The Expanding Role of Natural Gas:

Effects on Greenhouse Gas Emissions

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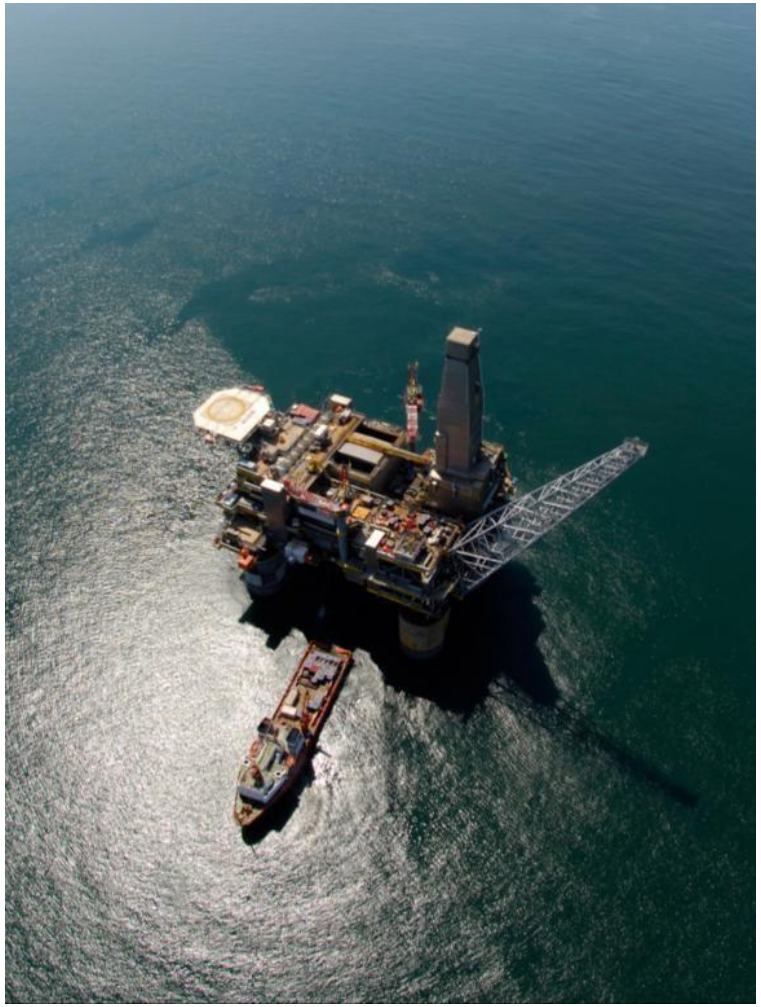
IPIECA – who we are and what we do

- Global association covering upstream and downstream oil & gas
- Formed in 1974 as the industry's main channel of communication with the UNEP
- Focus on environmental and social issues including:
  - Climate change
  - Water
  - Biodiversity
  - Human Rights



Our Mission – how do we get there?

- IPIECA helps the oil and gas industry *improve its environmental and social performance* by:
  - Developing good practices
  - Enhancing knowledge and understanding
  - Engaging members and the wider industry
  - Working with key stakeholders

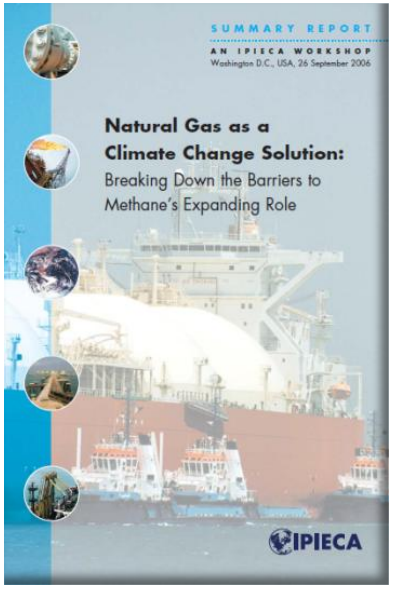
Company and association members

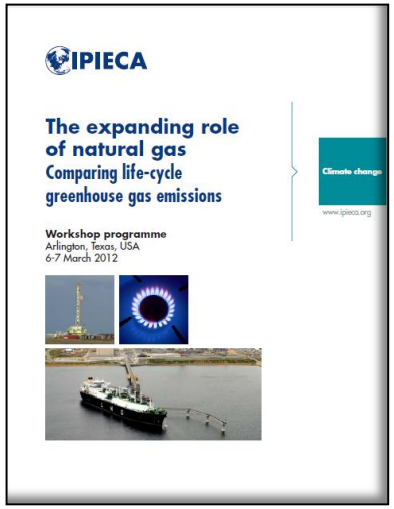
Introduction to IPIECA's perspectives on natural gas and climate change

