Shale: Opportunities & Challenges

Lecture 16

Unfinished Business: Coal Gas

- Prosper asked last time if coal gas is still being made and used anywhere
- Found no trace, but learned gas is being made from wood in several countries – for vehicles & other uses

Source: http://www.carboconsult.com

Courtesy of CARBO CONSULT & ENGINEERING (Pty) Ltd. Used with permission.

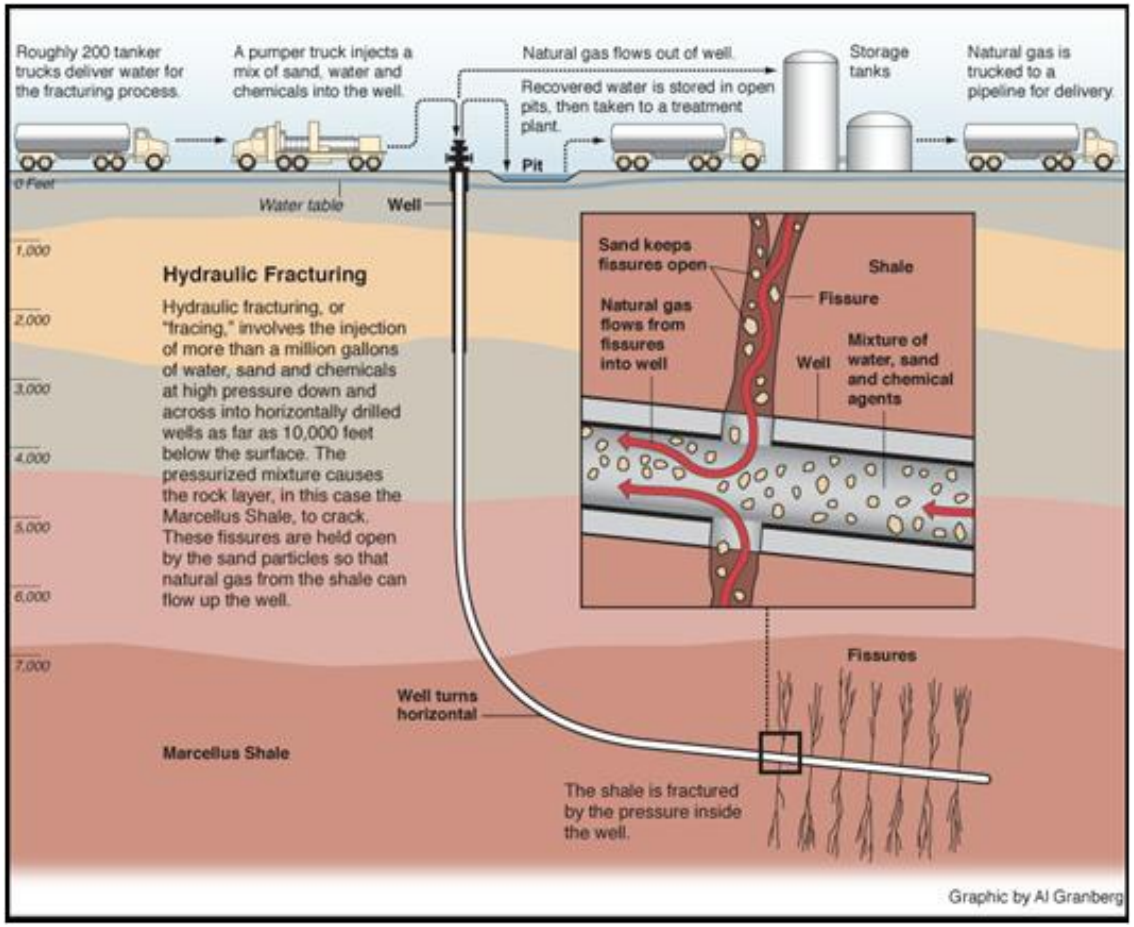
Wood-gas truck in North Korea, from Wikipedia

Photo by Raymond K. Cunningham, Jr. on Wikimedia Commons.

