Energy, Climate Change and the Natural Gas Bridge

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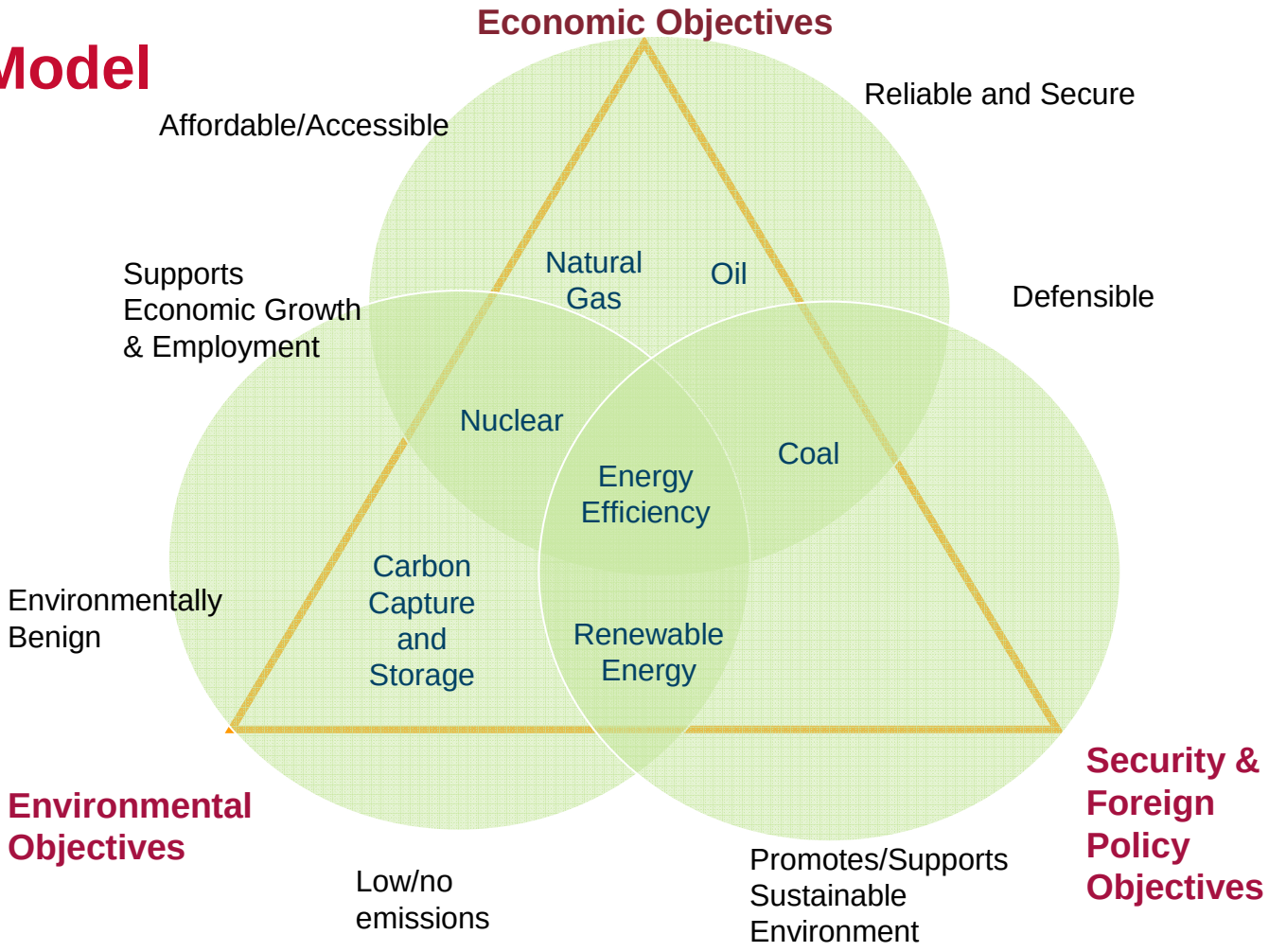
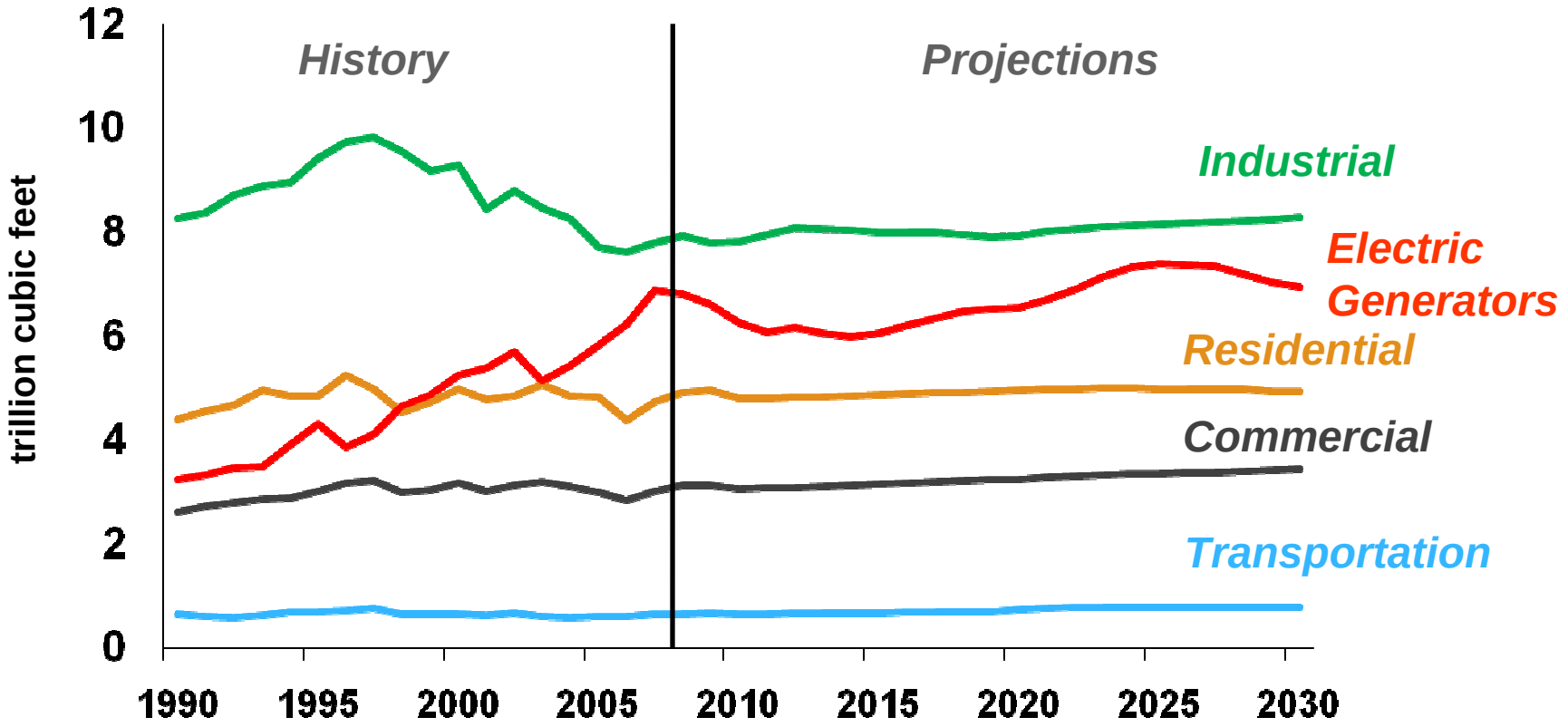
Policy Model



Why is Natural Gas so Special?