- Natural Gas is experiencing an expanding role in energy supply
  - In demand sectors such as electricity generation
  - With improvements in production and transport technologies
  - And significant increase in resource estimates

- Greater interest in continuing the effort
  - To develop accurate estimates of GHG emissions from natural gas systems
  - To better manage greenhouse gas emissions and compare alternate technologies

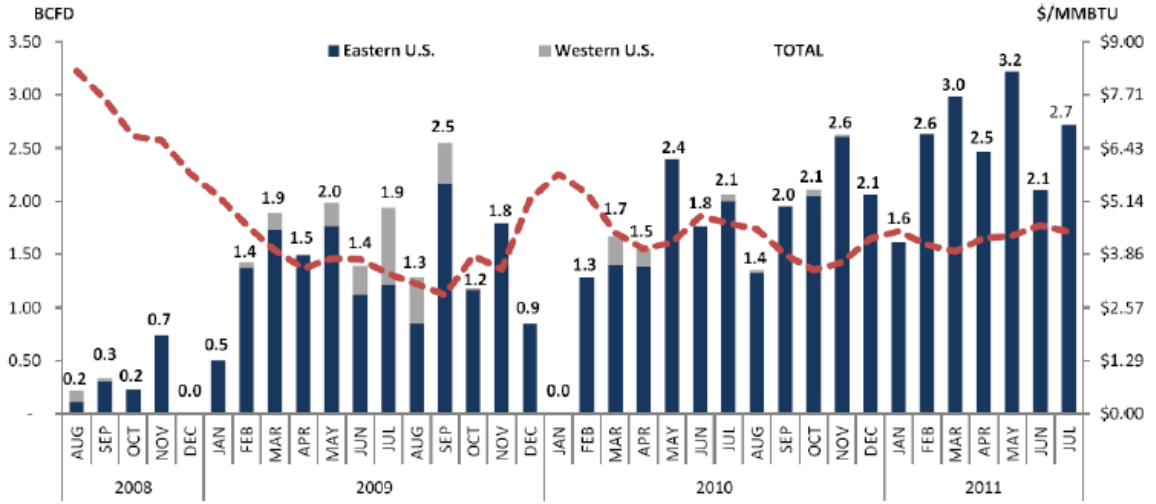
- This presentation draws on IPIECA workshops on climate change and natural gas held in 2006 and 2012



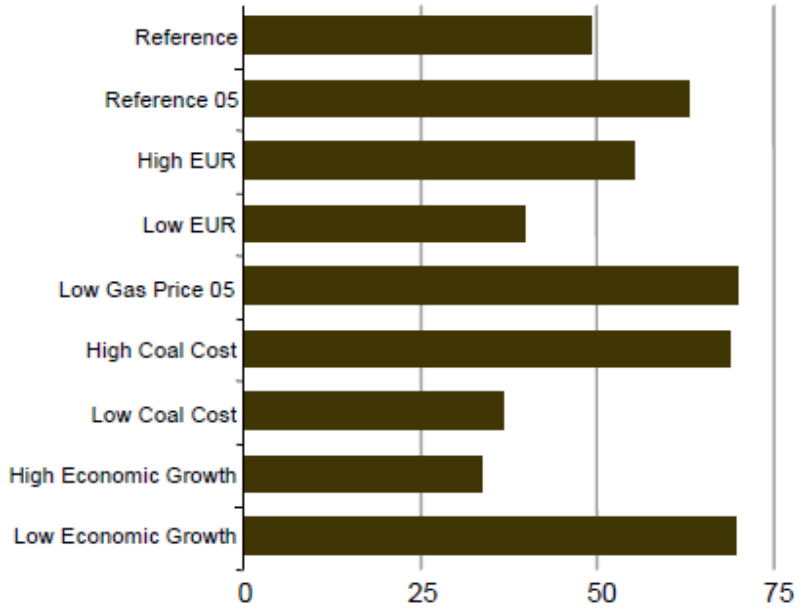


Significant coal to gas switching underway in U.S.

- Low natural gas prices and continuing expectations aid coal plant retirement.