Unfinished Business: CO_2 Emissions

- Sidhanth asked about how fossil fuels compare in terms of CO_2 emissions
- No simple quantitative answer:
  - Emissions per Btu when burned: set natural gas = 100, then gasoline = 133, kerosine 136, fuel oil = 138, coal = 175
  - Emissions per kwh also reflects (EIA average) efficiencies: coal = 33.6%, gas combined cycle = 43.6%, gas turbine = 29.4%
  - What about emissions in fuel production – including methane leakage, engine emissions, etc.? Haven't seen a good study

New Business: Horizontal drilling and "fracking"



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- Developed by <u>small</u> US firms over time (not DOE $$)
- Most fluid is water + sand; rest varies
- Makes it economical to extract gas & oil from shale

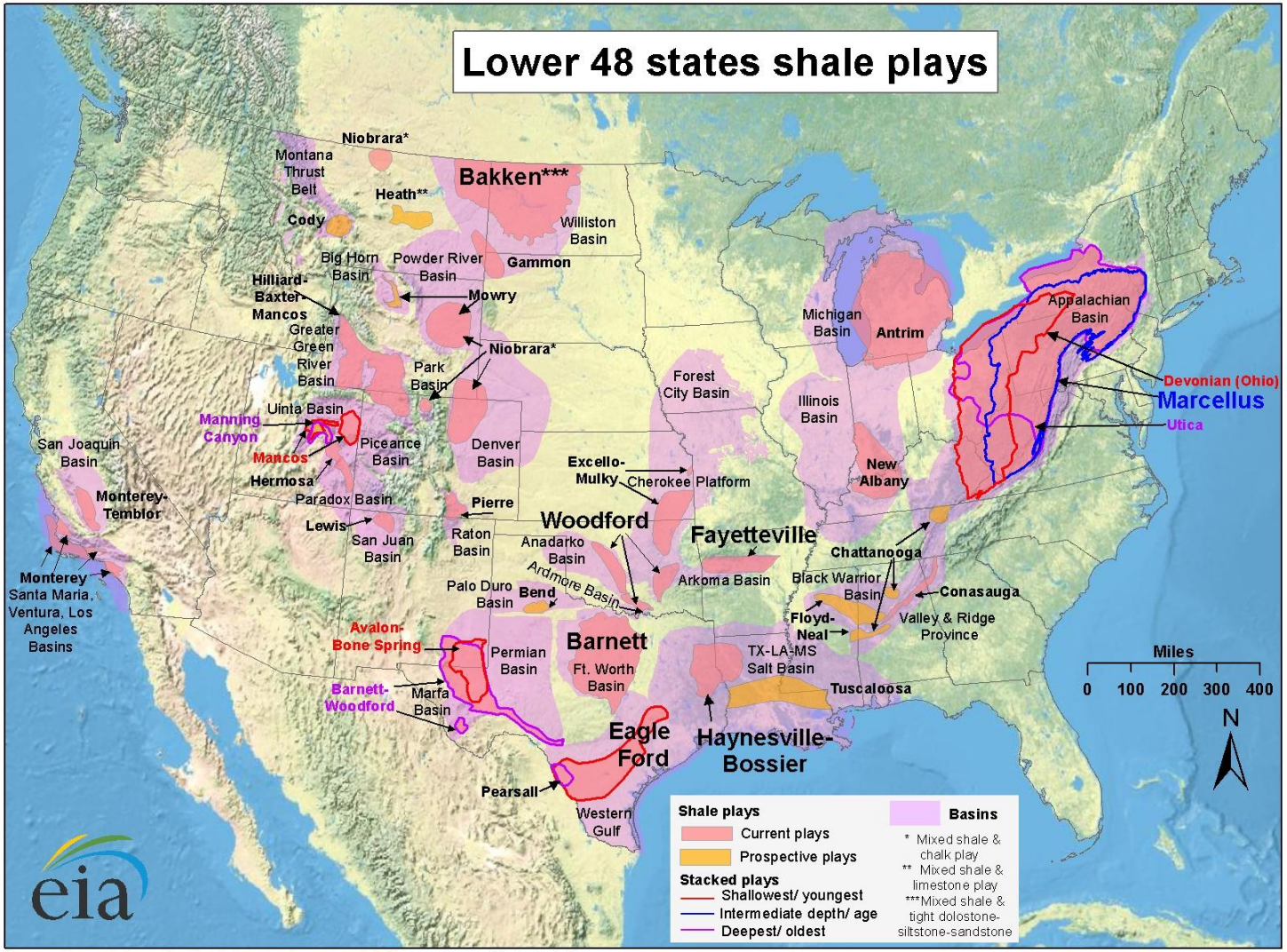
Multiple wells on a pad, waste water pond

