REINHOLD ENVIRONMENTAL Ltd.

2012 Coal to Gas Conversion Round Table & Expo Presentation

October 23, 2012, Chattanooga, TN / Sponsored by TVA

"To Convert or Not To Convert, That is the Question"

Reinhold Environmental
Coal-to-Gas Conversion Conference

Chattanooga, Tennessee
October 23-24, 2012

Keynote Speaker – Rick Collins

Introduction

- **From Shakespeare's time of Hamlet:**
  "To Be, or Not to Be, that is the Question"

  to <u>Today's topic</u>

  "To Convert or not to Convert, that is the Question"

Issues of the Time

- Shakespeare's famous soliloquy ("To-Be or Not-To-Be") in Hamlet discussed the complexity of ***life versus death*** and the future uncertainty from both worlds.
- Today's presentation discusses the complexity U.S. Electric Utilities face responding to environmental regulations and low natural gas prices, as companies strive to minimize cost of electricity for their customers.

Focus of U.S. Electric Utilities

- Whether regulated or deregulated, all U.S. Electric utilities are so very aware of the importance of the cost of electricity passed along to their customers.
- Customer electricity costs drive:
  - The ***success and failure*** of both small and large businesses
  - The ***attraction*** of new companies and jobs into states and regions, and the regional economic growth new ***jobs*** mean
  - The sending of U.S. businesses ***offshore***
  - The cost of electricity and the cost impact on so many ***products*** for individual Americans, both rich and poor

Decisions……Decisions…..Decisions

Decision Making Guidelines

- Identify all **Major Issues** – existing and future
- Identify all **Alternatives**, including details and costs
- Identify **Timing for Major Decisions**
- Identify and assess **Risks**

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Major Issues

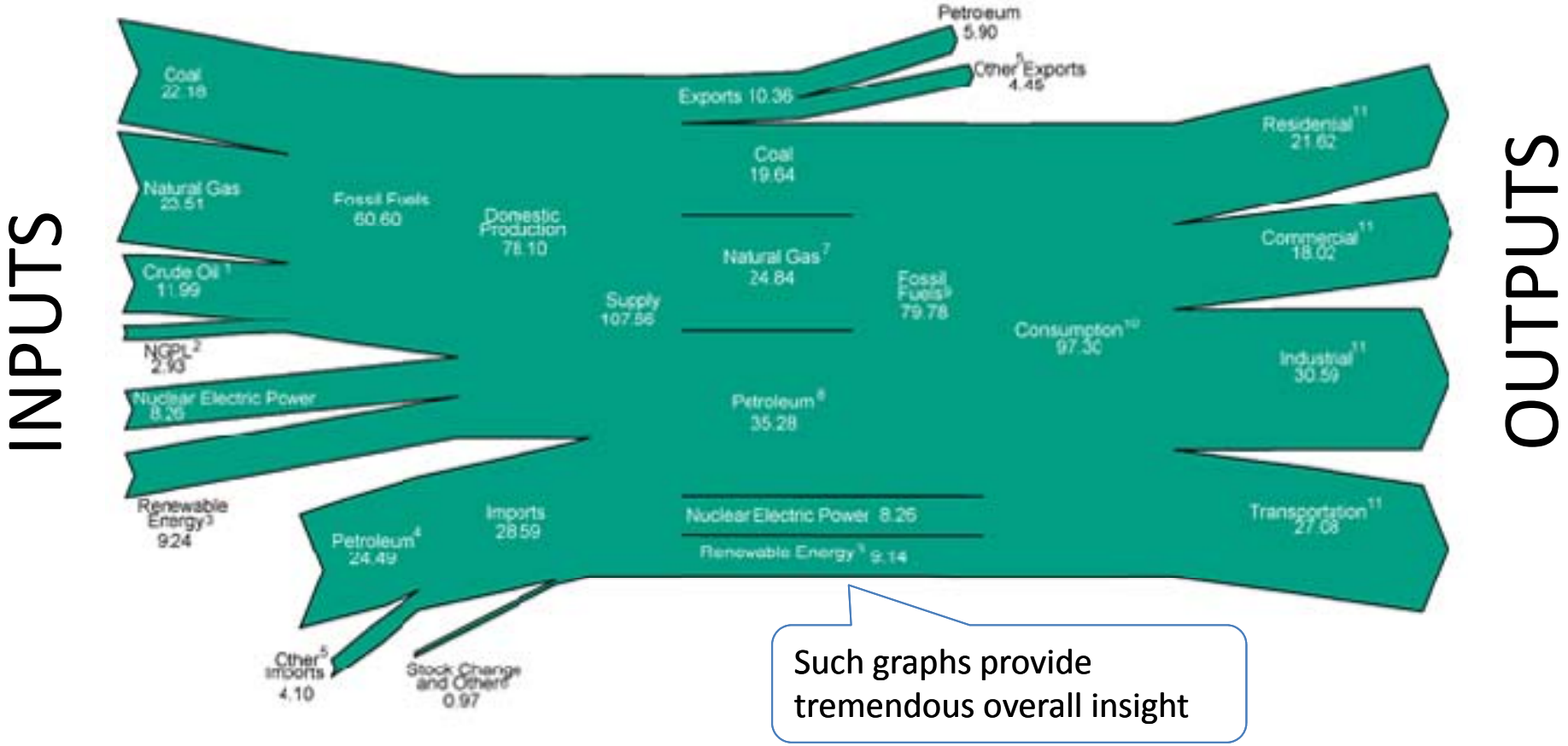
1. Domestic Coal and Natural Gas Markets
2. World Fuel Markets
3. U.S. Transportation Market for Natural Gas
4. Environmental Regulations/Legislation
5. Political Ramifications
6. Technology and Economic Issues