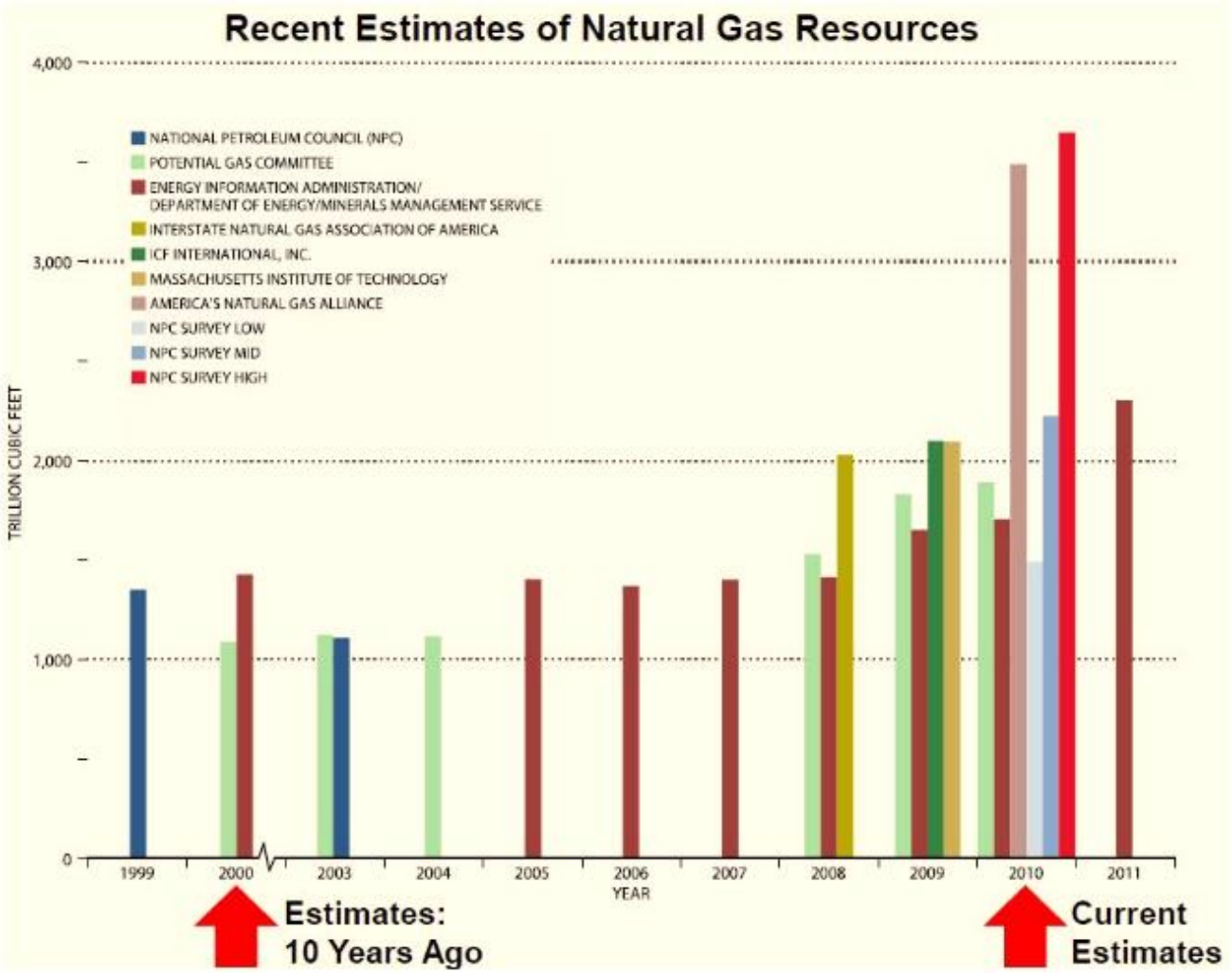
Cumulative retirement of coal-fired generation capacity 2011-2035 (gigawatts), EIA Annual Energy Outlook 2012.



…Over the next 10 years, the range for cumulative retirements of coal-fired power plants over the projection period varies considerably across the alternative cases (figure to the right), from a low of 34 gigawatts (11 percent of the coal-fired generator fleet) to a high of 70 gigawatts (22 percent of the fleet). The high end of the range is based on much lower natural gas prices than those assumed in the Reference case; the lower end of the range is based on stronger economic growth, leading to stronger growth in electricity demand and higher natural gas prices.

