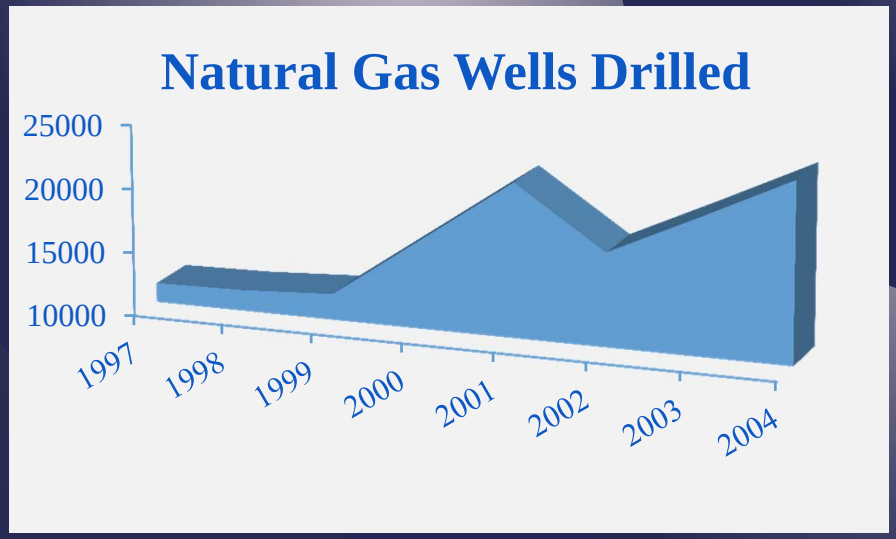
Shale Gas, Shale Oil
–
A Paradigm Shift

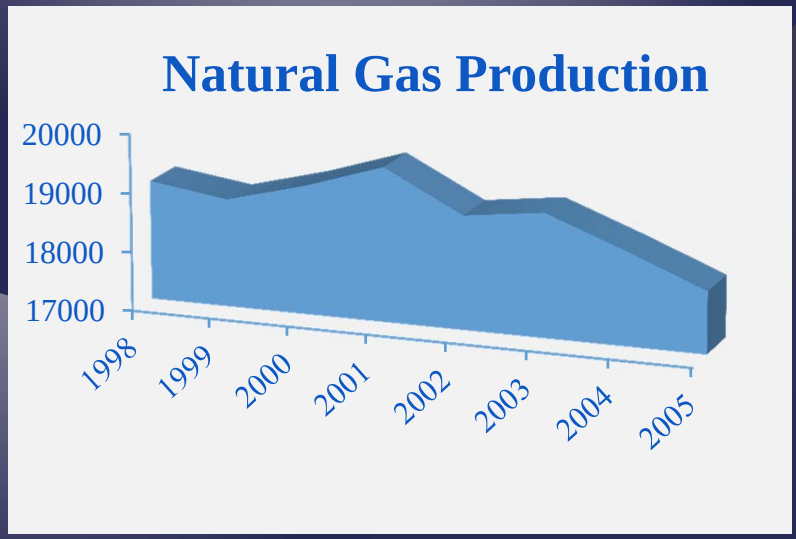
- Lee O. Fuller

- Farm Foundation, January 9, 2014

Beginning The Shale Revolution

- American Oil and Natural Gas were declining
  - Oil development had slowed; focus was on Alaska and offshore
  - Significant natural gas drilling activity in late 1990s and early 2000s had failed to generate much expansion