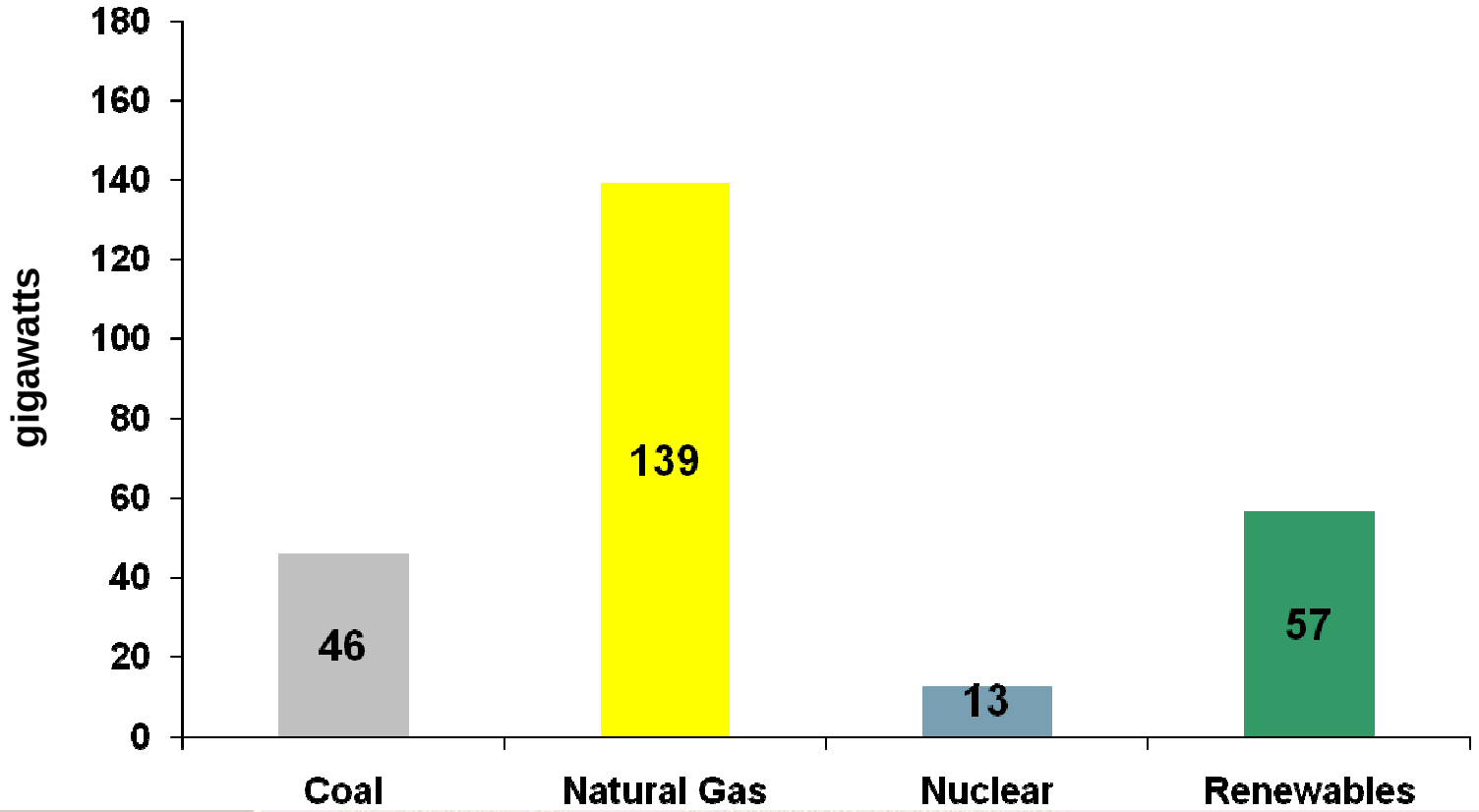
- Readily available in significant quantities
- Reliable
- Transportable
- Storable/flexible (peak, baseload, balance)
- Domestic
- Environmentally more beneficial than some other alternatives
- Has multiple uses

Natural gas demand is projected to increase across all U.S. sectors



Source: EIA Annual Energy Outlook 2009

Natural gas and renewables provide most of the new U.S. generating capacity added between 2007 and 2030