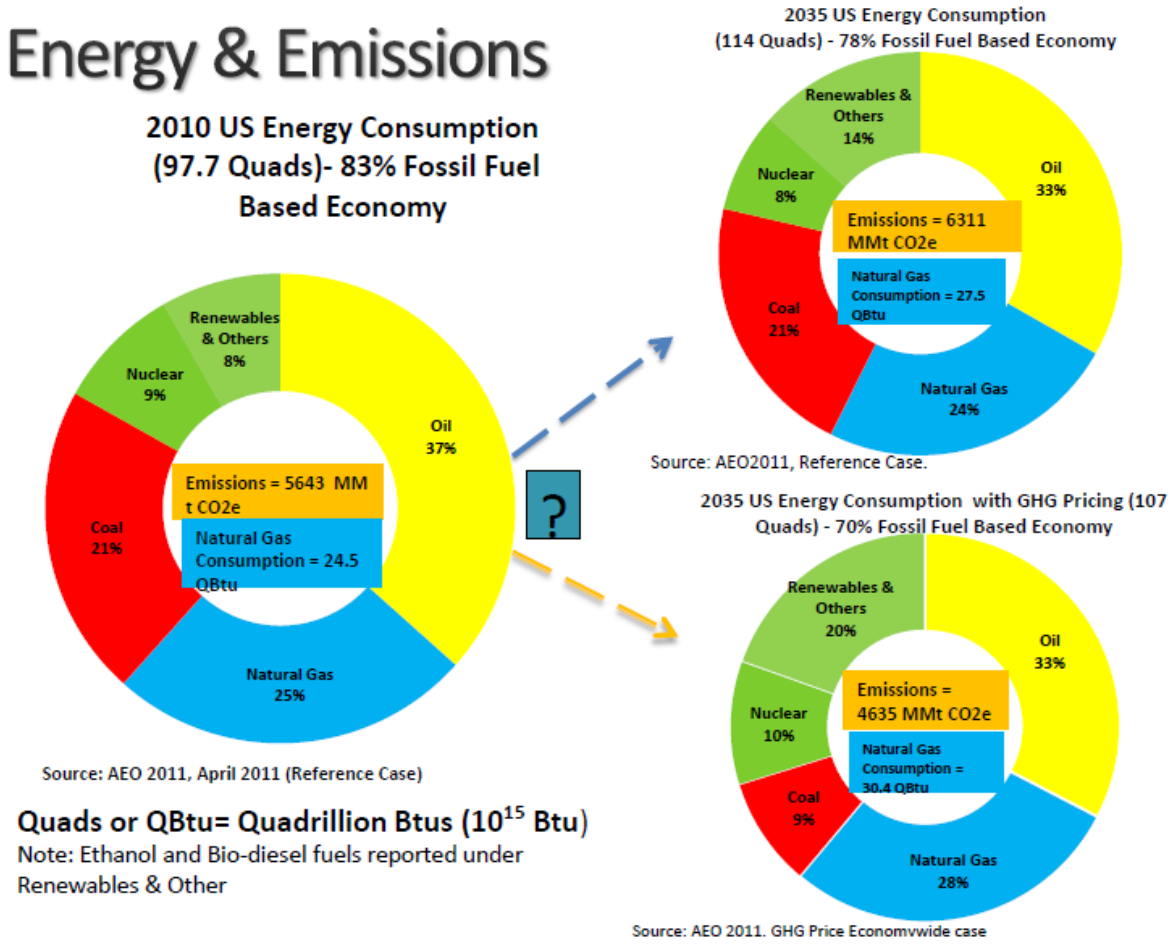
Scenarios show expanding role of natural gas

The potential supply of North American natural gas is far greater than was thought even a few years ago