Photograph of fracking pad at Marcellus Shale removed due to copyright restrictions.

Early Estimates ⇒ US The Big Winner!

World map of natural gas resources removed due to copyright restrictions.
Source: "World Energy Outlook 2011: Are We Entering A Golden Age of Gas?" *OECD/IEA* 2011.

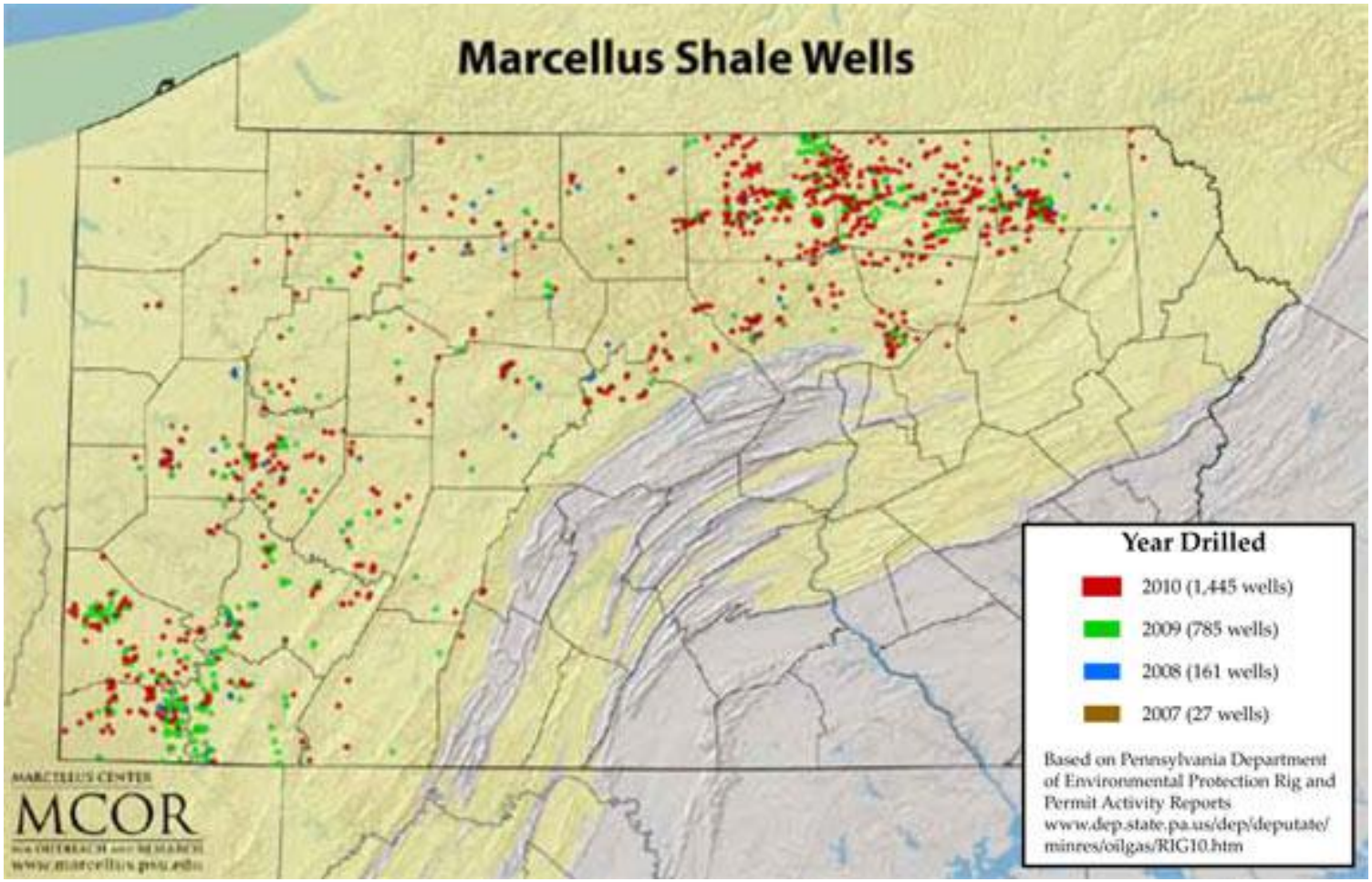
Lots of Shale Gas/Oil, Much Near Demand!



Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

Source: U.S. Energy Information Administration. *Shale Gas Plays.* Washington, DC: Government Printing Office, 2011.

2400 Shale Gas Wells in PA Alone through 2010; 3000 by April 2011



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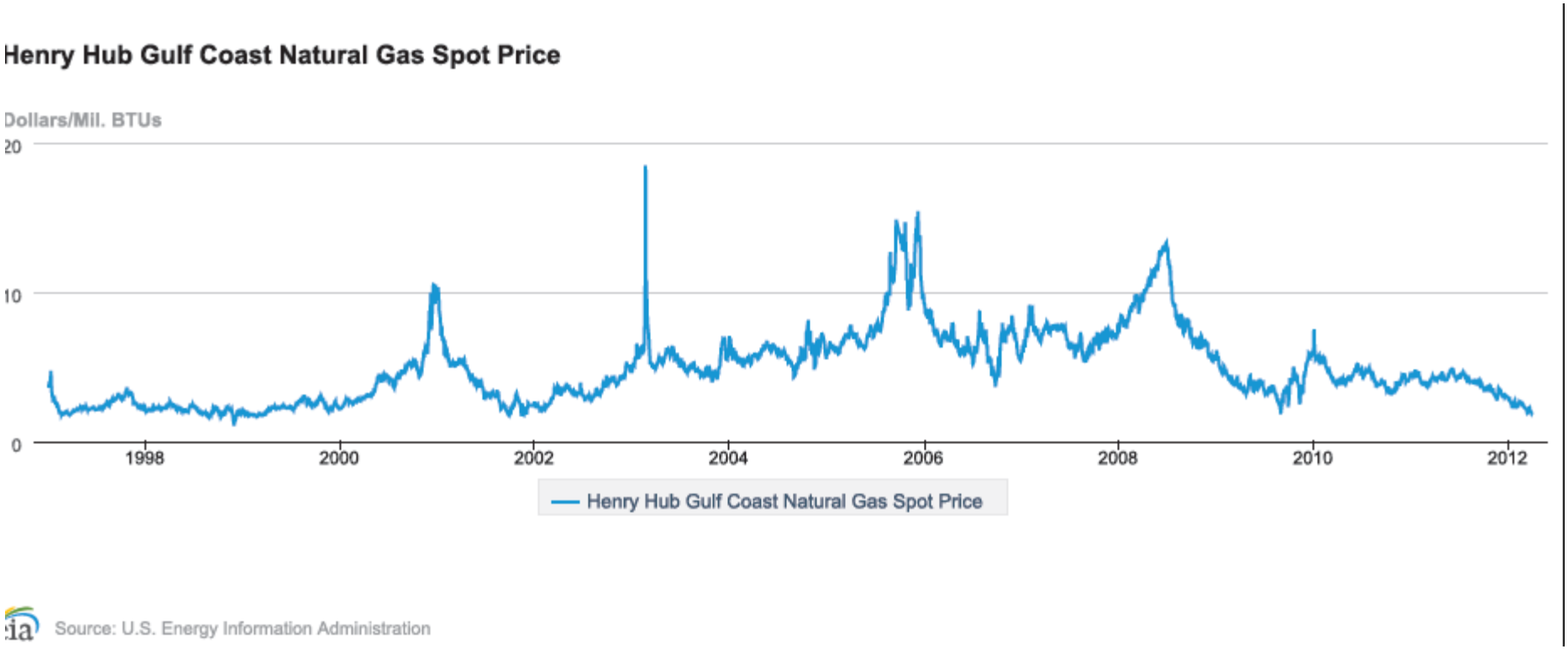
Shale boom has depressed gas prices



