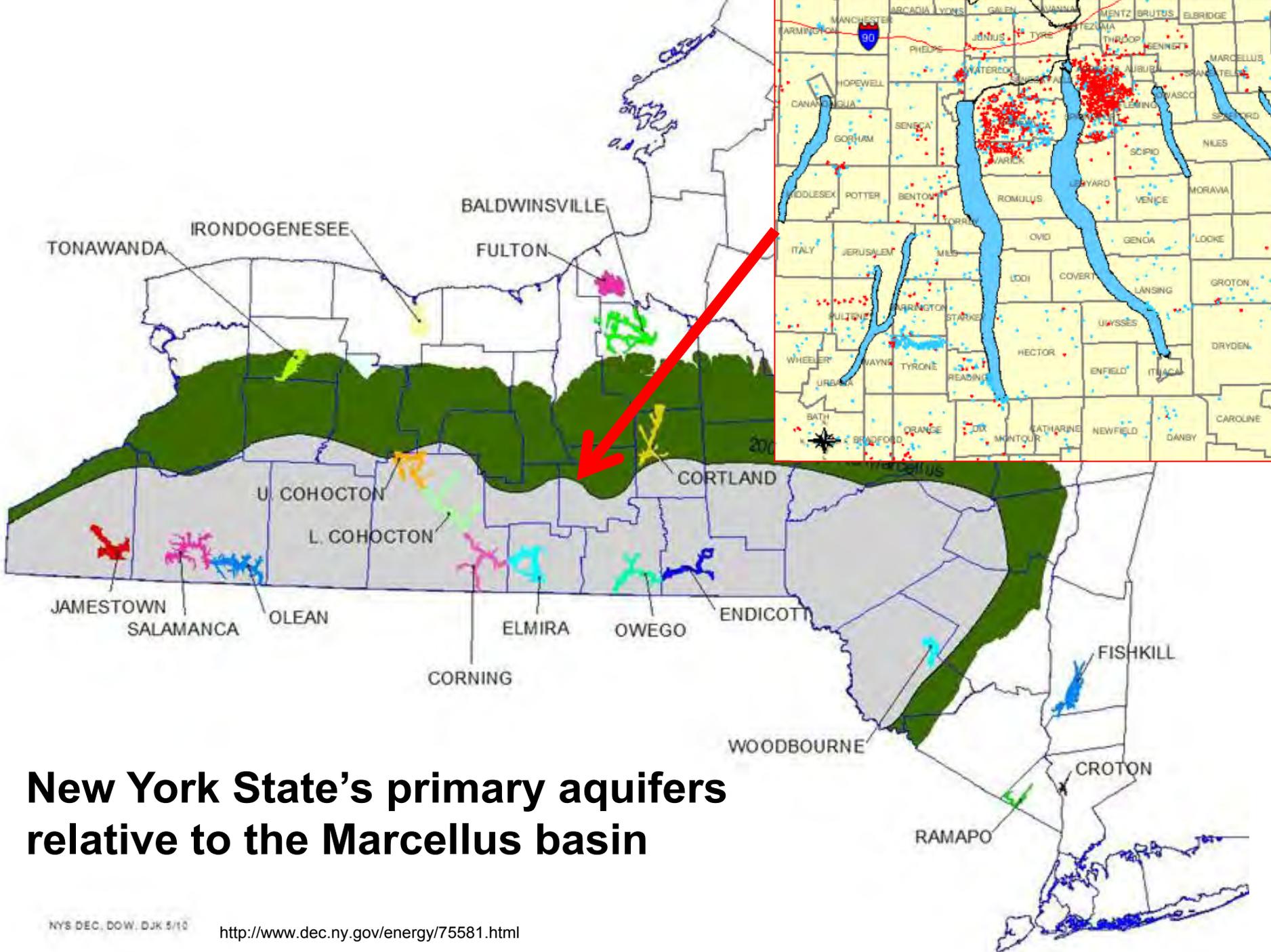
NY State gas development:

- Groundwater contamination
- Surface water contamination
- Water use
- Protection of critical watersheds
- Wastewater management
- Noise and visual
- Air emissions and air quality
- Road use, heavy vehicle traffic
- Community impacts from industrialization
- Cumulative Impacts
- Environmental Justice



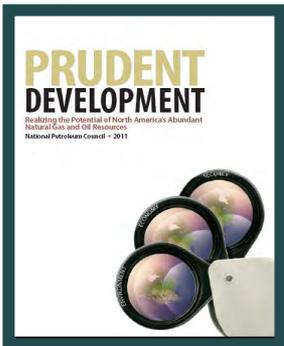
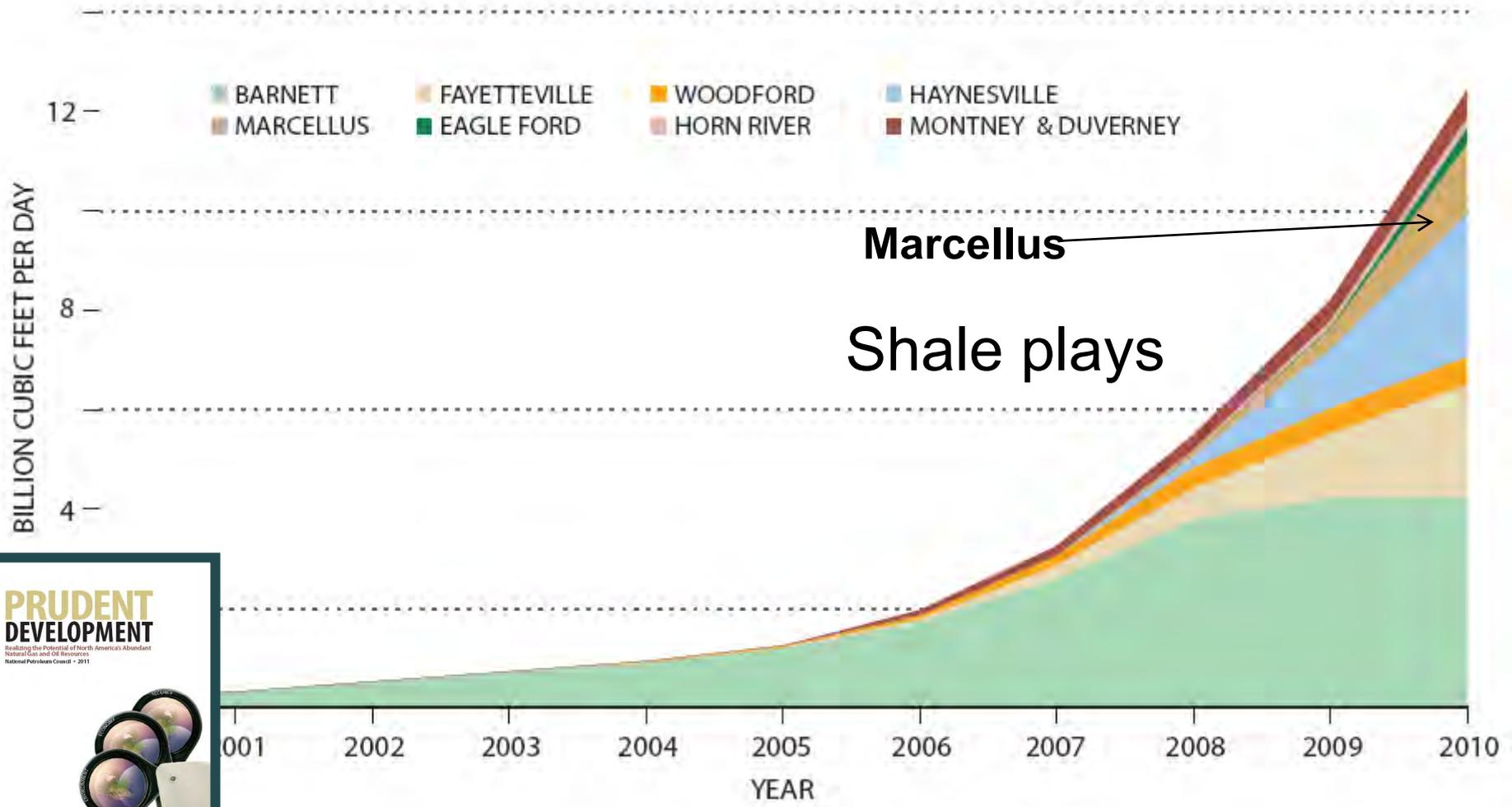
- Legend**
- ★ Active Marcellus Wells (2009 production)
 - ▭ Marcellus extent
 - ▭ NYC Watershed Boundary West
 - ▭ Catskill Park Blue Line