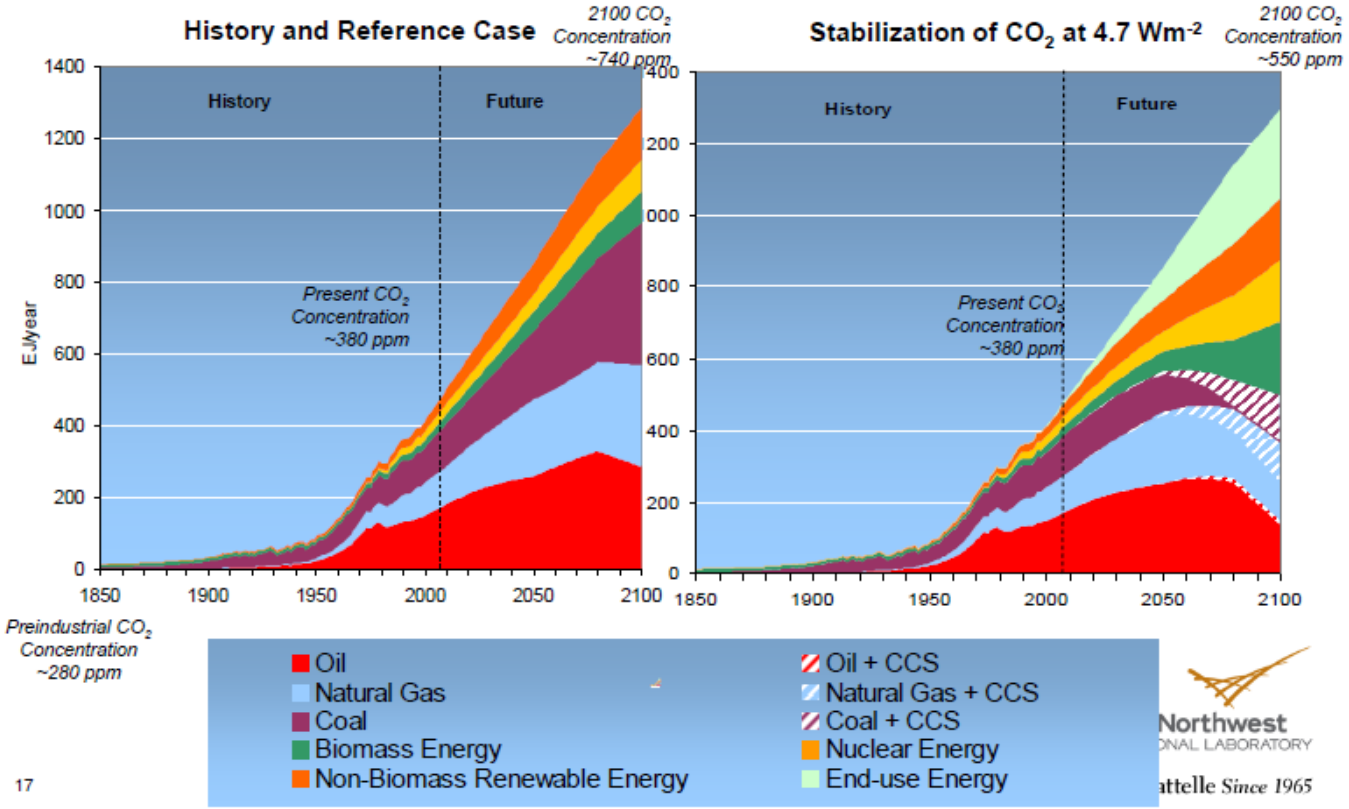
Scenarios show expanding role of natural gas

- Natural gas has an enhanced role in power generation in scenarios that put a price on carbon emissions



Scenarios show expanding role of natural gas

- Natural gas has an enhanced role in power generation in scenarios that put a price on carbon emissions
- In mitigation scenarios, natural gas with CCS plays an important role in the later half of this century



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Growth of natural gas supply enabled by improved technologies for unconventional gas

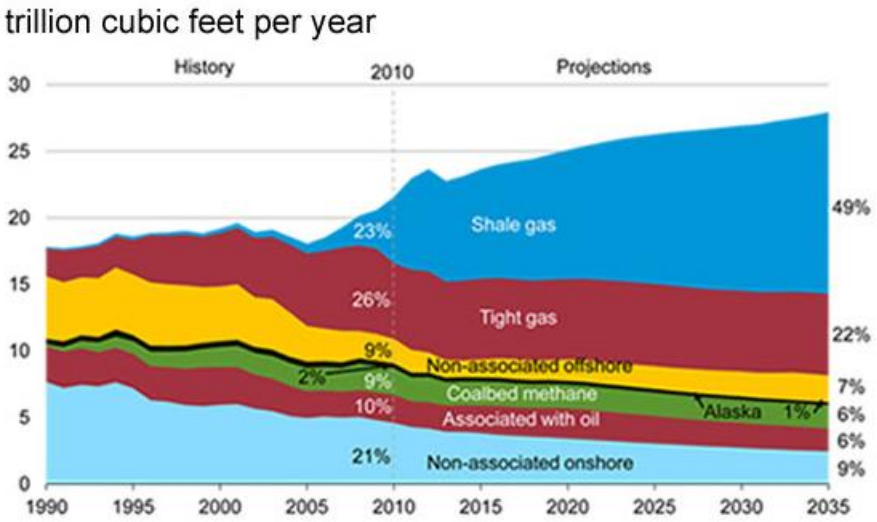
- Liquefied Natural Gas (LNG)
  - Scale, safety, efficiency and economics

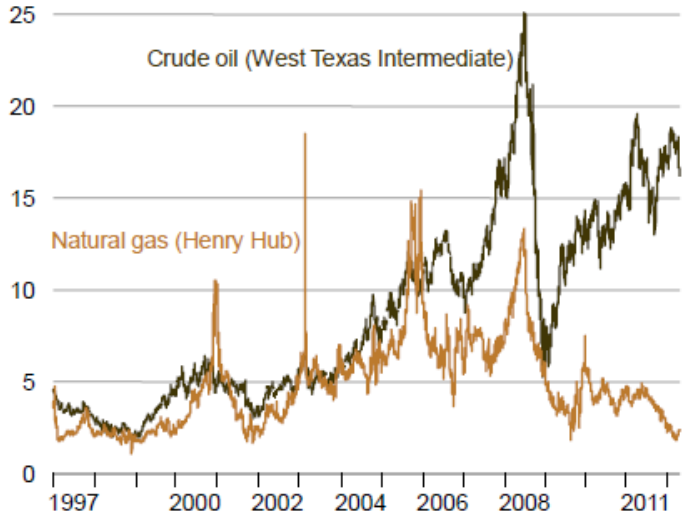
- Unconventional Sources
  - Shale gas, tight gas, coal bed.
  - Advances in and combinations of drilling technologies and methods