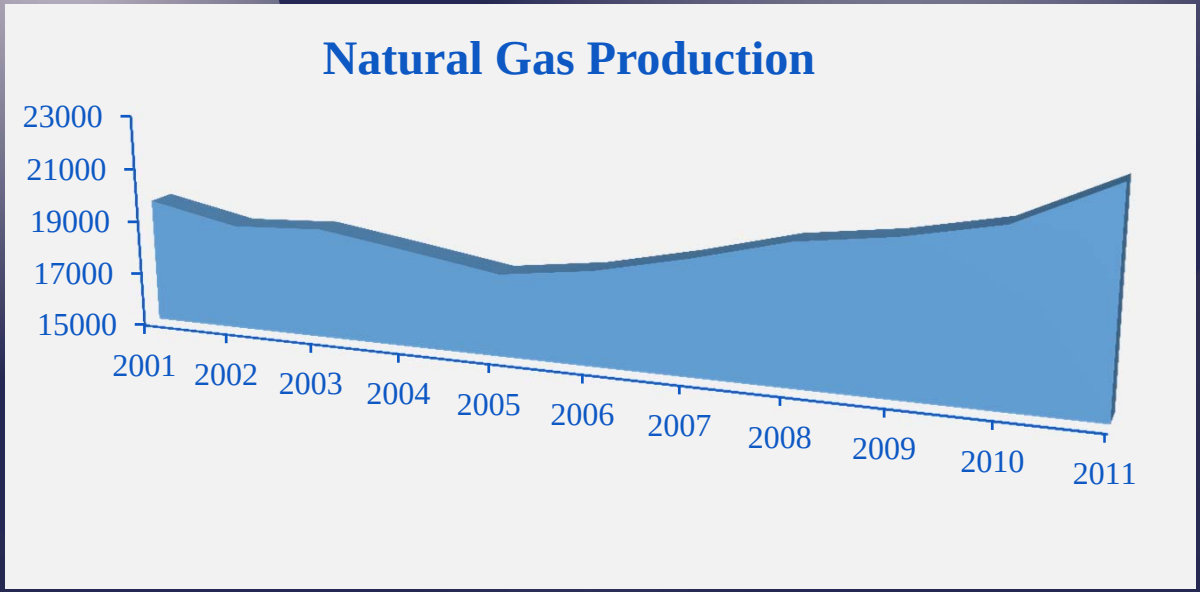
Beginning The Shale Revolution

- Imports would grow
  - Oil imports had exceeded 50 percent continued to trend upward
  - Natural gas hinged on LNG imports

- Barnett Shale starts the change
  - Horizontal drilling and hydraulic fracturing are effectively combined to open shale to economic development

Convincing The Doubters

- Initial natural gas production increases fail to convince analysts of sustainability
- Shale oil production begins but impact unclear
- Continuing successes and additional fields becoming productive demonstrate that shale resources are sustainable



Recognizing The Benefits

- American natural gas production reaches new highs; reserve estimates show capacity to meet future demand for 100 years

- American oil production moves toward levels not seen since 1992
  - Import dependency falls
  - Production expected to increase until 2019

A Positive Future

- American natural gas production benefits
  - Expanded use for electricity generation
  - Driving expansion of industrial production including chemicals and fertilizer
  - Opens opportunity for LNG exports to benefit trade balances
- American oil production benefits
  - Reduced imports shift international politics
  - Shale oil light, sweet crudes offer both domestic and international opportunities