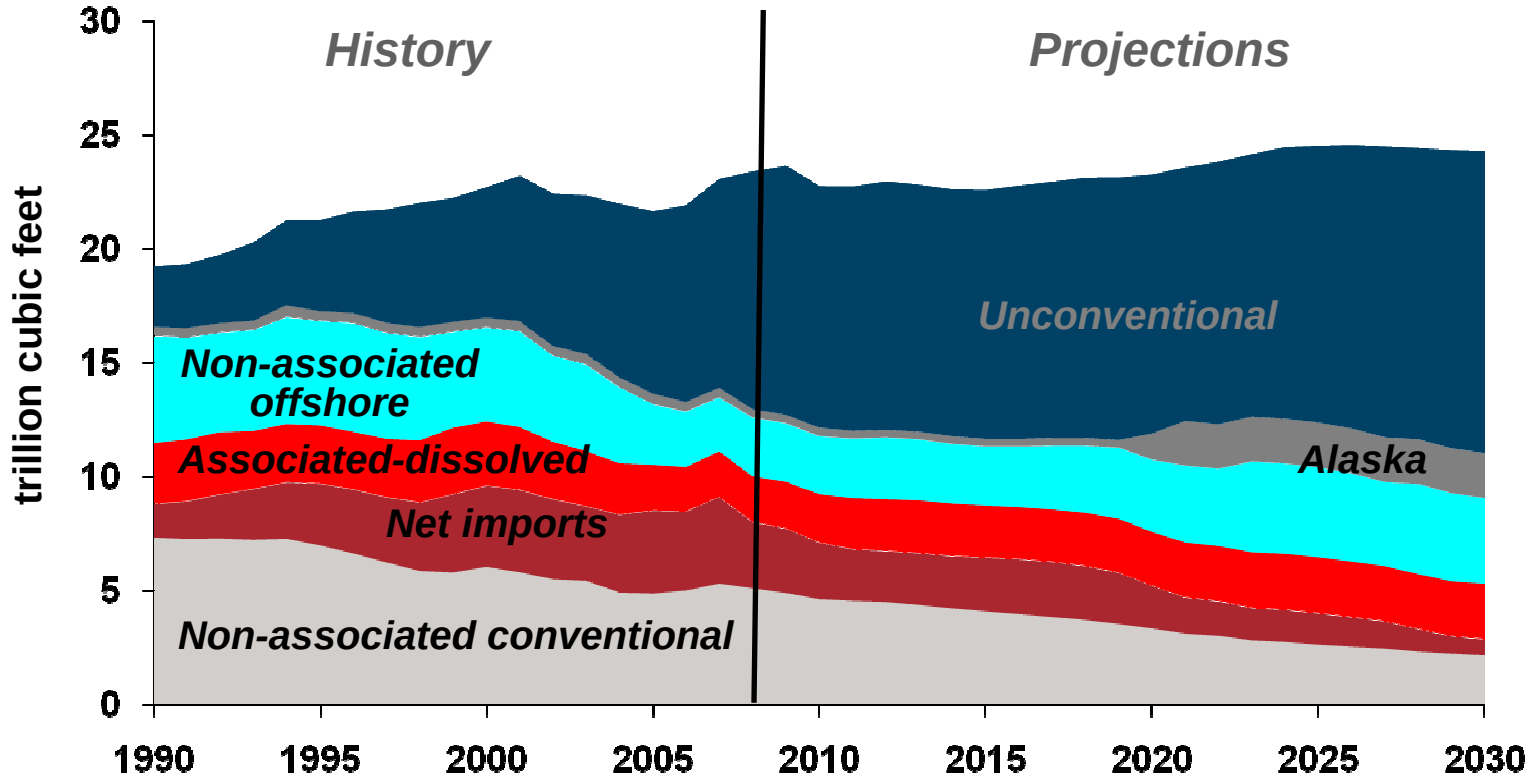


Source: EIA Annual Energy Outlook 2009

Potential U.S. Natural Gas Supply Sources

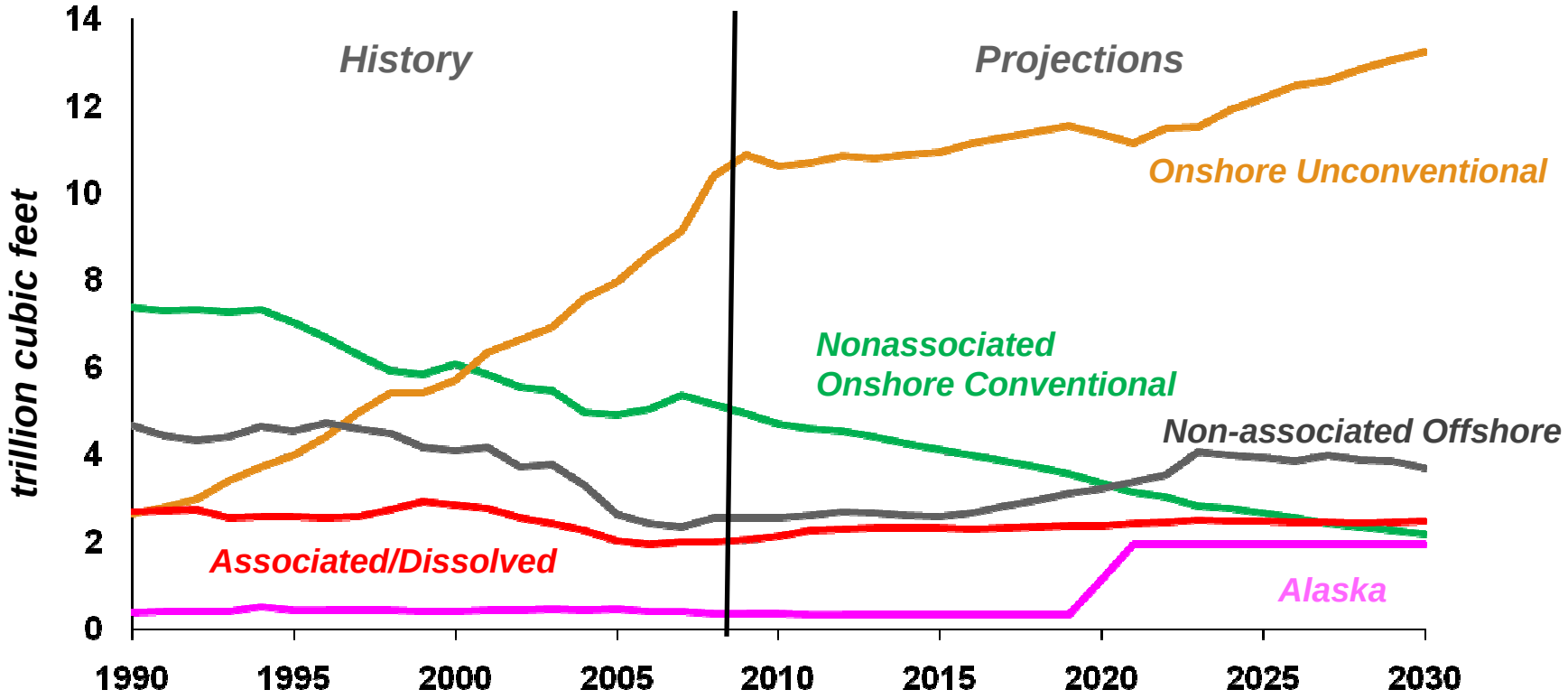
- Onshore Conventional
- Onshore Non-conventional
- OCS
- Imports from Canada
- LNG Supplies
- Alaskan and Arctic Resources

As conventional supplies decline, the gap will be filled by a mix of unconventional gas, Alaskan gas, and LNG