Rapid increase in USA unconventional gas production

- Increase in unconventional sources
- Significant growth of resource estimates
- Decrease in price
  - "…Led by technological breakthroughs in the production of natural gas from shale formations, domestic production of dry natural gas increased by about 14 percent from 2008 to 2011. … With the recent growth in U.S. natural gas production, domestic natural gas prices in 2012 are significantly lower than crude oil prices on an energy-equivalent basis. … "EIA Annual Energy Outlook 2012

U.S. EIA Annual Energy Outlook 2012 (June 2012)
U.S. Natural Gas Production (1990 – 2035)

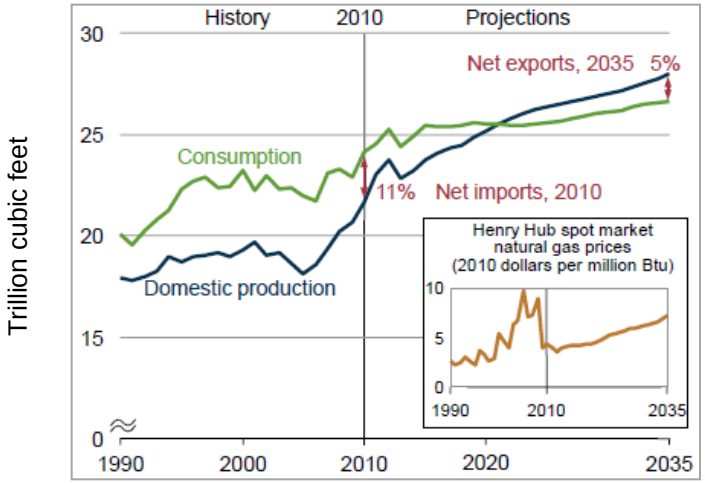


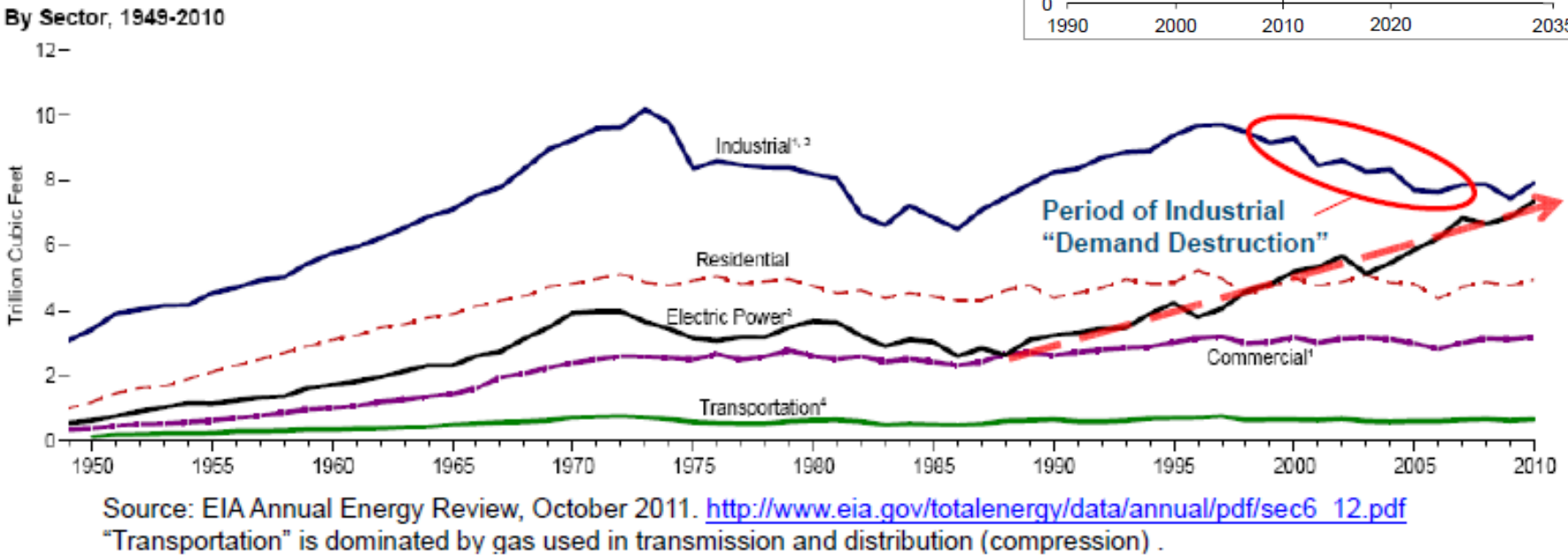


U.S. spot market prices for crude oil and natural gas, 1997-2012 (2010 dollars per million Btu)