Courtesy of Gary Evans. Used with permission.

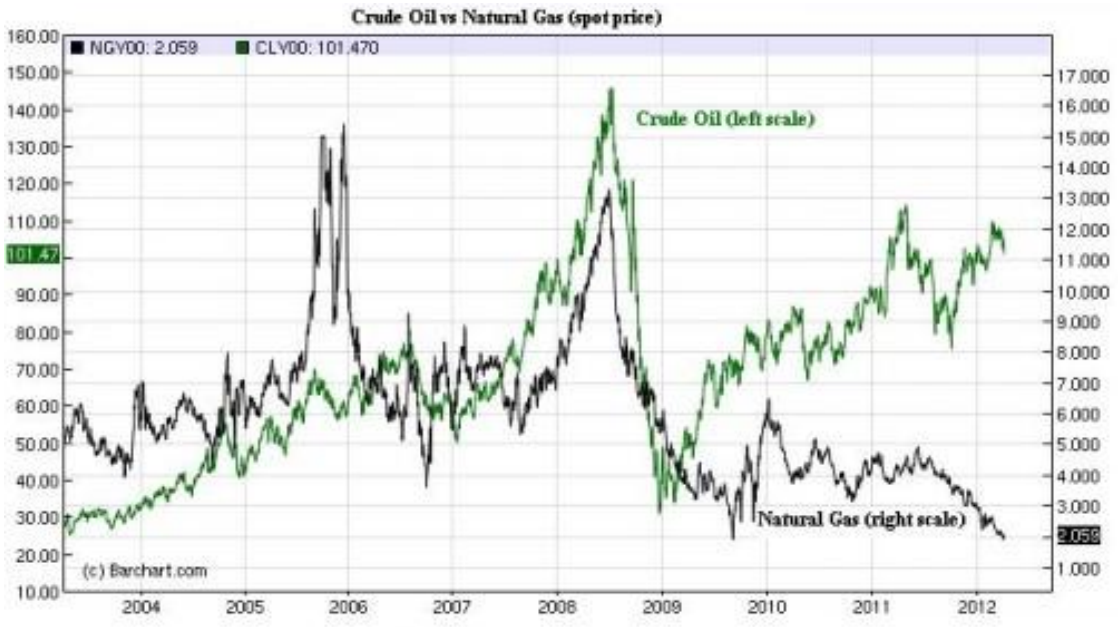
Current $2 price probably not LR viable, but $4-6 probably is…?