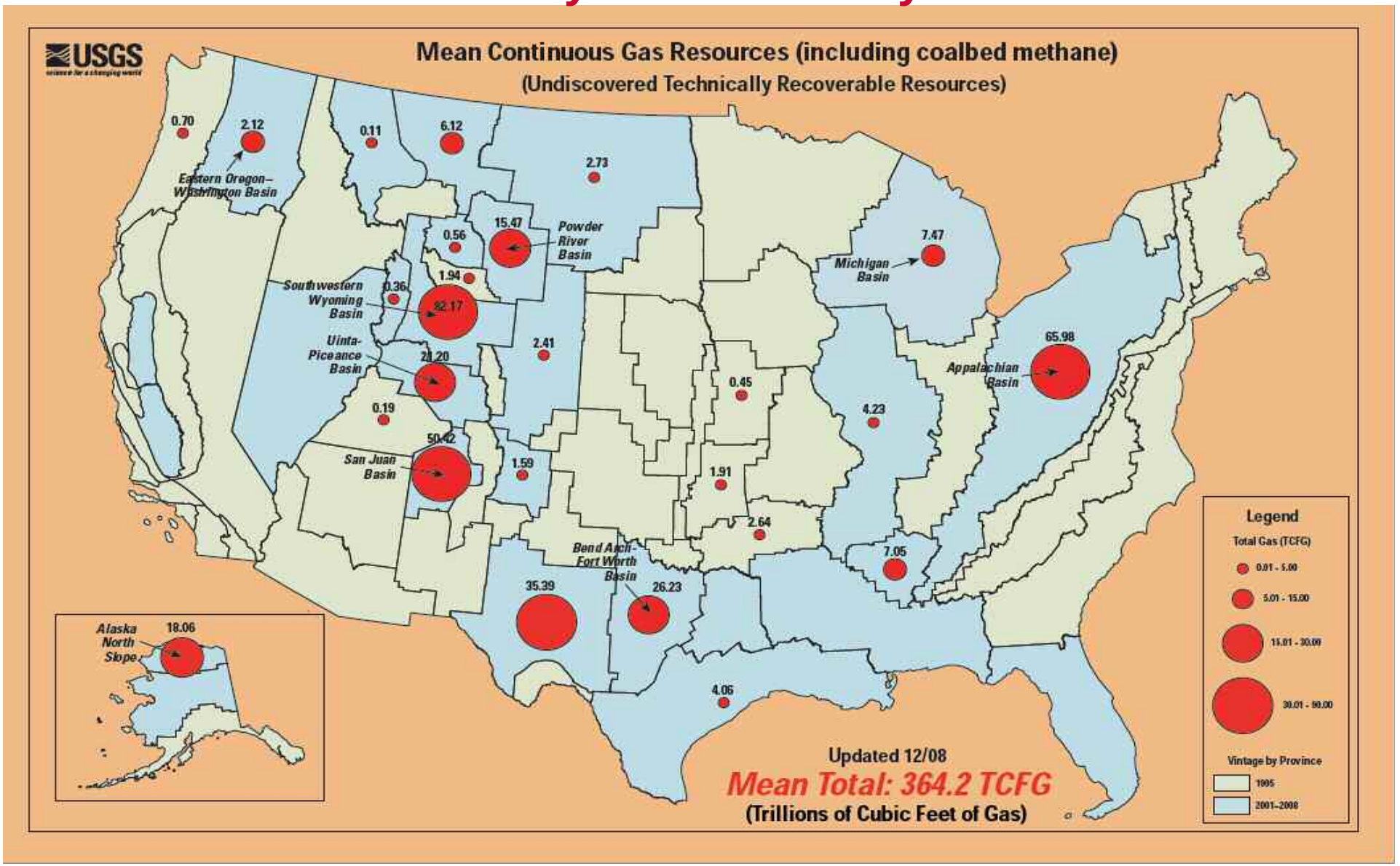
Source: EIA Annual Energy Outlook 2009

Growth in U.S. dry natural gas production through 2030 led by unconventional (tight gas, shale, CBM)



Source: EIA Annual Energy Outlook 2009

Estimates of U.S. unconventional gas resources have increased dramatically in the last 15 years



1995 Mean Est. = 2.1 tcf, 2008 Mean Est. = 364.2 tcf

Variety of estimates regarding the potential of US shale gas resources, but all conclude that the resource is enormous, possibly game-changing

EIA Annual Energy Outlook 2009: **267 tcf** undiscovered technically recoverable shale gas resources (mean)

- Based on 2007 U.S. Geological Survey assessment and 2006 Mineral Management Service data

Navigant Consulting Inc. 2008: **274 tcf** undiscovered technically recoverable shale gas resources (mean)

- Based on aggregated data from numerous studies including Potential Gas Committee Report (2006), USGS (2007), American Association of Petroleum Geologists (various), Minerals Management Service (2006), Producer Reports (2008), and Egerton (2007)

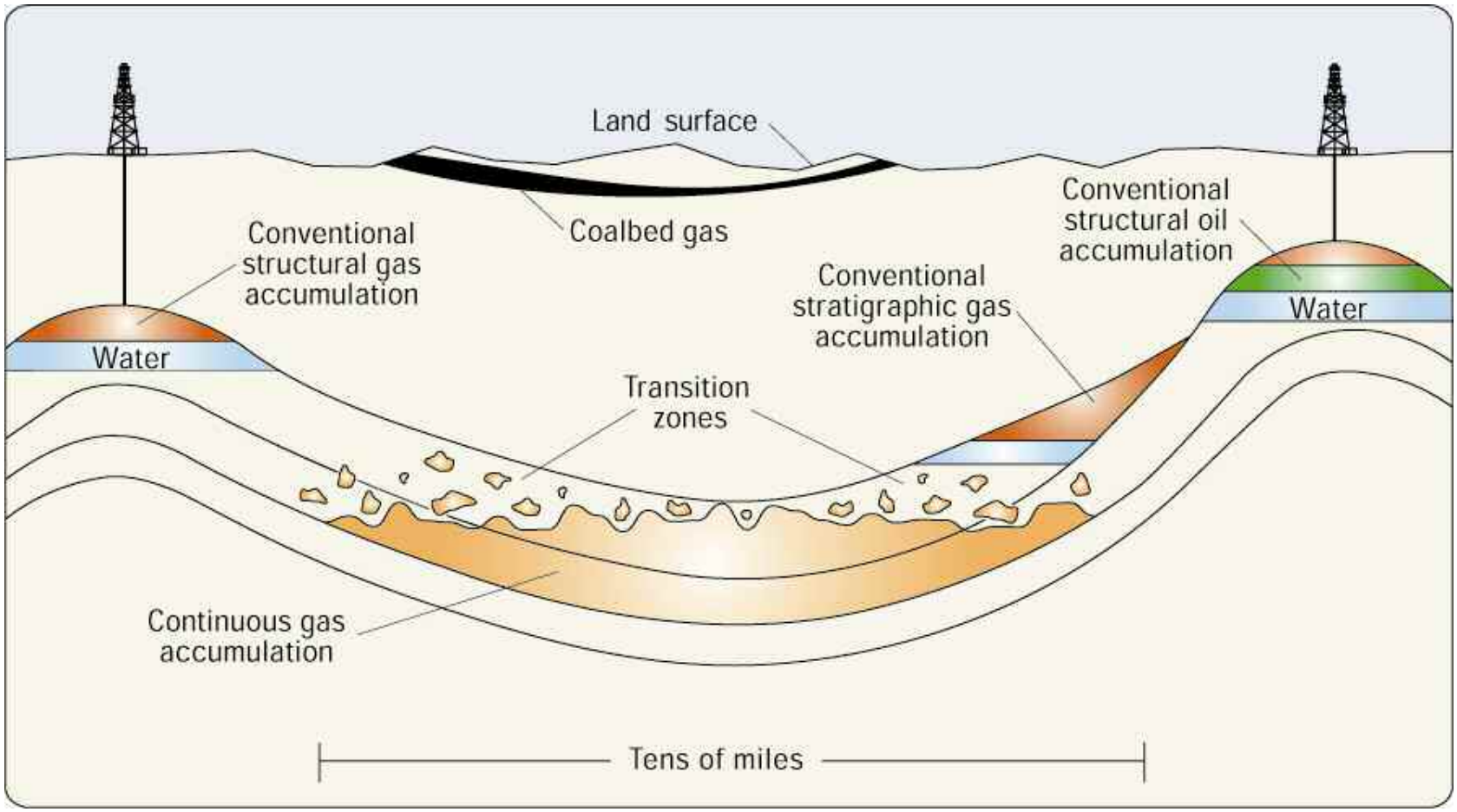
Navigant Producer Reports 2008: **up to 842 tcf** undiscovered technically recoverable shale gas resources (max reported)

- Ascertained by Navigant in 2008 study (accounts for Marcellus and Haynesville)

Potential Gas Committee 2009: **616 tcf** undiscovered technically recoverable shale gas resources (mean)