- Gas Well
- Oil Well
- Other Well



New York State's primary aquifers relative to the Marcellus basin

What does shale gas look like? PRODUCTION GROWTH



What does shale gas look like? ATTENTION (+ and -)



What does shale gas look like? JOBS

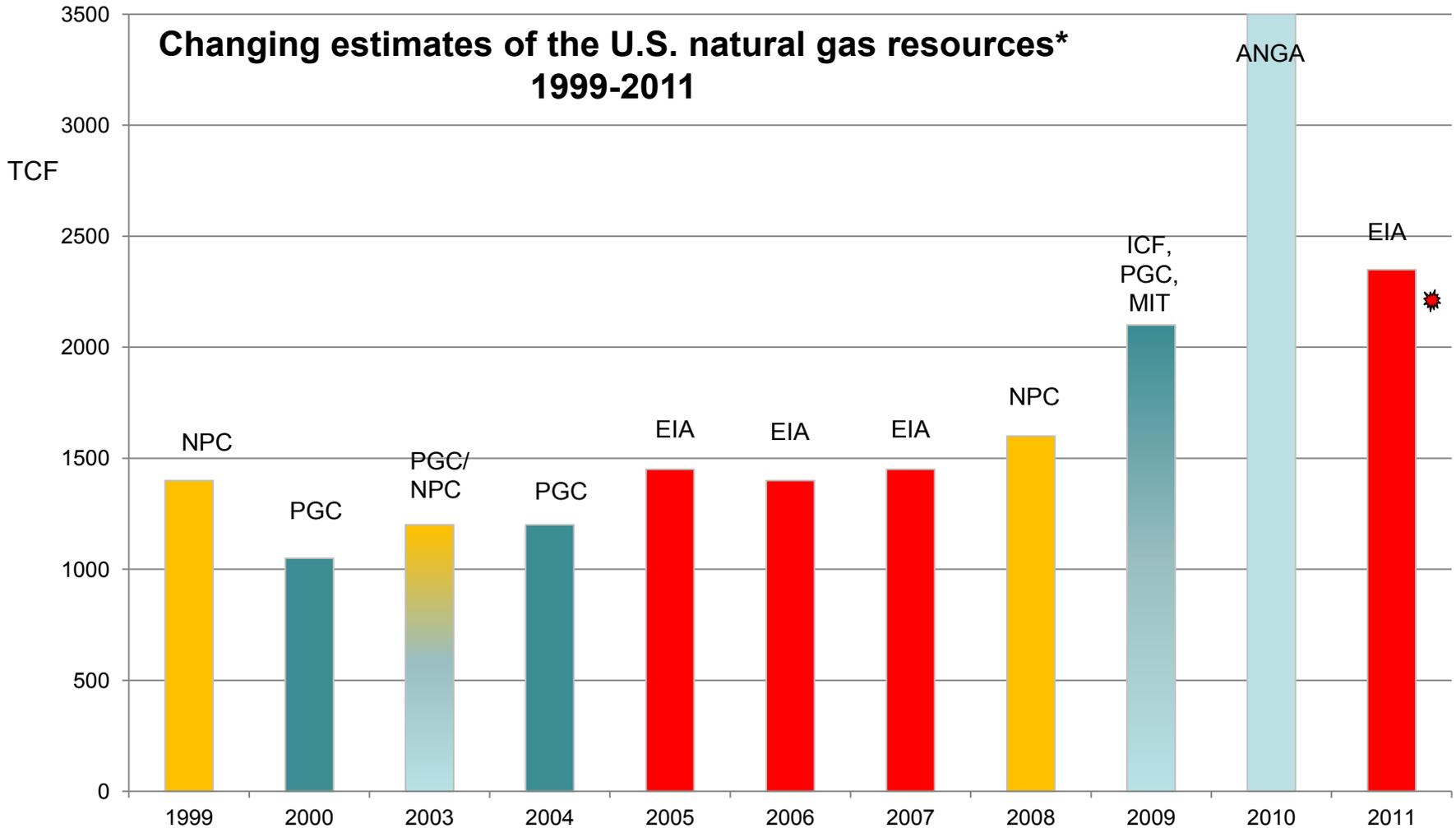
Marcellus Shale Coalition: 2010 estimate:

- **\$11.2 billion in economic activity**
- **\$1.1 billion in state and local taxes**

Keystone Research Center (9/2010): 10,000 jobs created



What does shale gas look like? SUPPLY ESTIMATES

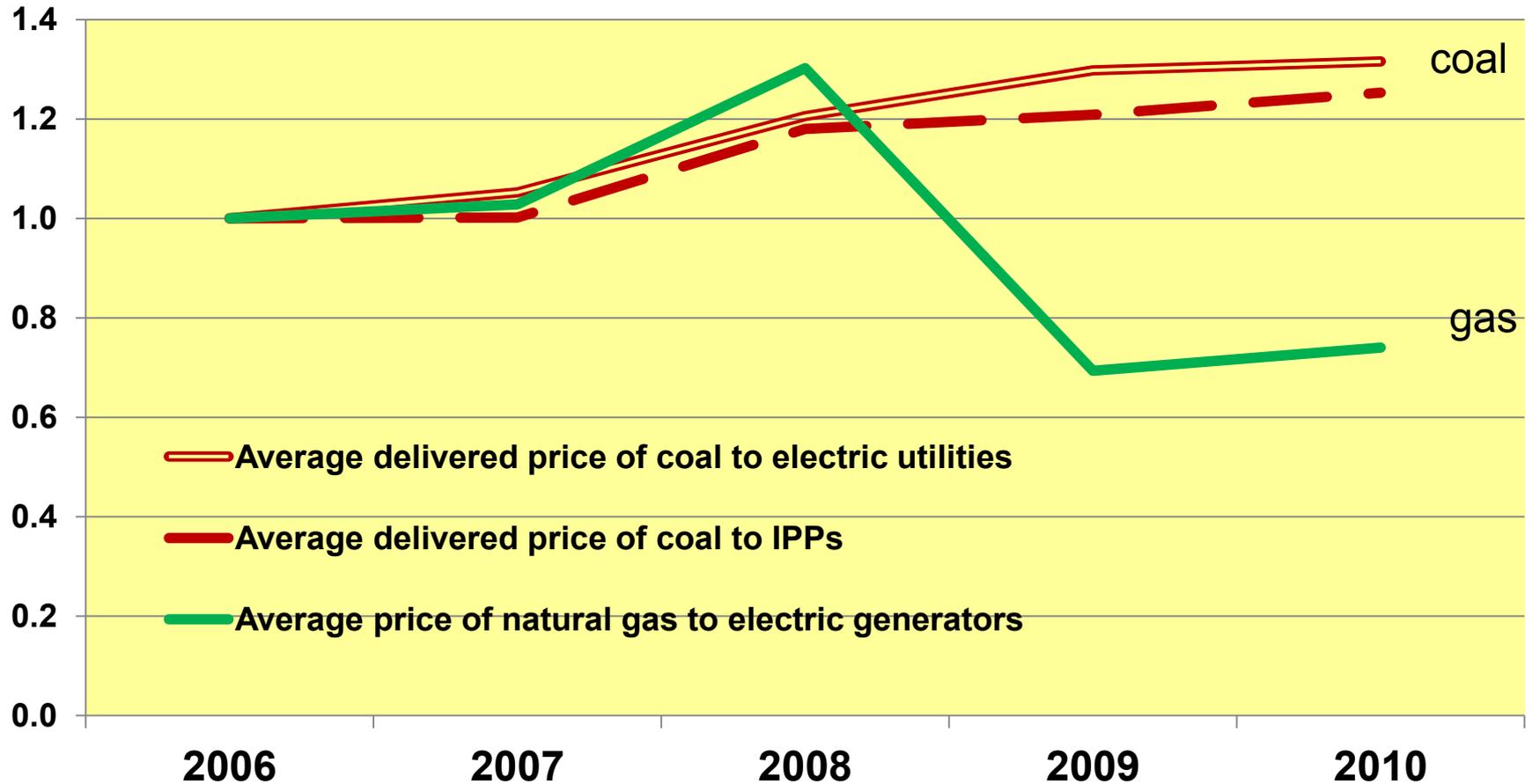


* **Technically recoverable**

December 19, 2011

The effect of a reduction in EIA's Marcellus estimate from 410 Tcf to 84 Tcf (the new USGS estimate, up from 2 in 2002)