Rapid increase in USA unconventional gas production

- Increased domestic use
  - Power generation, industry, and buildings
  - Interest in export





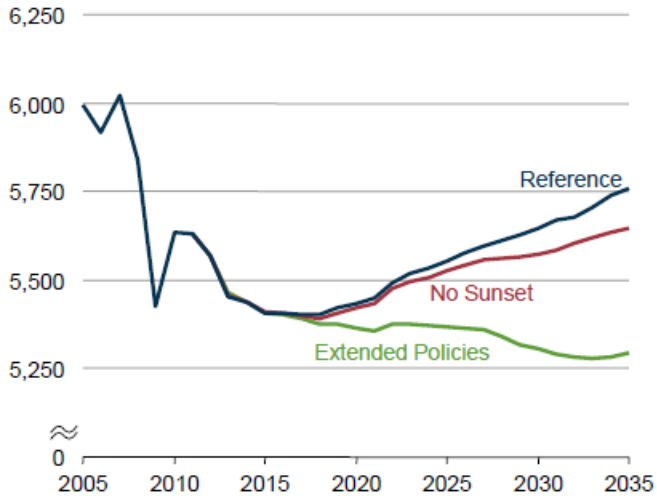
Source: EIA Annual Energy Review, October 2011. http://www.eia.gov/totalenergy/data/annual/pdf/sec6_12.pdf
"Transportation" is dominated by gas used in transmission and distribution (compression) .

Monthly average U.S. natural gas price history (EIA 2011)

Natural gas is a lower carbon fuel

- Carbon per unit energy
  - Methane: ~ 50 kg CO2/MMBTU
  - Coal: ~ 90 kg CO2/MMBTU
- Efficiency in power generation
  - Natural Gas Combined Cycle: 50 %
  - Coal: 30 %

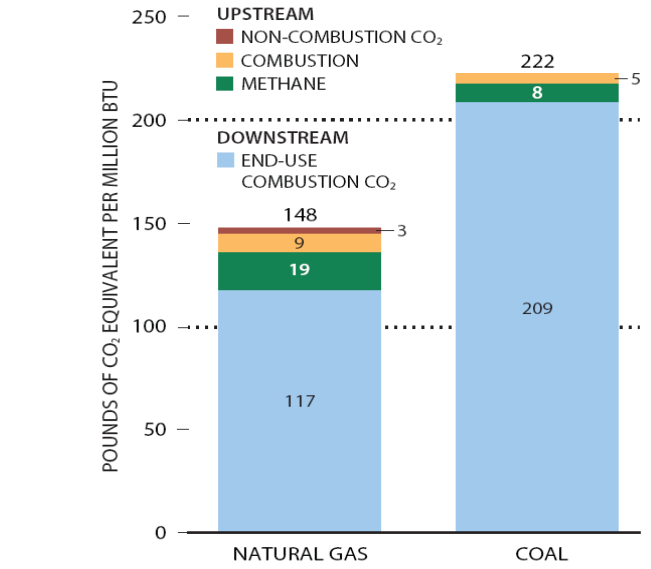
U.S. EIA Annual Energy Outlook 2012 (June 2012)
Energy-related carbon dioxide emissions
in three cases, 2005-2035 (million metric tons)

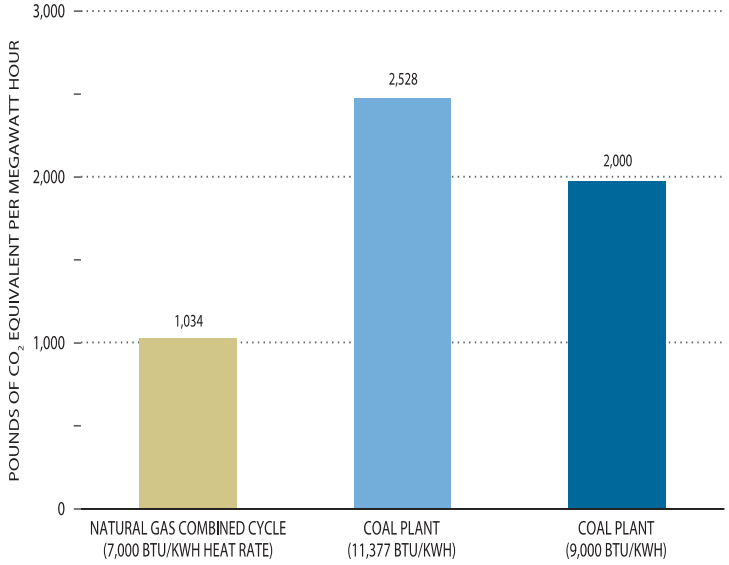


- Natural gas has adjustable power dispatch with less than half the CO2 emissions of coal
- U.S. energy-related emissions since 2005 has decreased by more than 400 million tonnes CO2e.