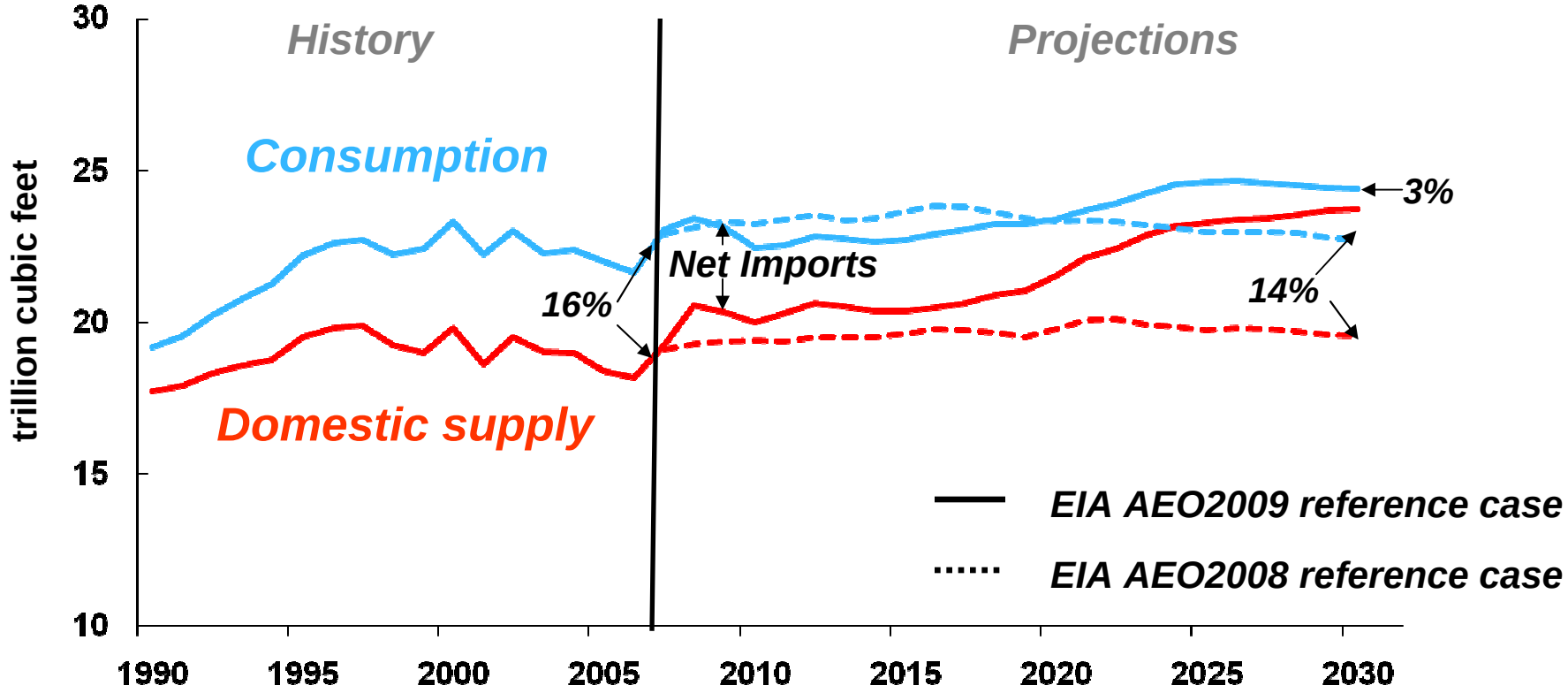
- Estimated total U.S. gas resources of 2,074 tcf (mean undiscovered tech recov + reserves)

Conventional vs. Continuous Resources



Source: USGS

Net gas imports to the U.S. projected to decline with onset of new domestic sources and falling Canadian imports



Source: EIA Annual Energy Outlook 2009

BUT …realizing the full promise of shale gas resources is not a certainty

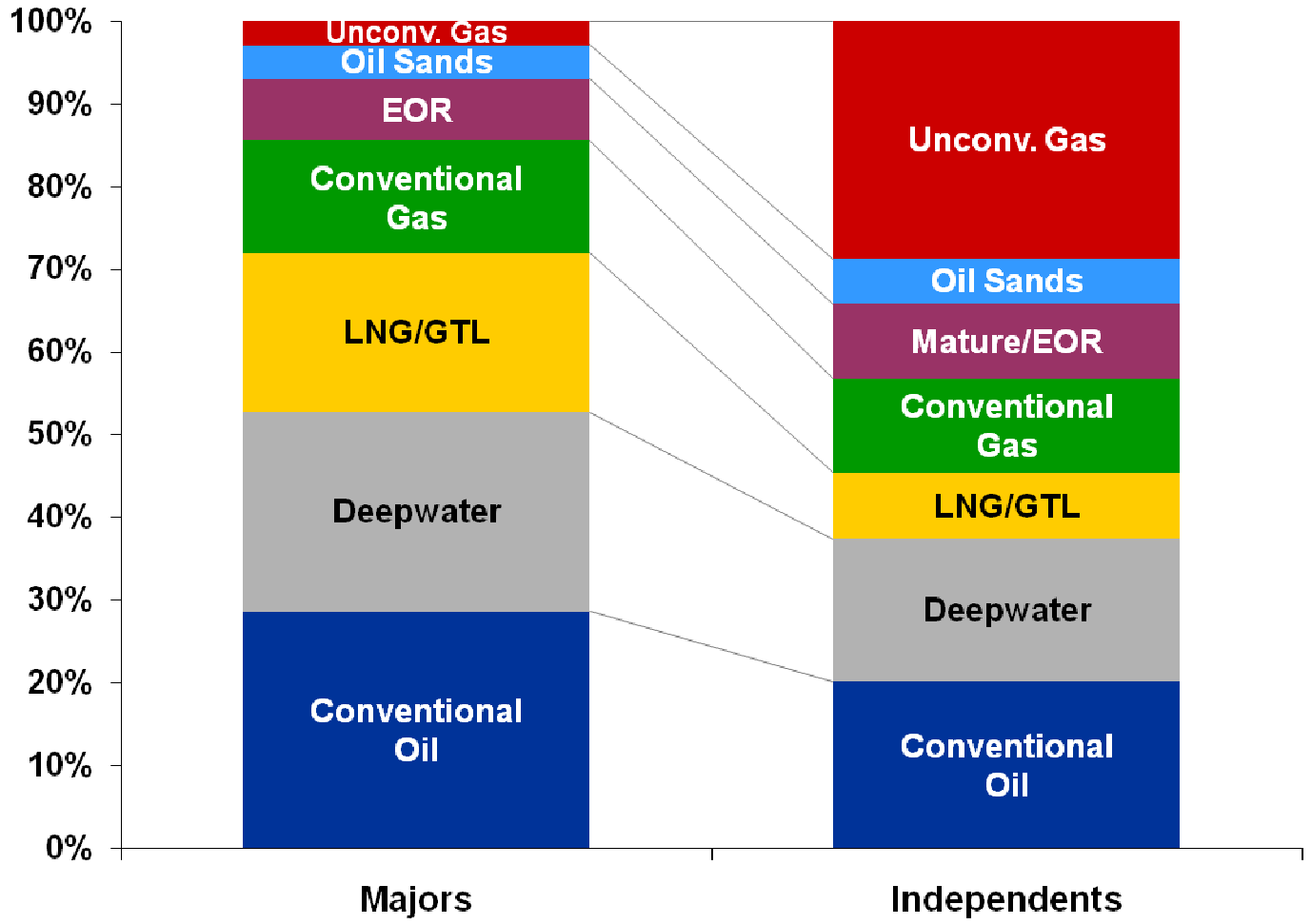
Technical/Economic Challenges

- All shales are not alike; application of drilling/reservoir fracturing technology & operational experience matters
- Steep decline rates require ongoing investment and drilling; and repeated fracturing
- Up front investment (lease acreage and pilot wells) not insignificant vs. cost basis relative to commodity price/value