What does shale gas look like? LOWER GAS PRICES



Source: Natural gas prices: EIA, http://www.eia.gov/dnav/ng/ng_pri_sum_dcunusa.htm;

Coal prices: William Watson, Nicholas Paduano, Tejasvi Raghuvver and Sundar Thapa, EIA, "U.S. Coal Supply and Demand: 2010 Year in Review," June 1, 2011 (available at <http://www.eia.gov/coal/review/pdf/feature10.pdf>)

Natural Gas as a Replacement for Retiring Coal Capacity:

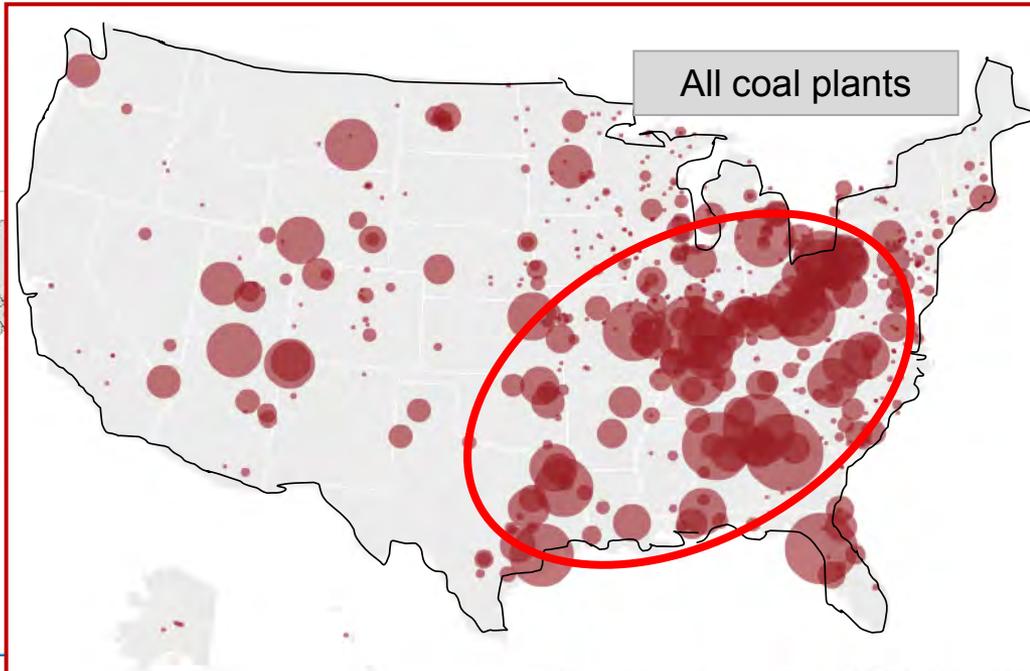
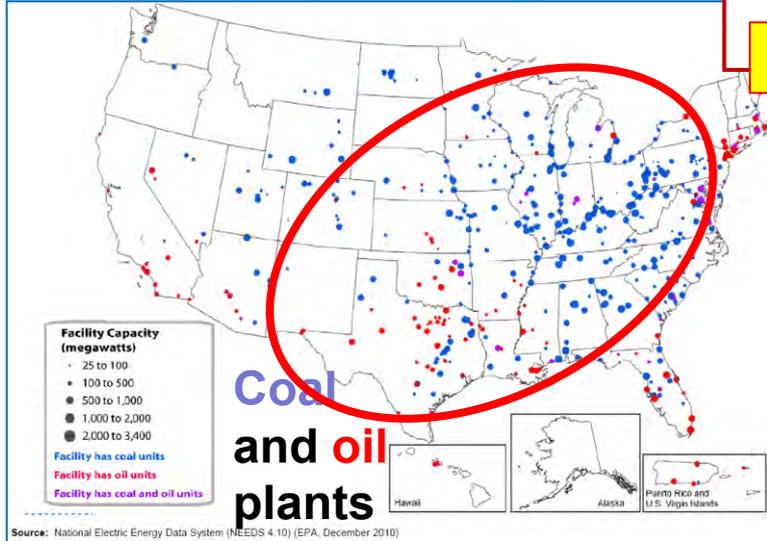
OPPORTUNITIES AND CHALLENGES

EPA's upcoming key air regulations affecting existing power plants:

Cross-State Air Pollution Rule (after 2012)



Utility Toxics Rule (after 2014)