Natural gas is a lower carbon fuel

- LCA GHG emissions from natural gas-fired plants are 50-60% lower than existing coal-fired plants
- Gas combined cycle plants have 99% lower SO2 and Hg emissions and about 82% lower NOx emissions relative to pulverized coal units



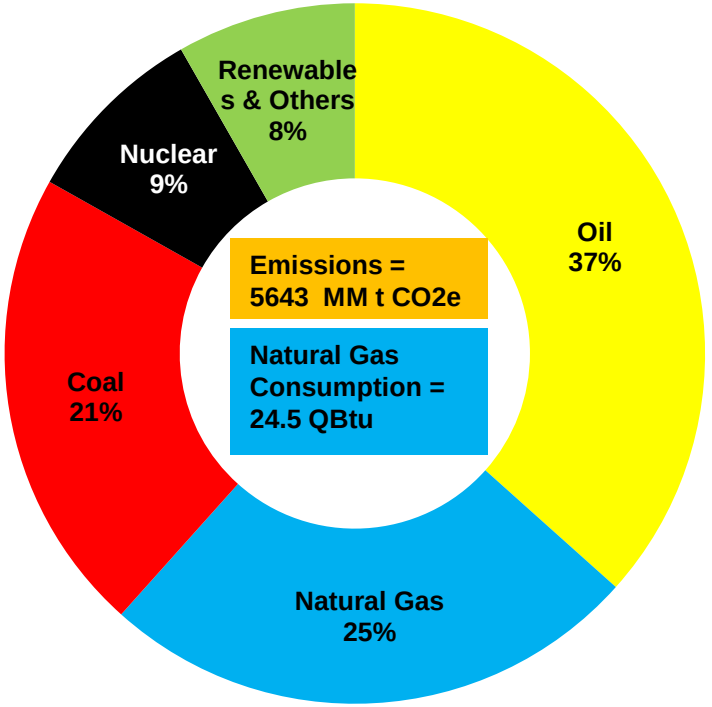


Source: National Petroleum Council 2011

Natural gas is a lower carbon fuel

- Power generation from natural gas has surpassed coal in USA

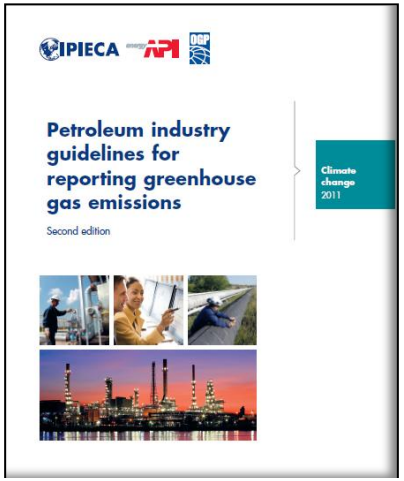
2010 US Energy Consumption (97.7 Quads)- 83% Fossil Fuel Based Economy



Source: AEO 2011, April 2011 (Reference Case)

Managing methane emissions from natural gas

- Improving measurement of emissions
- Reducing emissions
  - U.S. EPA Natural Gas Star began in 1993, expanded internationally in 2006
  - Over 120 domestic and 14 international partners have
    - Identified over 50 cost effective technologies and practices to reduce methane emissions
    - Reduced methane emissions by nearly 28 Bcm, saving over $3 billion(US)



NaturalGas
EPA POLLUTION PREVENTER

Global Methane Initiative

New U.S. initiative 2012

Summary

- Mitigation scenarios show expanding role of natural gas.
- Growth of natural gas supply enabled by improved technologies for unconventional gas.
  - Natural gas is a lower carbon fuel.
  - Significant coal to gas switching is underway in U.S.
  - Rapid increase in USA unconventional gas production contributed to reduced GHG emissions.
  - Methane emissions from natural gas systems are already being measured and managed.
  - New gas resources can be developed prudently with environmental safeguards, displace more carbon intensive emissions and other pollutants, and is already contributing to economic growth.

Thank you!

IPIECA

the global oil and gas industry association

for environmental and social issues

www.ipieca.org