Environmental/Regulatory/Societal Challenges

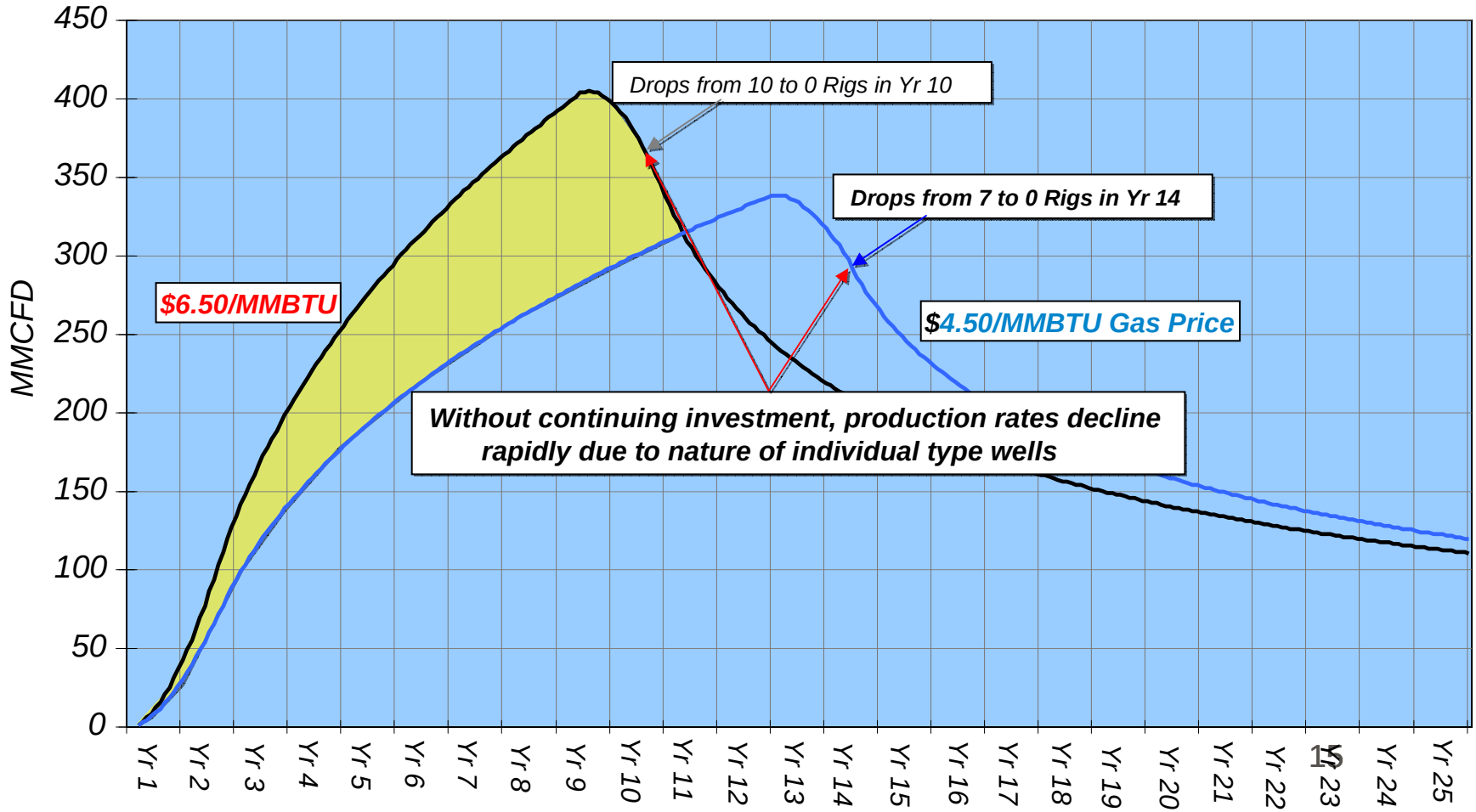
- Uncertain regulation (fracturing, HOH, land use, permits), “industrialization” of areas unfamiliar with development plans and associated impacts
- Location, location, location – shale resources are, at times, proximate to and distant from delivery infrastructure and demand centers – both present problems

New production prospects coming online (2009 – 2013)



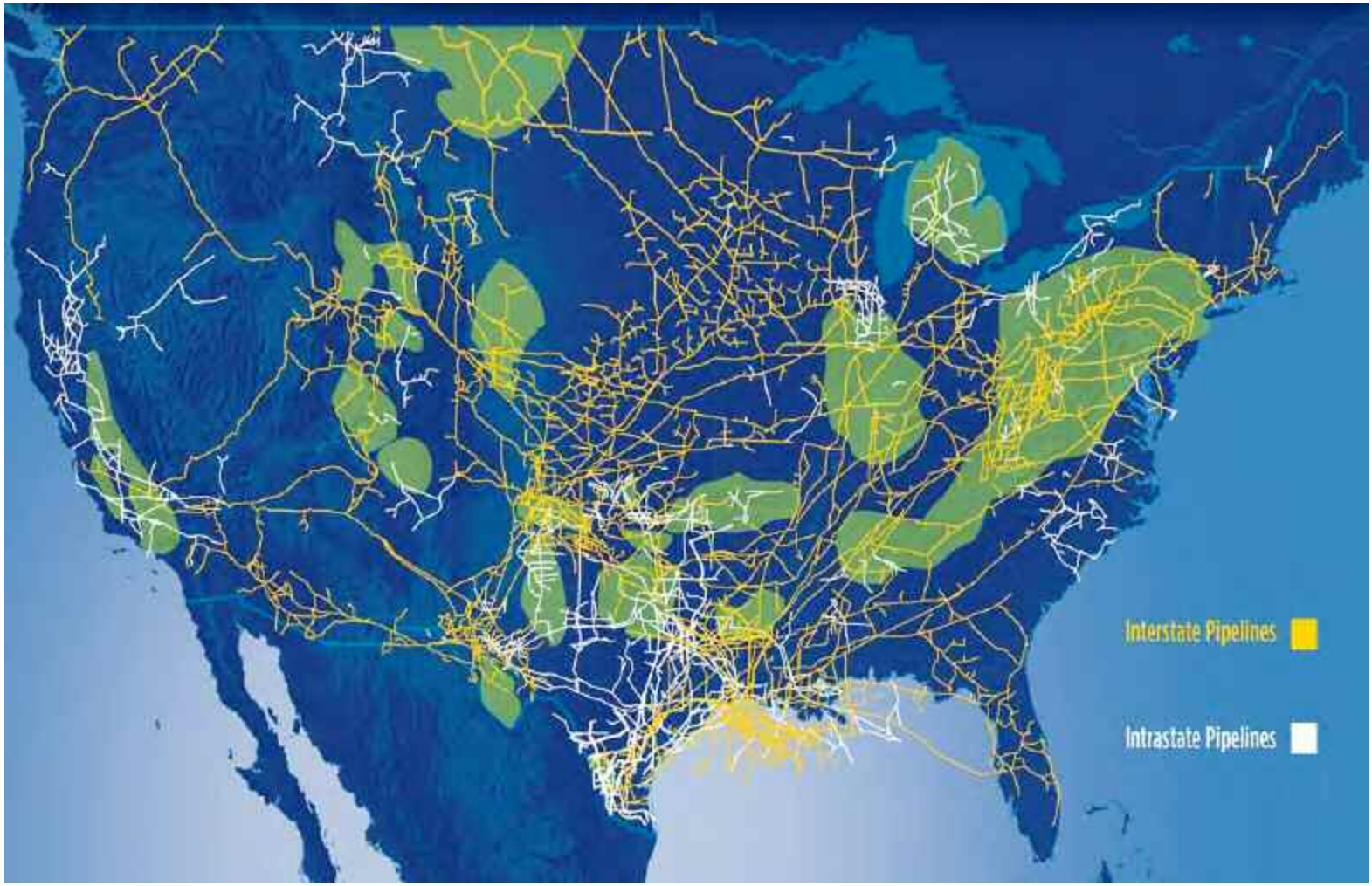
Source: PFC Energy Upstream Competition Service

Due to steep decline rates, steady production of shale gas must be maintained with continuous drilling and investment