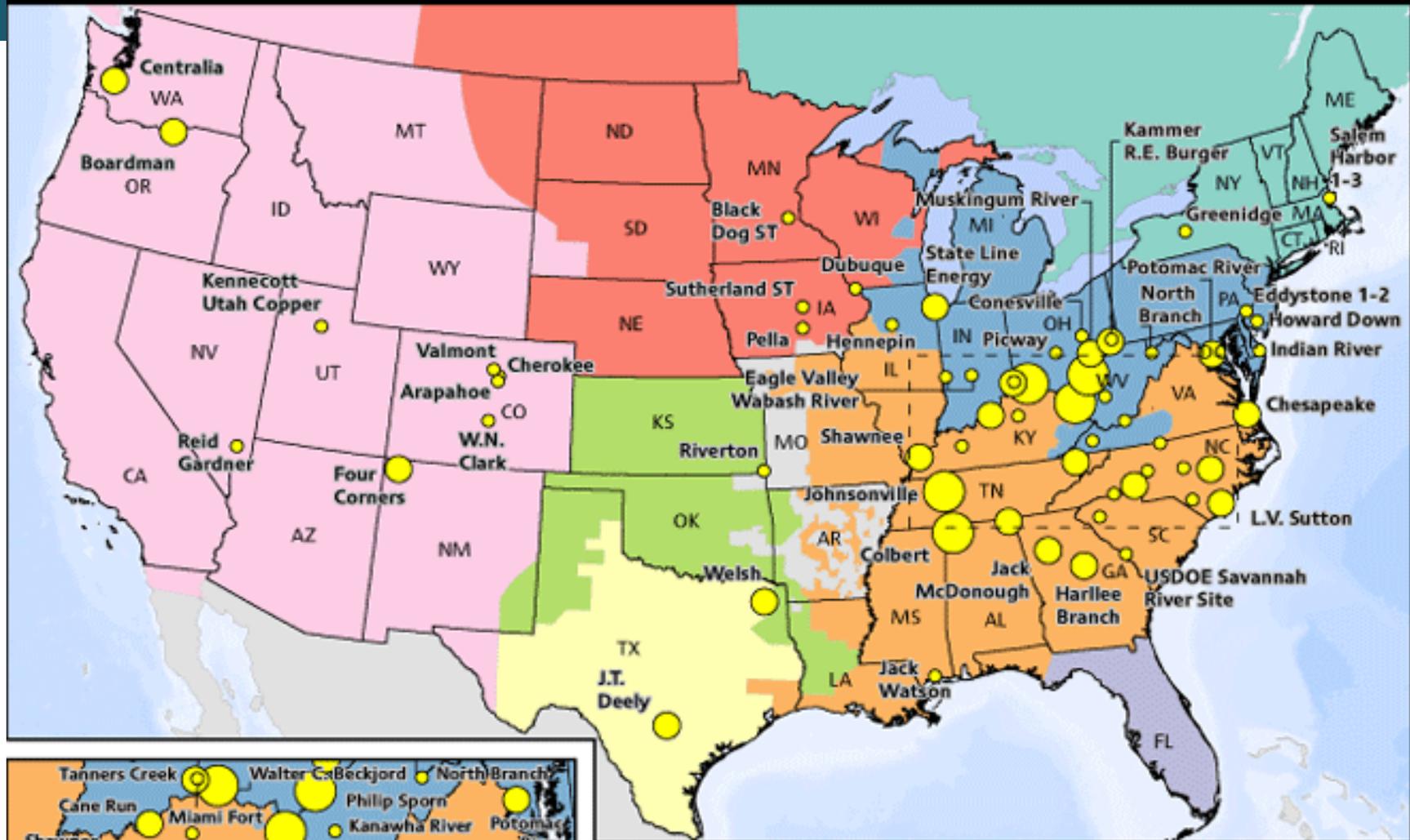


Plants most affected: small, uncontrolled coal units

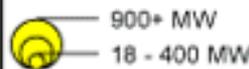


Plants with once-thru cooling (316(b)) (by 2017-2022)

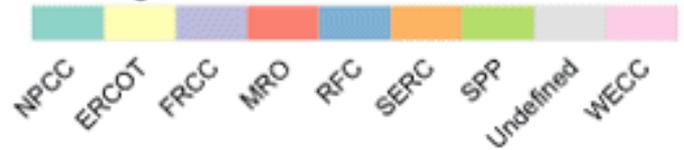
Announced coal plant capacity retirements 2011-2020



Capacity retiring in next 10 years



NERC region



As of Sept. 14, 2011

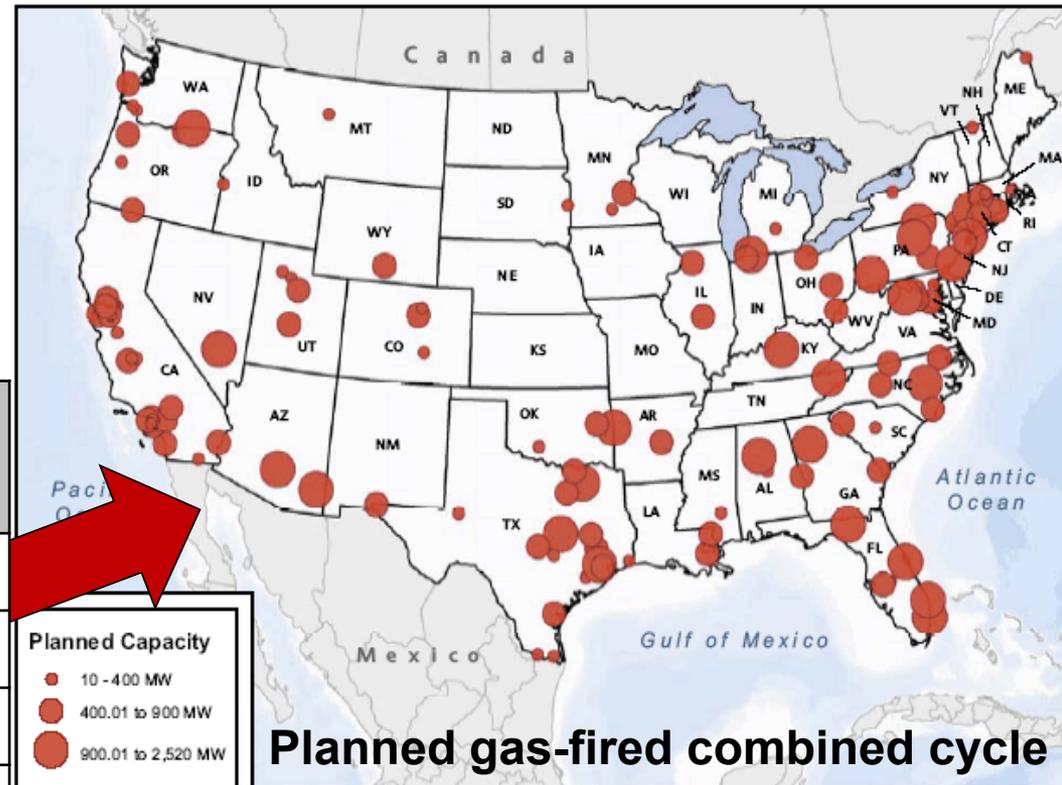
Source: SNL Energy

Map credit: Jesse Bellavance

New gas plants are relatively economical investments

Gas-fired combined cycle and peaking plants are the fuel/ technology of choice for new plants (except renewables)

Planned natural gas combined-cycle projects in the US



Planned gas-fired combined cycle

SNL Energy
(data as of 8-26-2011)

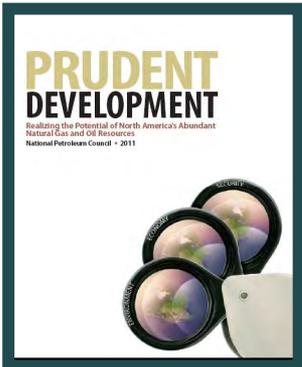
	Under Const. (GW)	Adv'd Dev (GW)	Annc'd (GW)	Total (GW)
2011	2	0	0.2	2.2
2012	5.6	0.6	5.7	11.9
2013	5.2	1.2	4.4	10.7
2014	0.6	4.7	8.6	14.0
2015	0	1.0	9.8	10.8
2016+	0	0	13.8	13.8

Shale Gas:

OPPORTUNITIES AND CHALLENGES

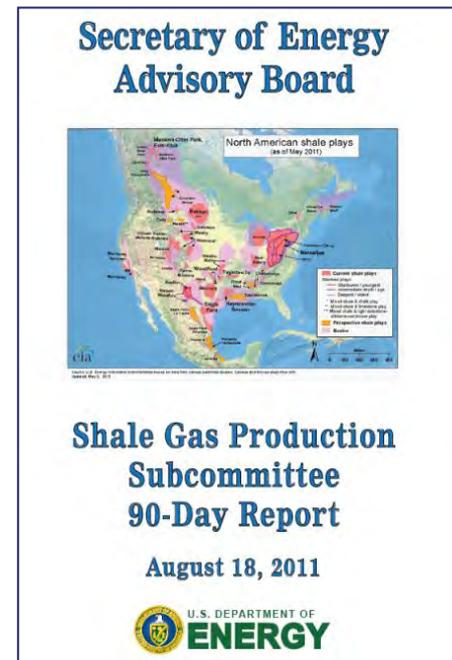
1. Natural Gas is an Abundant Resource

- N. America's natural gas resource base is enormous – with potential benefits to the economy, environment and energy security
- The benefits depend upon access and responsible development practices