Issue #1: Domestic Coal and Natural Gas Markets

- Major Reference – EIA website (www.eia.gov)
- Natural Gas Price Uncertainty
- Long Term Natural Gas Supply
- Natural Gas Contracts – Annual Average Costs versus Seasonal Prices
- Coal and Gas price charts

2011 EIA Energy Graphs

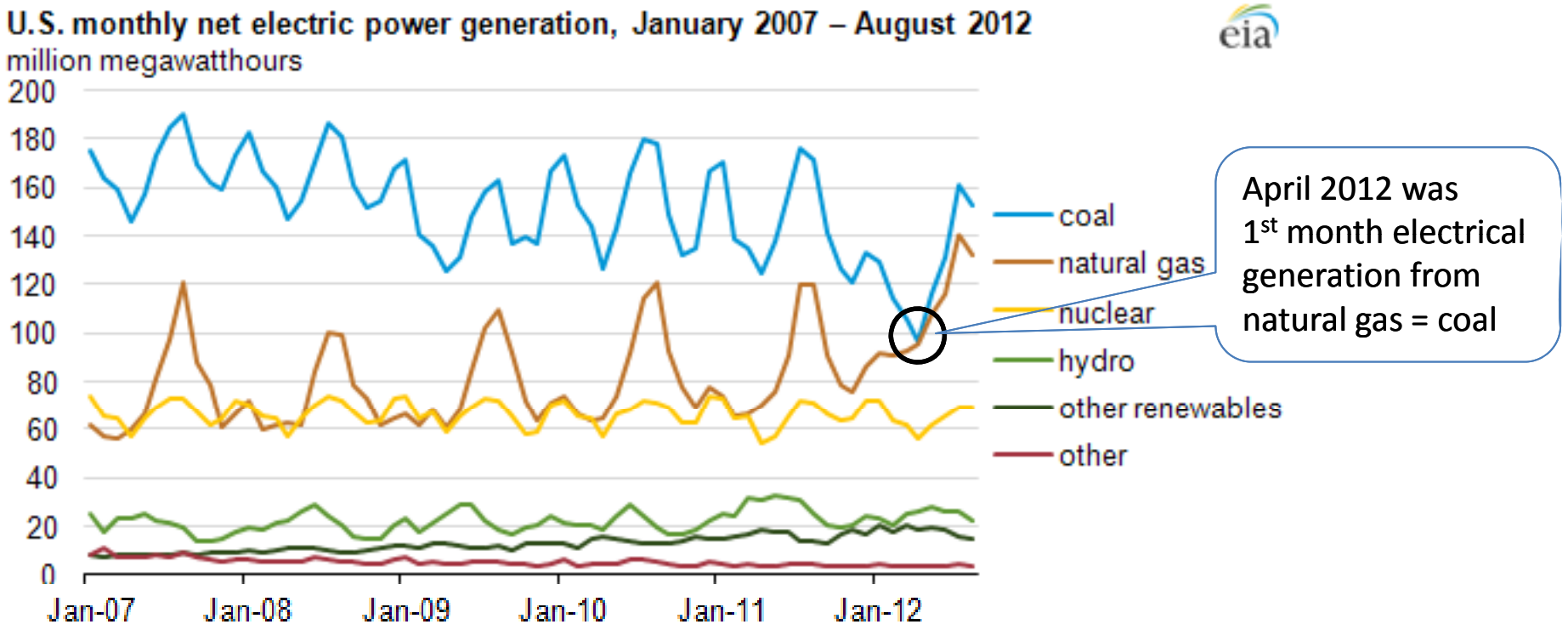
TOTAL ENERGY FLOW, 2011 (QUADRILLION BTU)