Source: Example by Julie Struble, Anadarko

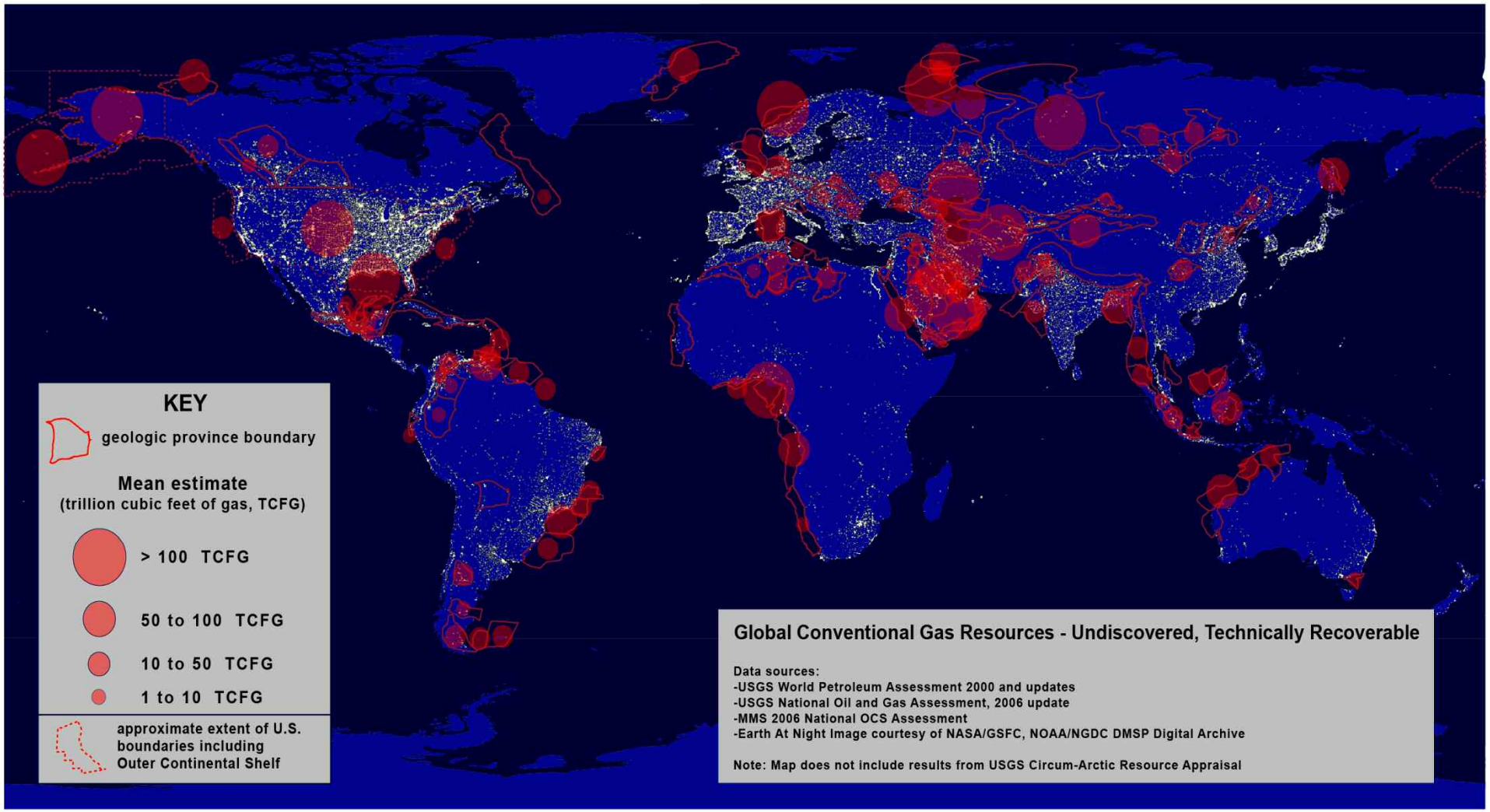
Shale Resources and Natural Gas Pipeline Network



Source: R Hefner

Global Gas Supply Dilemma

- Global gas demand to grow, especially in a carbon constrained world
- Conventional supply sources become more concentrated geographically
- Concentration can affect leverage, supply and prices, geopolitics, etc.
- Delivery System Under Greater Stress
- Price rise + increased import dependence recreates balance of payments concerns



