THE MYTH OF 100 YEARS OF GAS SUPPLY

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Fig. 1. Natural Gas Production by Type in the Contiguous U.S., 1960-2006

Sources: Nehring Associates, EIA
Fig. 2. Natural Gas Production by Type in the Contiguous U.S., 1960-2012

Sources: Nehring Associates, EIA
THE PROMISE

• New technologies have proved their potential

• Increasing production occurring despite plummeting prices

• Therefore [trumpet flourish]: 100 years or more of gas supply

• Cornucopia of benefits
THE REALITY

• Geologic constraints – majority of new gas areas are low productivity

• Costs count – recent production increases limited to a few low cost areas

• Low cost areas are geographically limited

• The promise of a 100 years of gas supply is thus a classic overpromote – a myth (in the pejorative sense)
Intellectual Foundations: The Resource Pyramid

Conventional

Unconventional

Source: Steve Holditch, SPE
The U.S. Gas Resource Pyramid
View 1) Reservoir Rock Volume (12:1 Ratio)
The U.S. Gas Resource Pyramid

View 2) Porous Reservoir Rock Volume
(3:1 Ratio)

Conventional

Unconventional
The U.S. Gas Resource Pyramid

View 3) Recoverable Gas (1:1 Ratio)
HOW MUCH GAS DO WE NEED TO PROVIDE 100 YEARS OF SUPPLY?

- 2500 – 3000 trillion cubic feet (TCF)
- 26.2 TCF (2013 U.S. consumption)
- 2-2.5 X 1200 TCF (US cumulative gas production thru 2013)
- 4-5X 604 TCF (US gas production, 1980-2012)
MASSIVE GAS RESOURCES REQUIRE MASSIVE GAS PLAYS

- Monster Mega (400+ TCF) 1 600 TCF
- Super Mega (100-400 TCF) 3 750
- Large Mega (60-100 TCF) 5 400
- Small Mega (30-60 TCF) 10 450
- Large Major (15-30 TCF) 15 300
- Small Major (3-15 TCF) 20 200
- Total – 2700 TCF (54 plays)
U.S. MASSIVE GAS PLAY POTENTIAL

- Monster Mega (400+ TCF) 0 0 TCF
- Super Mega (100-400 TCF) 1 250
- Large Mega (60-100 TCF) 0 0
- Small Mega (30-60 TCF) 4 180
- Large Major (15-30 TCF) 6 120
- Small Major (3-15 TCF) 15-20 150-200
- Total: 700-750 TCF (26-31 plays)
GEOLOGIC LIMITS ON TECHNOLOGY

- Low porosity (low density)
- Low Total Organic Carbon (TOC)
- Immature or overmature
- High ductility (shales)
- Low pressure (CBM)
KEY LESSONS LEARNED

• Variability within plays and the ability to map, explain, and predict this variability

• Salience of well density and completion practices

• Importance of cost of production
  – Supply curve instead of technically recoverable resources

• Development of assessment methods that incorporate these lessons


**SHALE GAS**

- Largest of new resources (includes tight oil)
- Not enough mega plays
  - Marcellus: only super mega play
  - Only four other mega plays: Barnett, Eagleford, Haynesville, and Utica
- Only a few other major plays
- Cumulative (thru 2012): 67 TCF
- Ultimate potential: 460-760 TCF
TIGHT SANDSTONES/CARBONATES

- Mostly major plays – at least 24
  - Only two (barely) possible mega plays
- Leading source of unconventional production thru 2010
- Mostly mature – majority of plays developed and peaked between 1995 and 2005
- Cumulative (thru 2012): 140 TCF
- Ultimate Potential: 270-340 TCF
COALBED METHANE

- Most disappointing unconventional resource
- Only one mega play (Fruitland CBM)
- Four small major plays
- Most remaining potential is high cost
- Cumulative (thru 2012): 31 TCF
- Ultimate Potential: 56-70 TCF
TRANSITIONAL RESOURCES

- Limited – major geological constraints
  - Deepwater – low thermal gradient
  - Deep/Ultra Deep - poor reservoir quality and thermal destruction
- All have peaked (Deep in 1970s!)
- Cumulative (thru 2012): 55 TCF
- Ultimate Potential: 77-100 TCF
CONVENTIONAL RESOURCES

• Great resource, but highly mature

• Few sizeable discoveries in the past 25 years

• Cumulative (thru 2012): 882 TCF

• Ultimate Potential: 975-1050 TCF
REMAINING US GAS RESOURCES
BY BROAD TYPE

- Conventional 93-168 TCF
- Transitional 22-45 TCF
- Unconventional 549-926 TCF
- Total 664-1139 TCF

(27-46 years @ 25 TCF/year)
IMPLICATIONS: PRODUCTION AND PRICES

• Production likely to plateau by 2020
• Production greater than 25 TCF/year likely to be maintained only to 2025-2040
• Low cost (<$4/Mcf) resources will be largely developed by 2020; gas development from 2020 to 2030 will need $5-8/Mcf prices
• Because post-2020 wells will have lower productivity, maintaining production will require more rigs drilling for natural gas
IMPLICATIONS: DEMAND

• Expanding markets for natural gas is an idea whose time has gone
• Increasing use for transportation would require displacing traditional uses
• Gas supply insufficient and too expensive to displace coal and nuclear for generation
• Other than pipeline exports to eastern Canada and Mexico, exports (specifically LNG) are not good for domestic consumers
CONCLUSIONS

• Expanded domestic gas resources are not a game-changer; they only provide us with a long extra-period

• A natural gas economy for the United States is not a possibility if it is to be based primarily on domestic gas resources