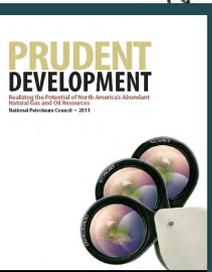
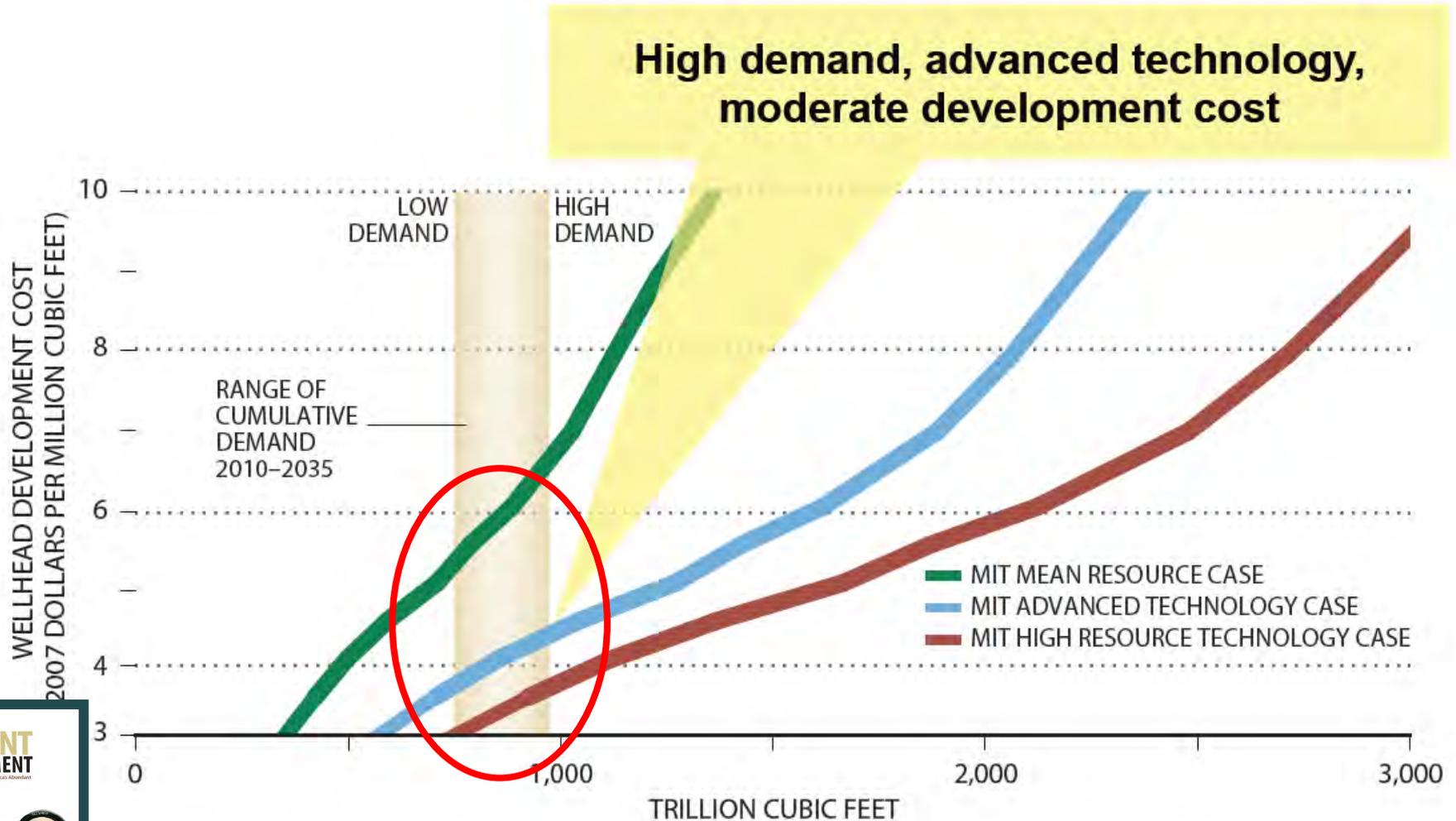


SEAB 90-Day Report – context: Shale gas is game-changing opportunity

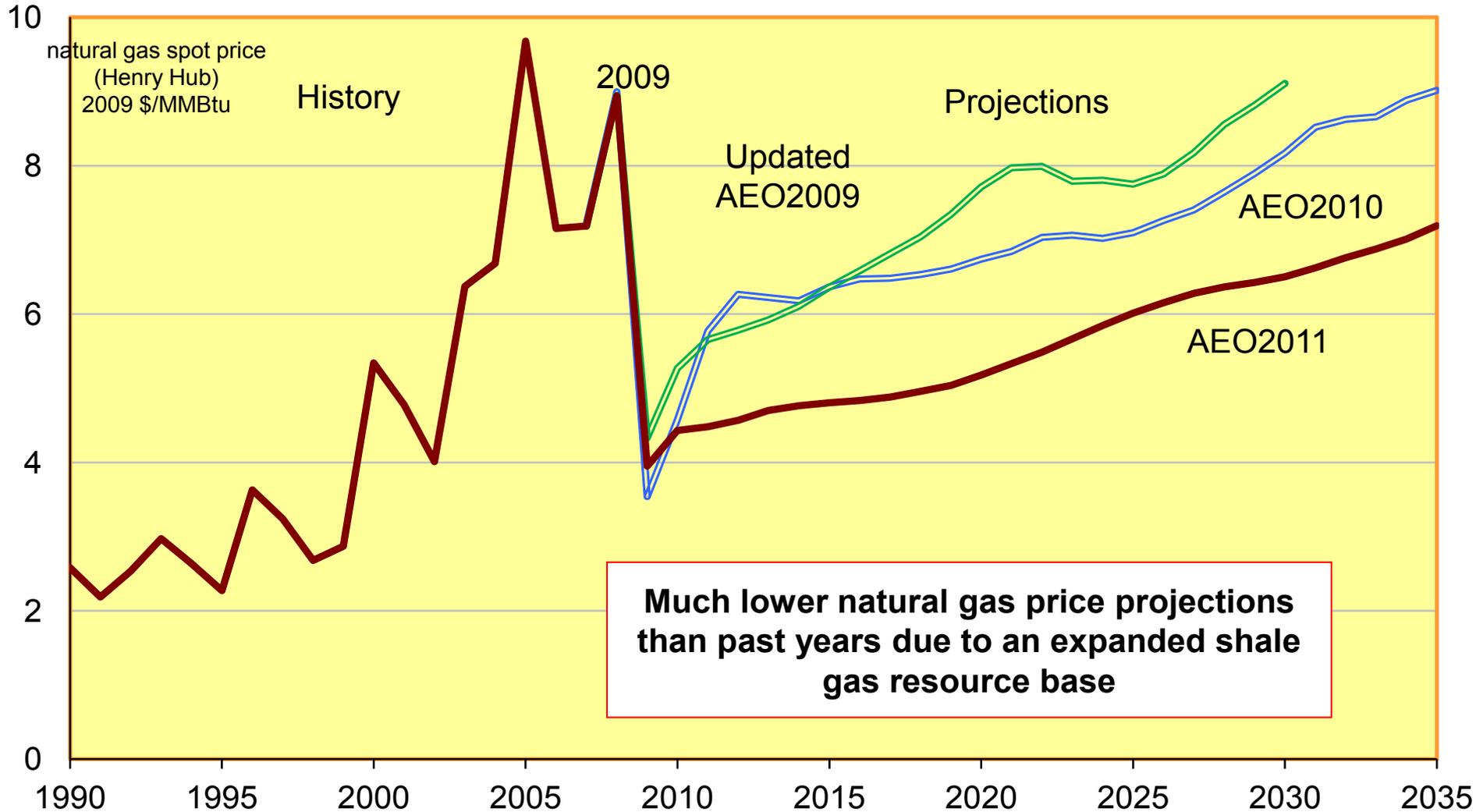
- extremely important to U.S. energy security
- currently accounts for 25% of the total US natural gas production
- has a large positive economic impact on local communities and states
- creates jobs