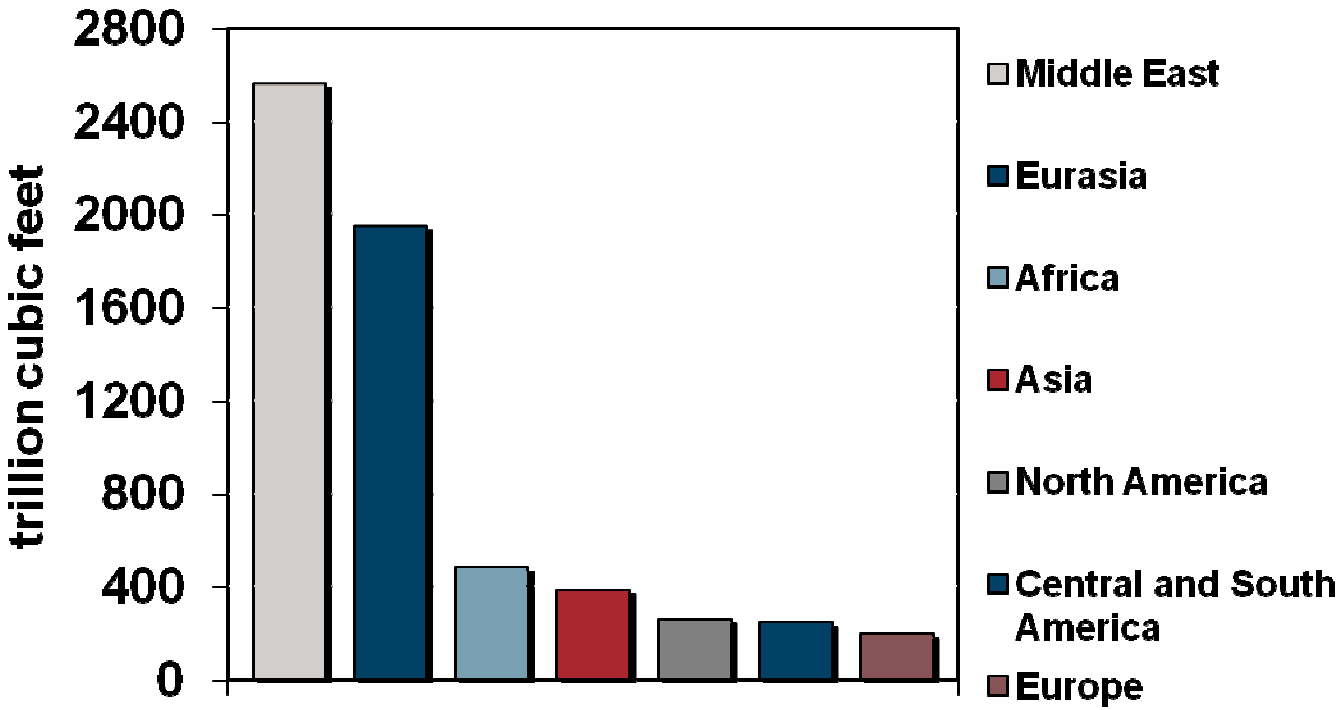
World (exclusive of U.S) = 5,576 TCF

U.S. conventional (on- and off-shore) = 713 TCF

continuous (unconventional onshore) = 275 TCF

Source: USGS

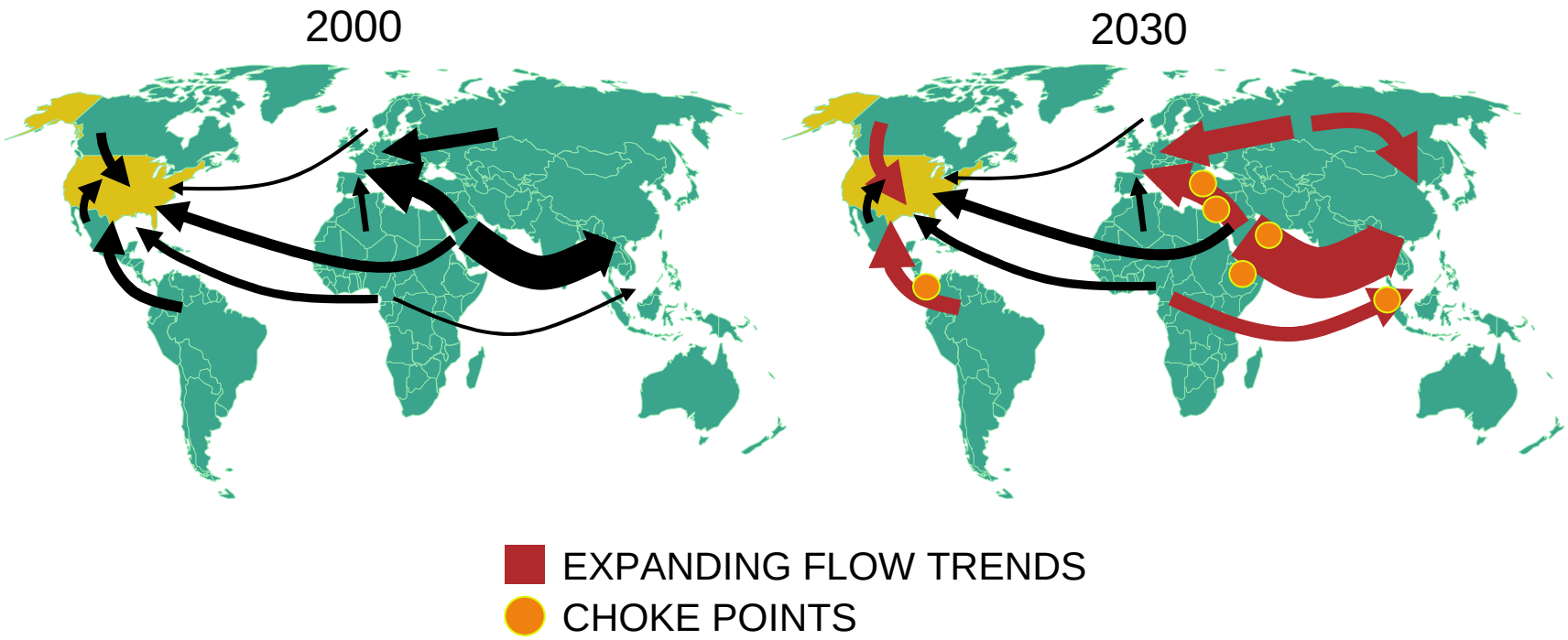
Global Natural Gas Reserves



Source: EIA

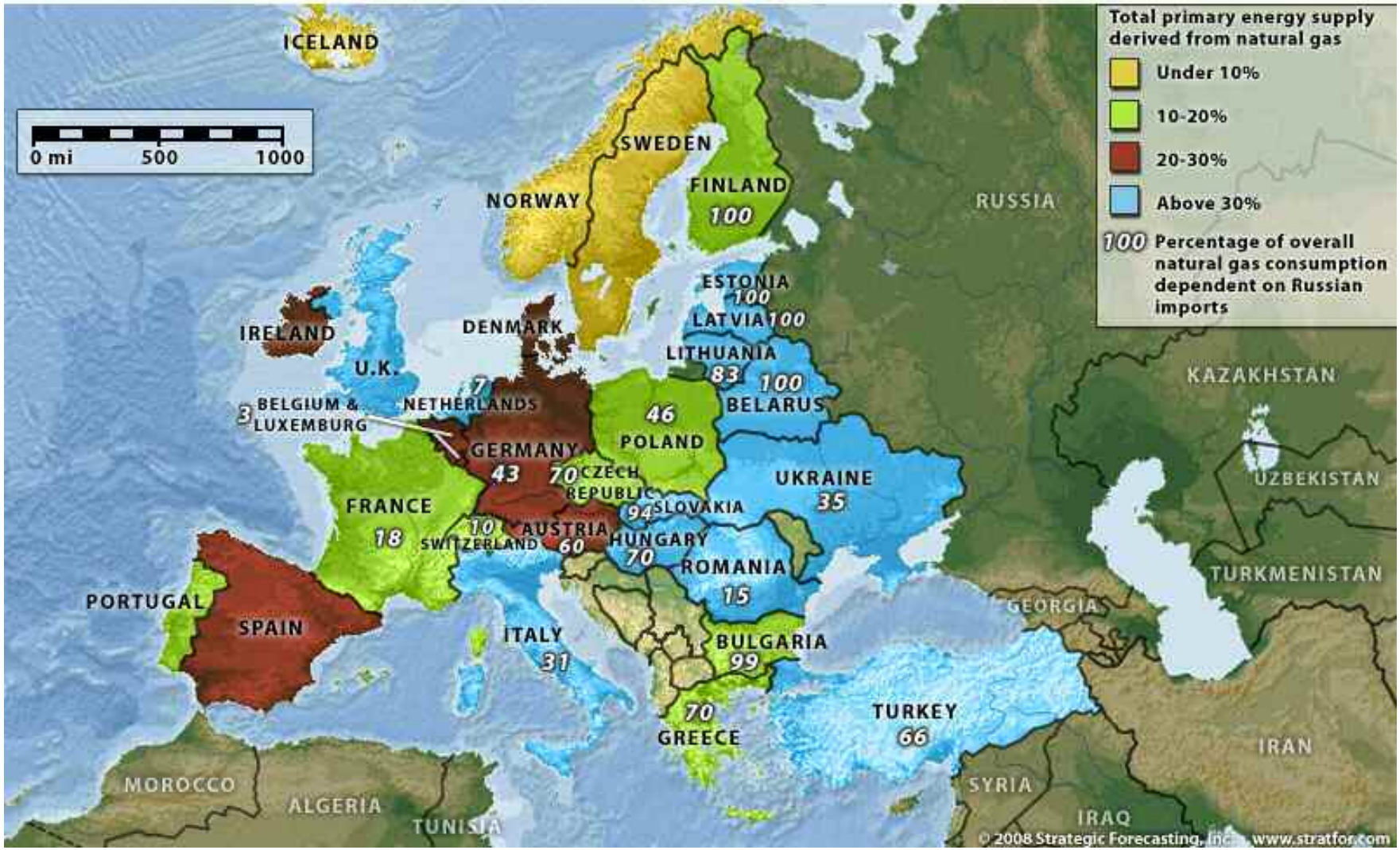
Global energy trade flows will expand and must be protected against sabotage, geopolitical conflict, and climatic events

Energy Trade Flows



Source: NPC Global Oil and Gas Study 2007

EUROPEAN DEPENDENCE ON NATURAL GAS



Policy Model