Such graphs provide tremendous overall insight

http://www.eia.gov/totalenergy/data/annual/diagram1.cfm

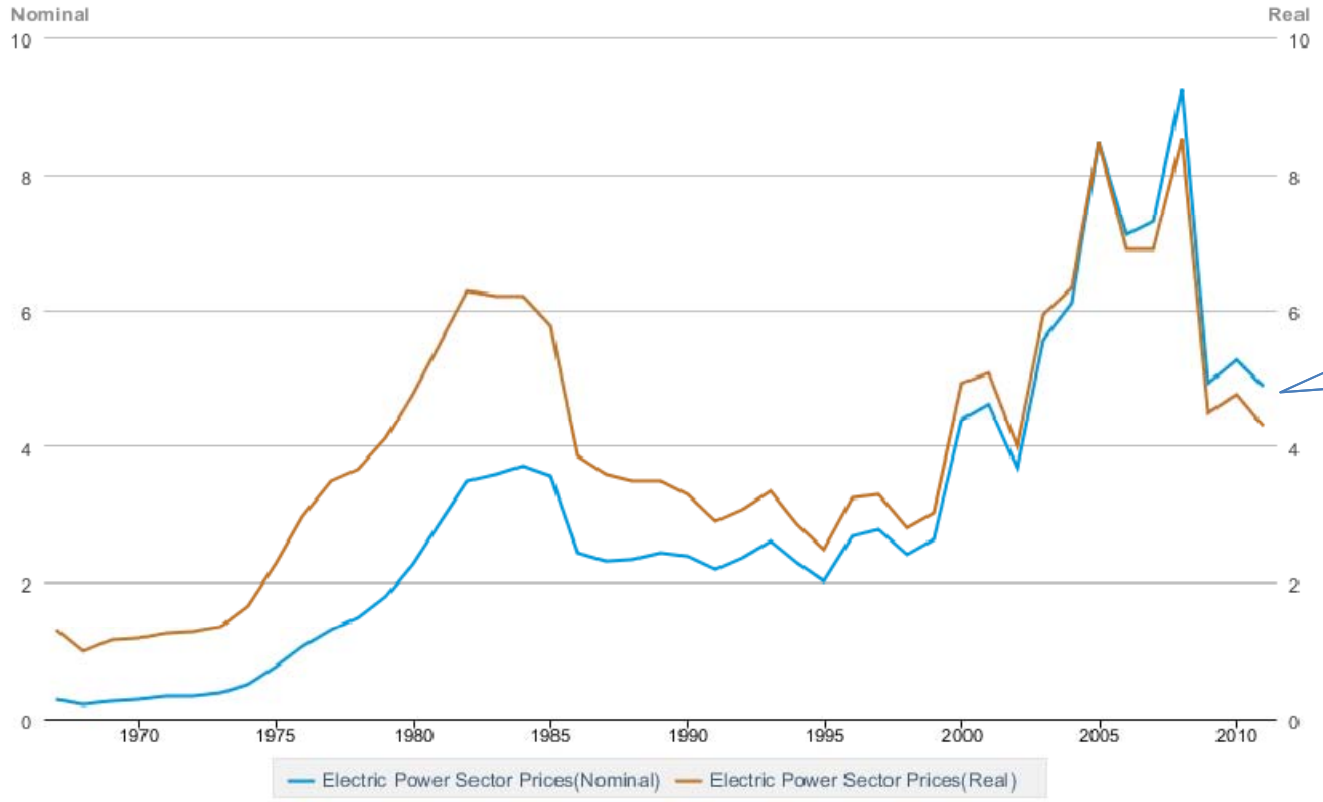
Electric Generation Fuel Breakdown



http://www.eia.gov/todayinenergy/detail.cfm?id=8450

Historical Natural Gas Prices

Table 6.8 Natural Gas Prices by Sector, 1967-2011 (Dollars per Thousand Cubic Feet, Except as Noted)