Source: U.S. Energy Information Administration. http://www.eia.gov/dnav/ng/hist/rngwhhdd.htm

… and driven gas & oil prices apart

If $/btu the same (despite oil's energy density advantages), $/MBtu(gas) x 5.825 = $/bbl (oil), so

$2/MBtu gas → $11.65/bbl oil



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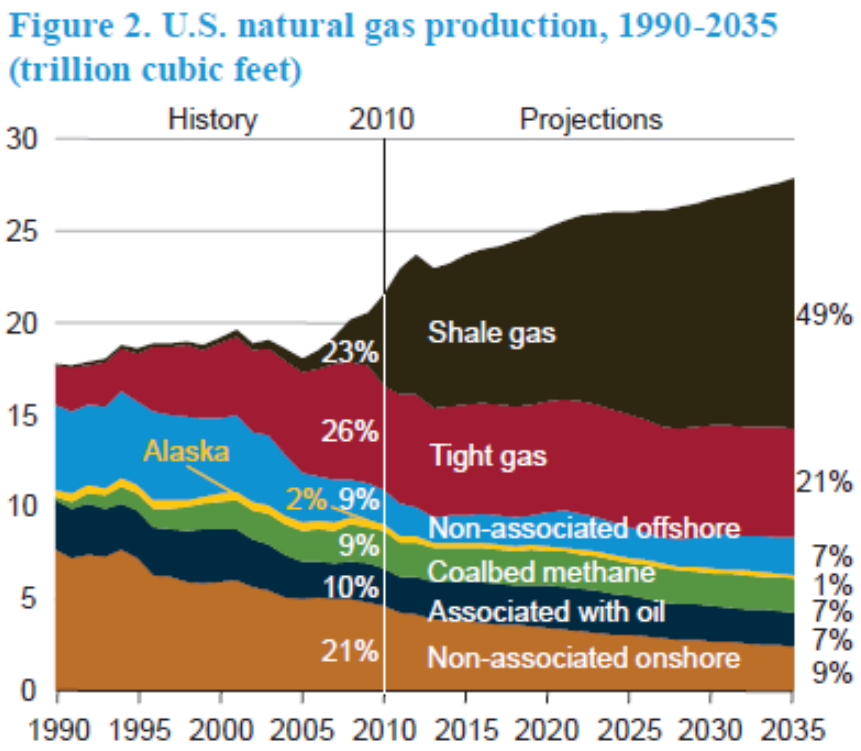
But when gas hit $2 recently, oil was over $100!

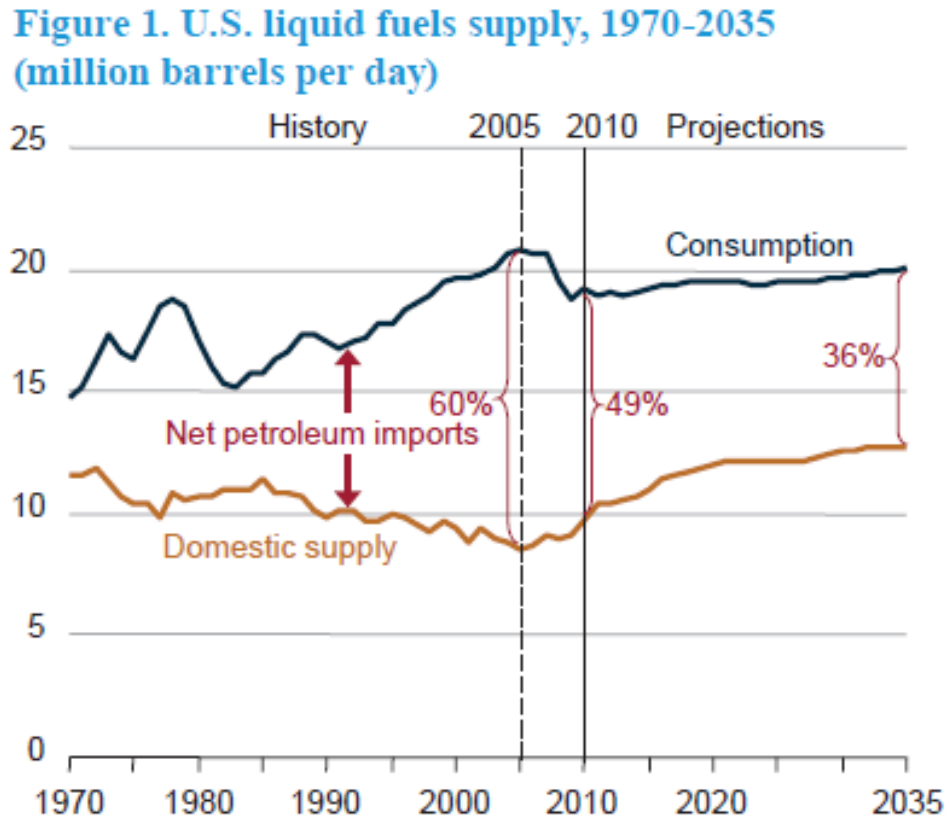
EIA, AEO 2012 Early Release: US a net LNG exporter by 2016, overall net exporter by 2021!