Challenges

- Environmentalist fossil fuel opposition

Challenges

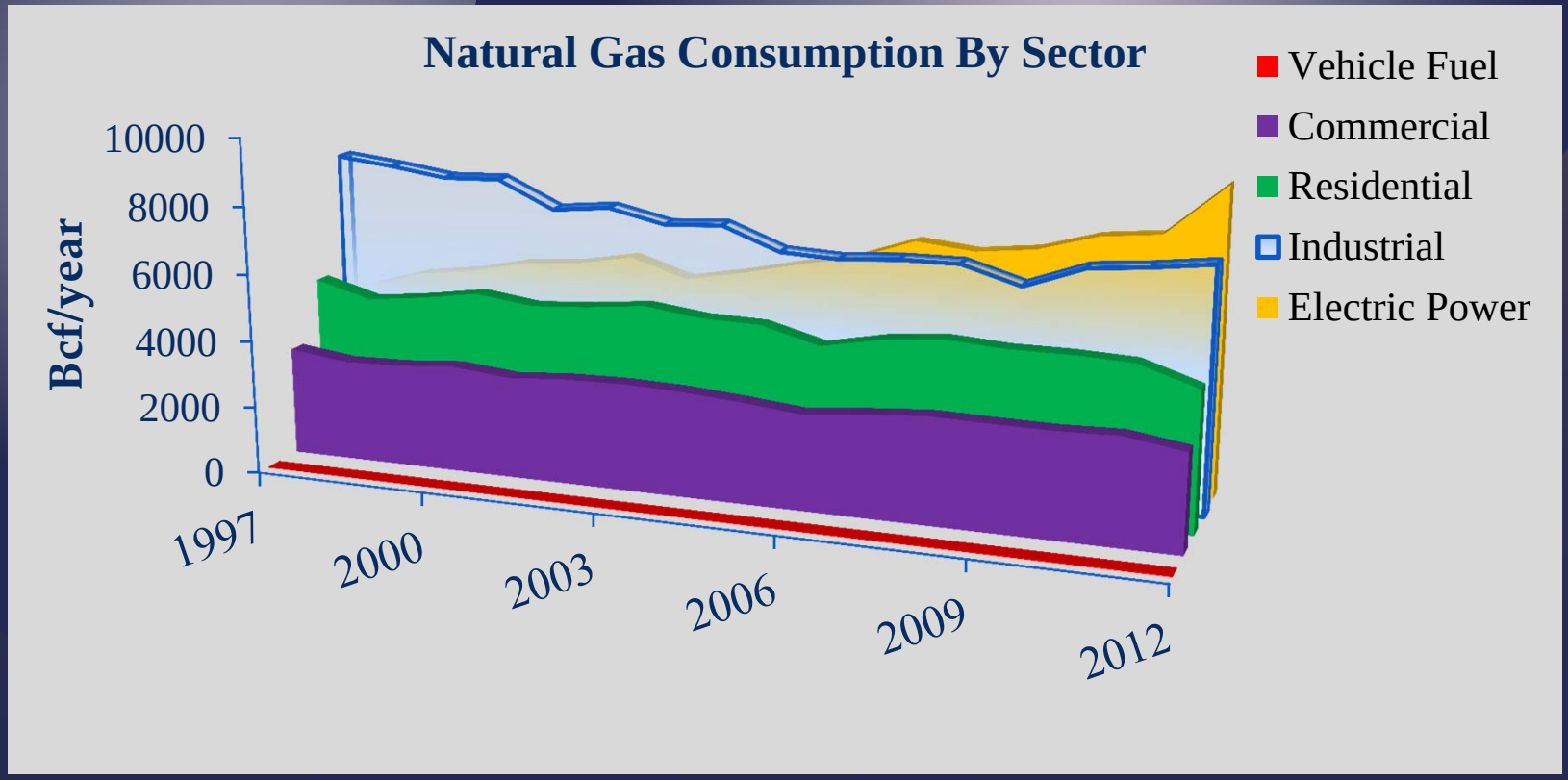
- Excessive regulation – Environmentalists targeting federal, state and local regulations, including bans
  - Drilling and Fracturing
    - Federal regulations focusing on BLM, use of diesel fuel
    - States drawing attention – California, Illinois, NY
    - Local ban initiatives – Colorado
  - Water management
    - Federal focus on discharges under the Clean Water Act, waterborne transportation
    - States looking at UIC management (including induced seismicity) and water use
  - Air emissions
    - Methane emissions drawing federal and state attention
      - Federal NSPS focused on new natural gas wells; environmentalists want oil and existing facilities covered
      - States developing regulatory frameworks for both new and existing sources

Challenges

- Technical challenges
  - Managing water
    - Fracturing water use continues to draw attention although it is small compared to other demands
    - Produced water management drawing new attention
      - Discharge prohibited under the Clean Water Act
      - Primarily managed under UIC but increasing volumes drawing attention
      - Substantial growth in reuse of water but salt content and costs can limit applicability
  - Expanding recovery of resources
    - Even with fracturing significant amounts of oil and natural gas will remain in the ground and the industry will be challenged to recover these volumes in the future

Challenges

- Markets
  - Developing domestic markets



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