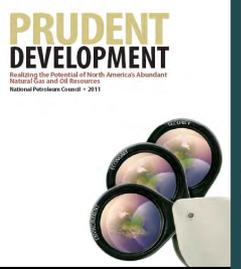
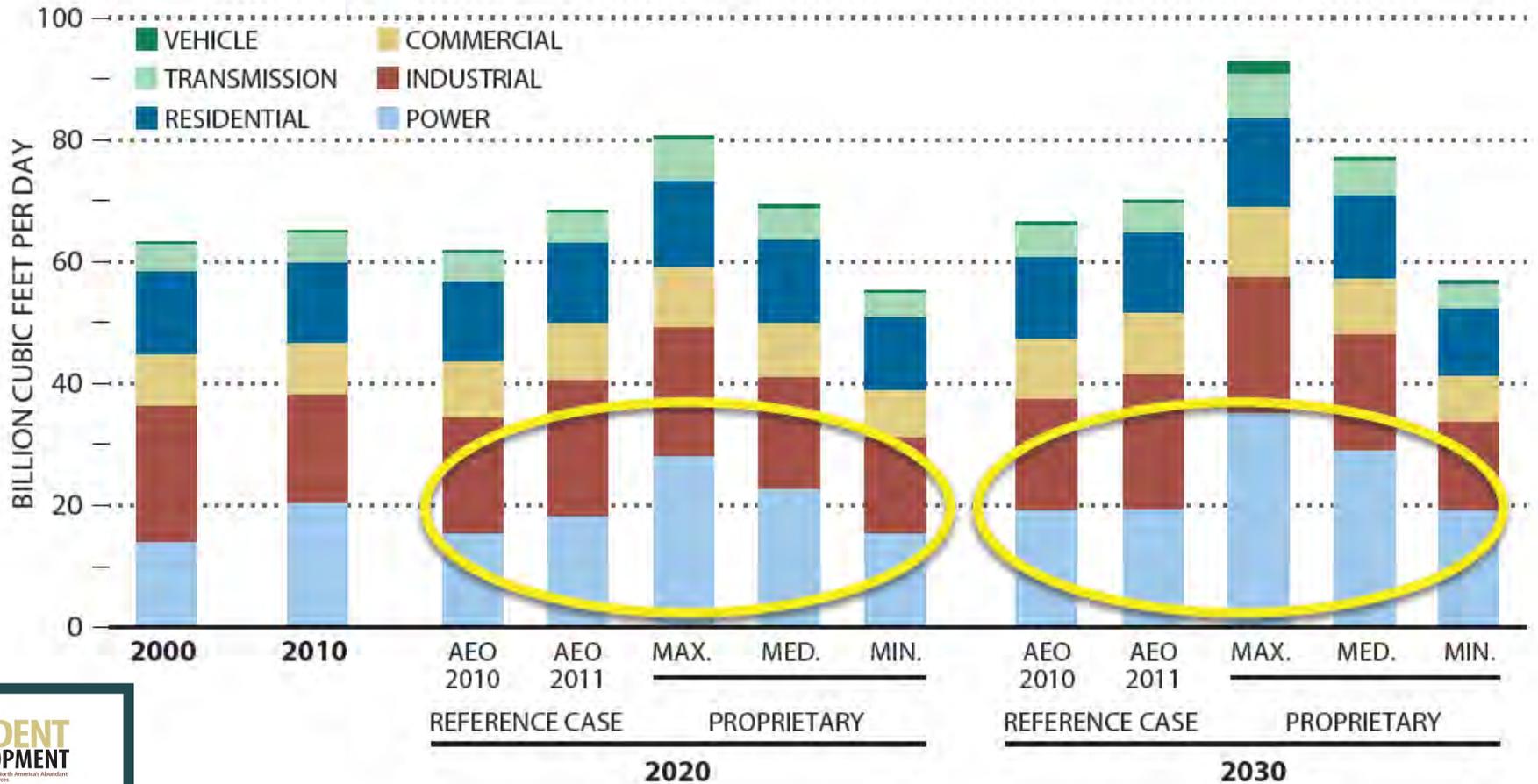
Implications of gas supply/demand scenarios:



Lower outlook for natural gas prices....

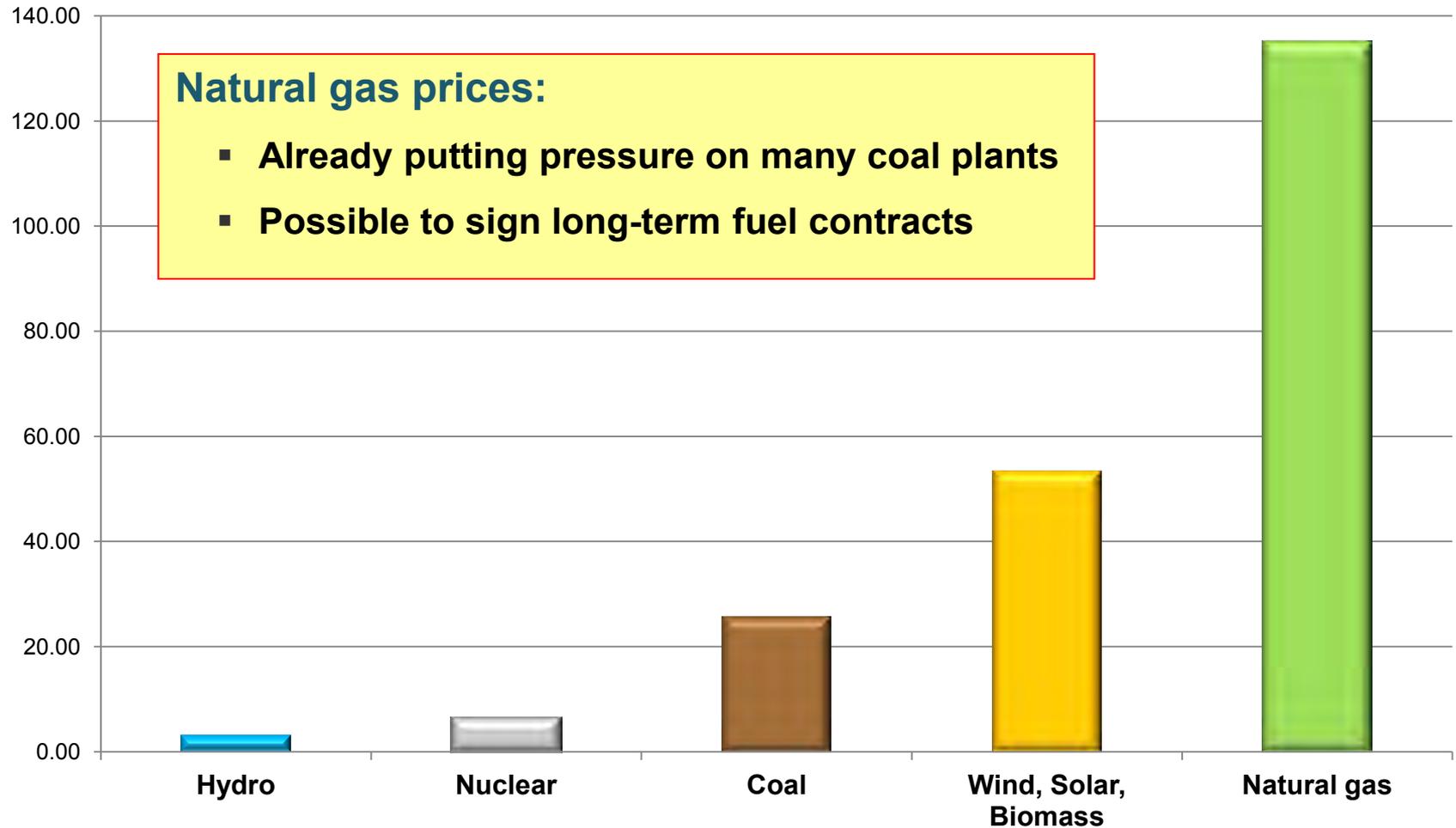


Gas demand outlooks – driven by power sector demand



Markets:

Gas-fired plants are now the fuel/technology of choice



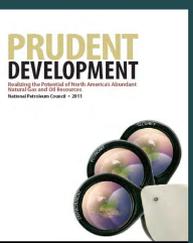
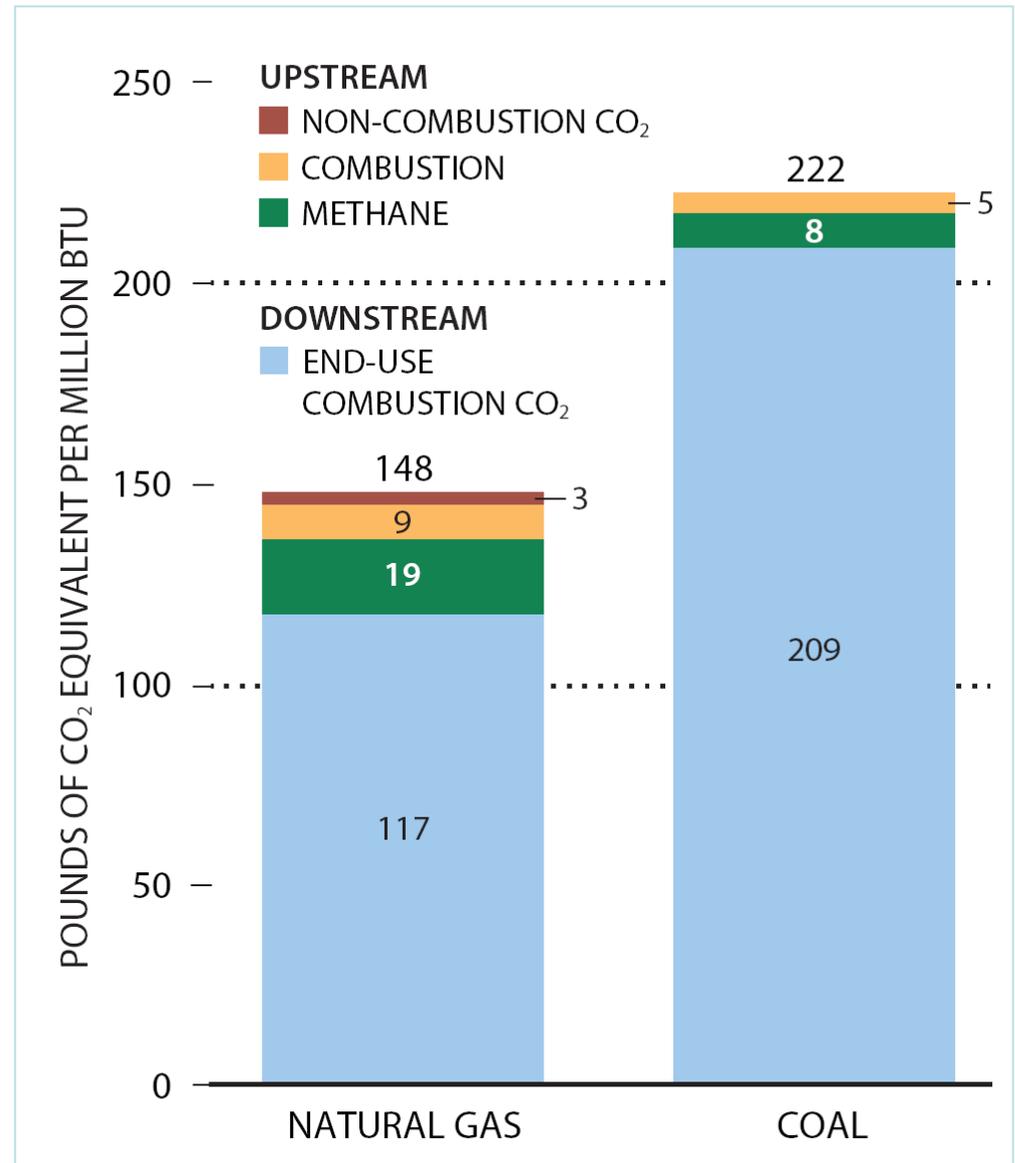
Life cycle emissions

Comparing natural gas and coal – life cycle emissions (on a Btu basis for the fuel):

Includes

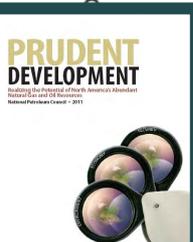
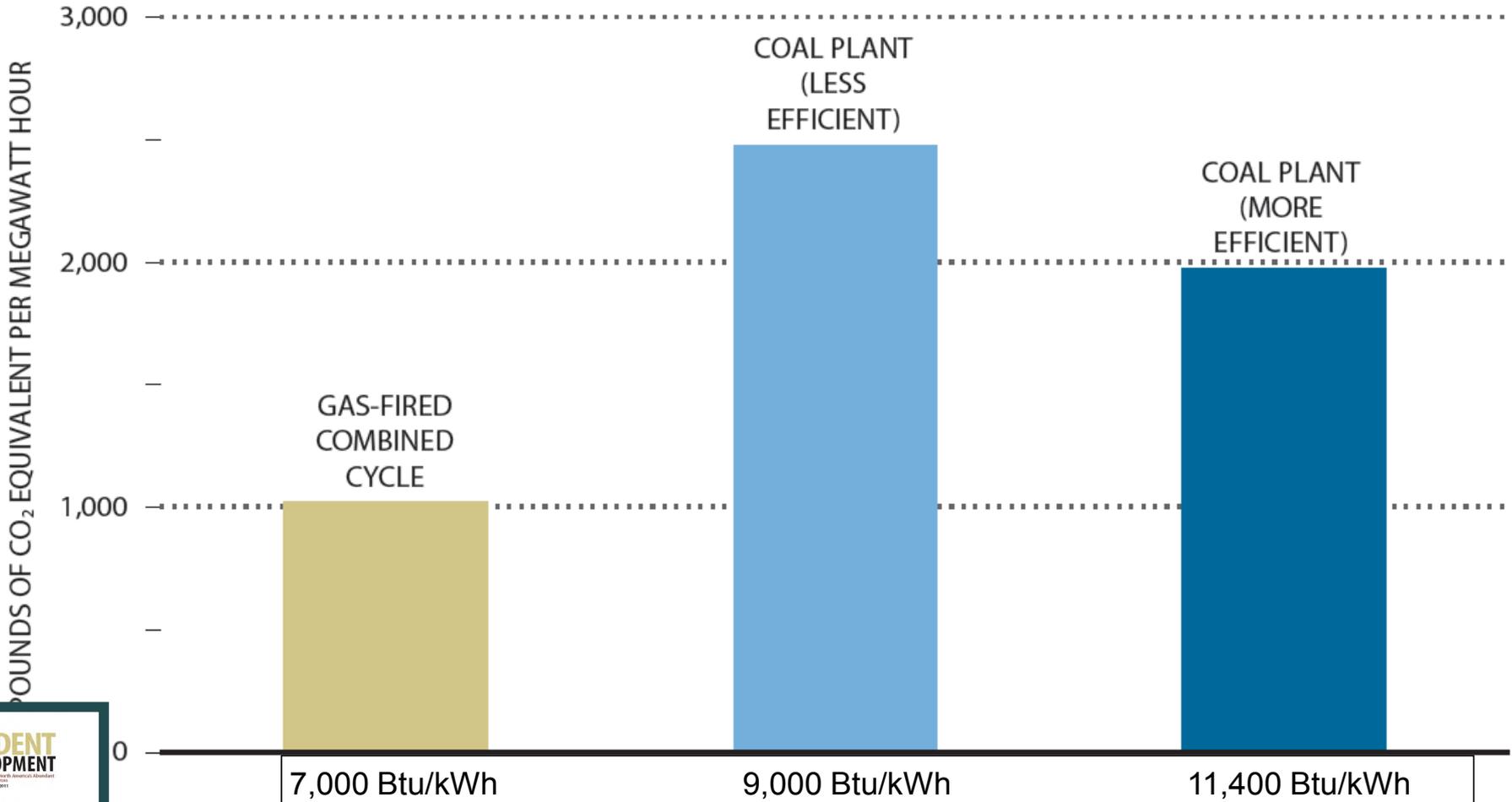
- mining and extraction
- fuel delivery
- combustion