AEO 2011 projected net imports through 2035!

Source: U.S. Energy Information Administration. *Annual Energy Outlook 2012 Early Release*. Washington, DC: Government Printing Office, 2012, p. 1.

Also Increasing Domestic Oil Production

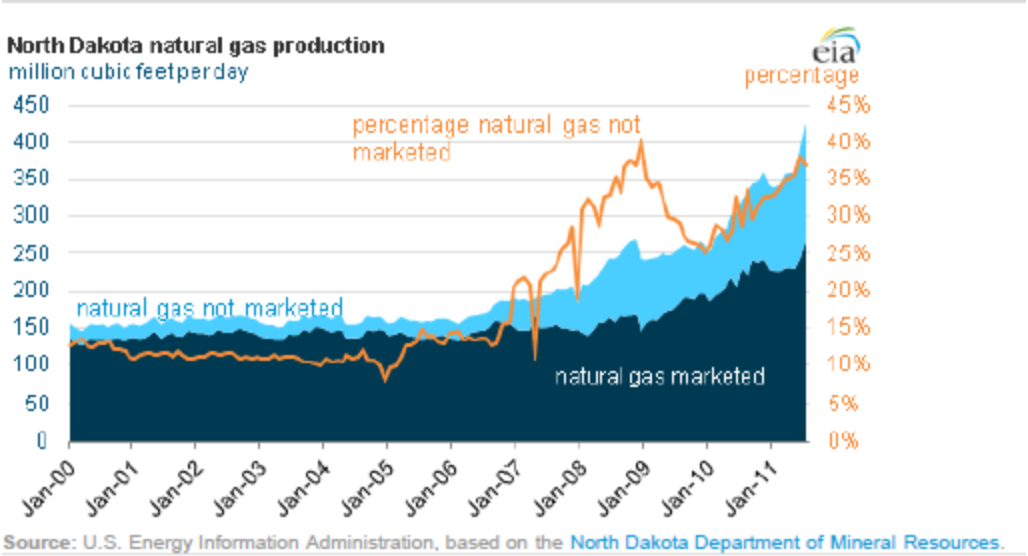


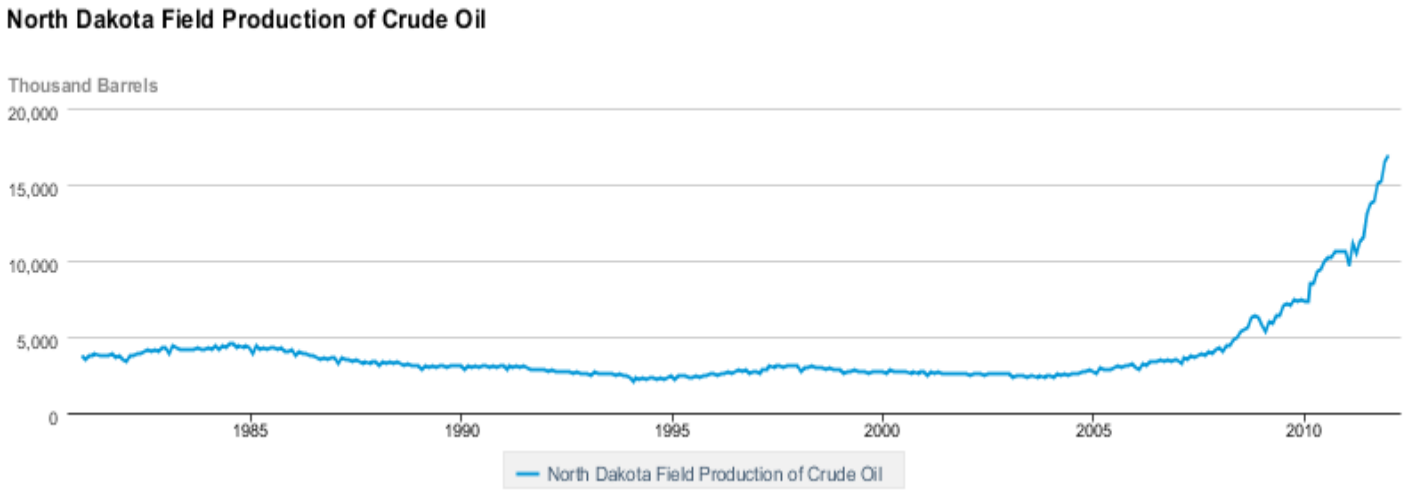
Source: U.S. Energy Information Administration. *Annual Energy Outlook 2012 Early Release*. Washington, DC: Government Printing Office, 2012, p. 1.

Potential Benefits

- Lower heating, electricity costs (Won't move oil price.)
- Reduced gas, oil imports (via use of gas in transportation); improves trade balance, energy security
- US manufacturing rebounding in large part because of low energy & gas (feedstock) prices
- Lower running cost of gas turbines means lower cost of integrating wind & solar in the electric power system
- Money for some landowners, e.g. rural Texas
- And, of course, everybody's favorite…

JOBS!!





In 2009, 2010, and 2011, North Dakota had the lowest unemployment rate in the nation. It is now the #4 oil producing state.

But there are serious environmental issues!

Major Enviro Issues (Penn doc is advocacy)

- Basic: Some fracking fluids contain toxics; waste water has more; wells go through aquifers; methane is toxic, flammable, & a GHG
- Groundwater contamination: well bore leakage & waste water, not leakage from fracking zone
- Local pollution: methane, misc. air toxics, dust, noise, vehicle emissions (PA/NY v. ND/TX)
- Methane leakage has (serious?) climate implications
- Waste water disposal via deep wells can sometimes cause earthquakes (verified in Ohio; led to regs)
- (Jacoby et al): Cheap shale gas may be a “bridge to nowhere” as regards climate if it slows development of very low carbon technologies like renewables & nuclear power that will be needed

The Policy Environment

- EPA can set standards for air emissions, including methane, has rules in process; fracking excluded from Safe Drinking Water, etc. (PennE)
- Enforcement, rules about fluids, well construction, waste water, etc. are in the hands of the states
  - Experience, expertise, attitudes vary widely (NY v. PA v. TX)
  - Several have reviewed regulations; TX, others require fluid disclosure
- Small producers want to keep fluids secret, generally oppose regulation
- Large producers fear backlash, think (per Jacoby) that enviro protection is cheap; push best practices, favor sane regulation
- Many enviros: states weak, enforcement too hard, kill it – NY, French, Westphalian moratoria; debated elsewhere
- PennEnvironment: eliminate federal exemptions, tighten PA regulation, increase enforcement resources
- EDF (Krupp): Feds can't legislate (sensibly), shouldn't (or can't?) kill, must work with states

Suppose Massachusetts had shale; What Should We Do?

(How would you get the votes?)

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