▪ Based on methane’s global warming potential (100 year GWP of 25)*

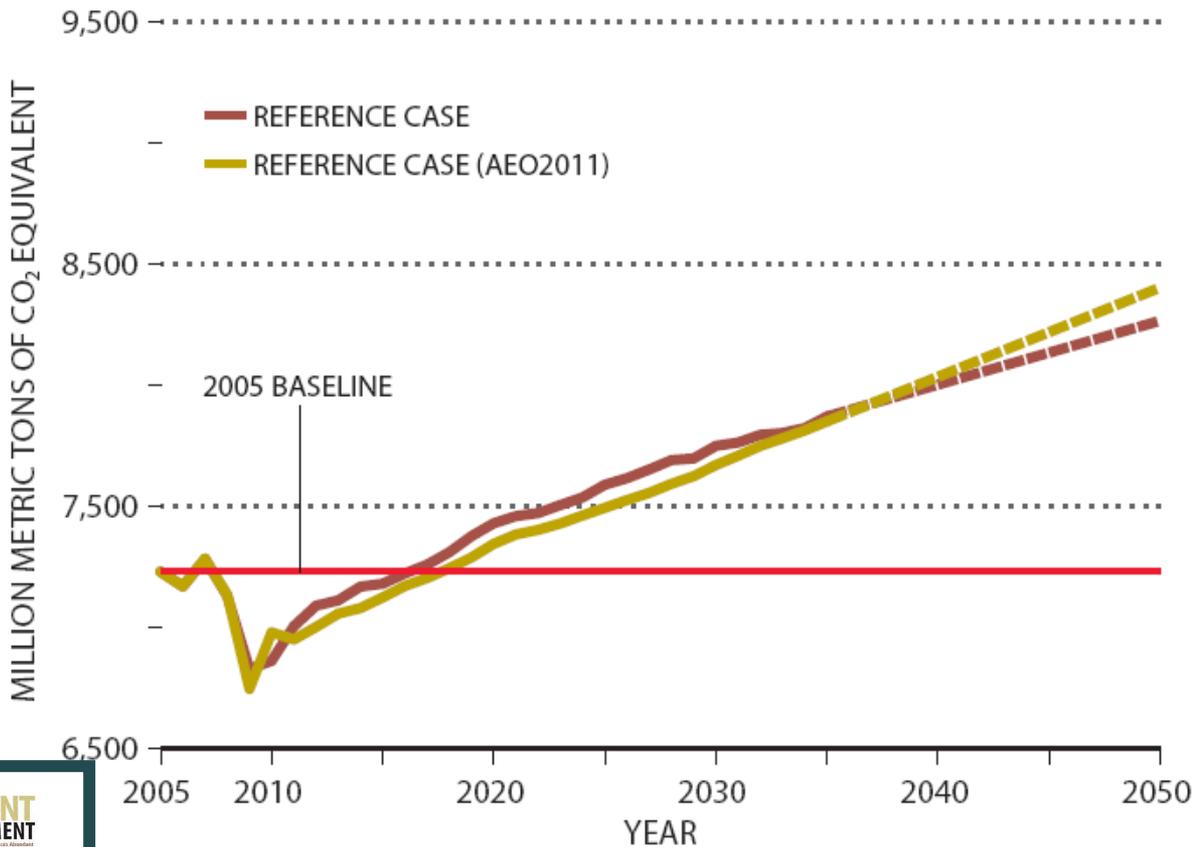


Relative GHG per MWh – natural gas v. coal (Fuel cycles and plant efficiencies combined)

GHG emissions per MWh



GHG emissions are rising – Natural gas can help lower GHG emissions



Reduction Pathways

- Coal displacement
- Natural gas end-use technologies
- EPA non-GHG regulations
- Price on carbon



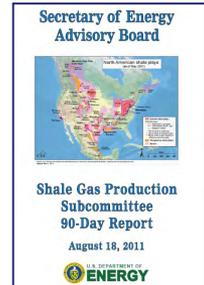
Deep reductions require
CCS or other zero-carbon technologies



Environmental urgency:

Areas of concern:

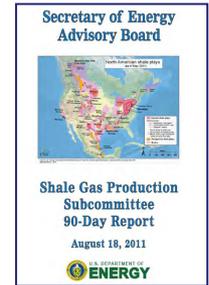
- **Water – possible pollution of drinking water (methane, chemicals), water consumption, disposition/management of flow back water**
- **Air pollution – GHG (methane), ozone precursors**
- **Community disruption during shale gas production**
- **Preservation of unique and/or sensitive areas**
- **Cumulative adverse impacts (traffic, noise, visual, odors, intensity) on communities and ecosystems, wildlife**



Environmental urgency:

Perspective:

- There are serious environmental impacts underlying these concerns
- These impacts need to be prevented, reduced and, where possible, eliminated as soon as possible.
- Absent effective control, public opposition will grow, thus putting continued production at risk.



Natural Gas: Shale Gas

WHAT'S NEEDED

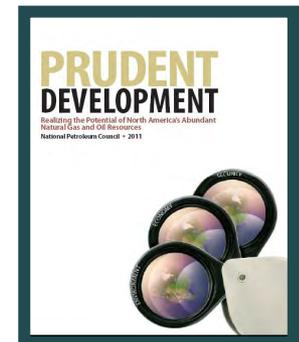
Timely implementation of EPA air regulations

Increased natural gas supplies may yield a market-driven substitution of natural gas for other fuels (mainly coal).

- Gas can help meet emissions targets to 2030
- 50% reduction from a 2005 baseline by 2050 using natural gas

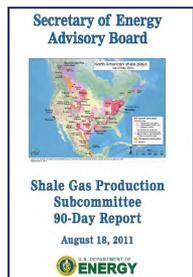
Low natural gas prices – combined with upcoming environmental regulations affecting coal-fired power plants without adequate emission controls – will likely result in the retirement of many coal plants.

- This can be supported by:
 - “Providing regulatory certainty by finalizing the EPA proposed rules for coal-fired power plants”
 - Addressing location-specific implementation hurdles, such as grid reliability.



Recommendations: 90-Day Report of the SEAB Shale Gas Subcommittee (August 11, 2011)

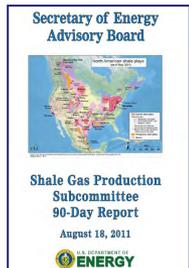
- Better information about shale gas production operations more accessible
- Immediate regulatory actions to reduce env'l and safety risks
- Creation of a shale gas industry organization
- R&D to improve safety and env'l performance



SEAB Recommendations: Regarding information disclosure

- **No economic or technical reason to prevent public disclosure (except genuinely proprietary information)**
 - Base line conditions – pre-drilling
 - Chemical injections
 - Composition of flow back water
 - Disposition of water
 - Air emissions

- **Supported by a portal for access to a wide range of public information**



SEAB Recommendation: Regarding improved regulation (not who, but what...)

Effective and capable regulation

- Adequate regulatory resources – state and federal level
- Technical expertise to issue, inspect, and enforce regulations
- Fees, royalty payments and severance taxes = sources of funding

Benchmarking needed for the efficacy of regulations

- Useful to disclose company performance and enforcement history
- Field studies of emissions (water, air).

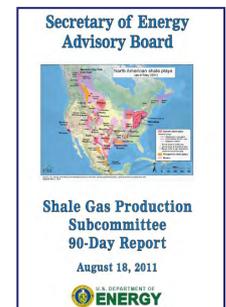
Peer review of state regulatory practices:

- Better participation in STRONGER (more states & issues, more often)
- Industry & government should support expanded *Risk Based Data Management System*.

SEAB Recommendation: Regarding best practices

Creation of a shale gas industry production organization :

- **Dedicated to continuous improvement is needed:**
 - defined as improvements in techniques and methods that rely on measurement and field experience
- **A national approach: including regional mechanisms**
 - Supported by technology peer reviews
 - Reporting on individual companies' performance
 - A compliment to, not a substitute for, strong regulation and effective enforcement.



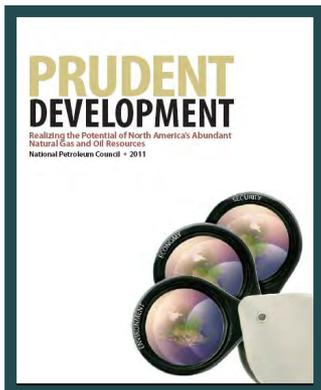
NPC Finding and Recommendations: Regarding best practices

These Benefits Depend Upon Prudent Development

- Development in different areas require different approaches.
- Everywhere, responsible practices are needed.
- Regulators must evolve their own regulatory requirements.
- These steps are necessary for public trust, protection of health, safety and the environmental, and access to resources.



<http://www.ornl.gov/info/news/pulse/no344/story3.shtml>



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