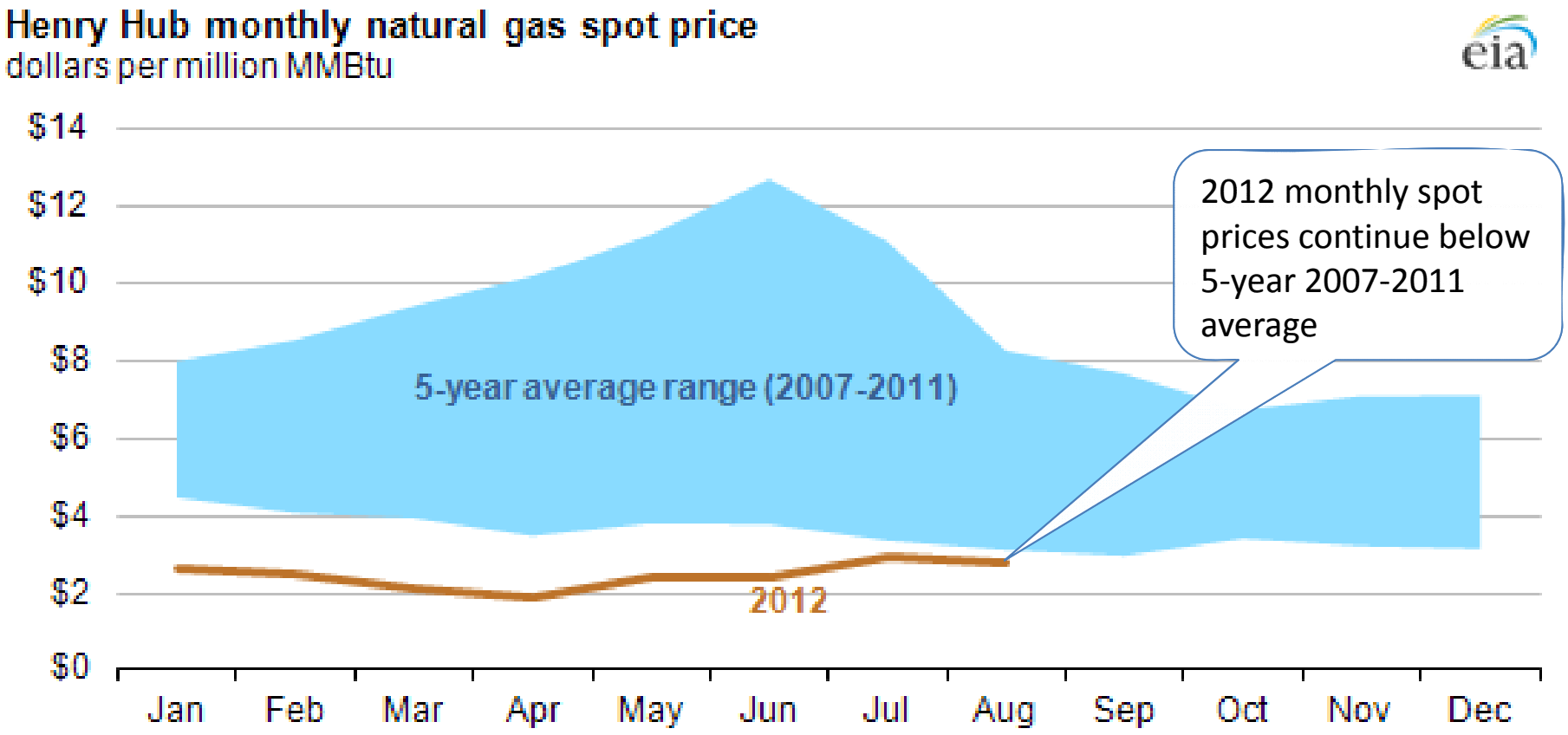


Graph shows **Nominal** and **Real** (corrected to 2005) dollars.

Source: U.S. Energy Information Administration

http://www.eia.gov/totalenergy/data/annual/

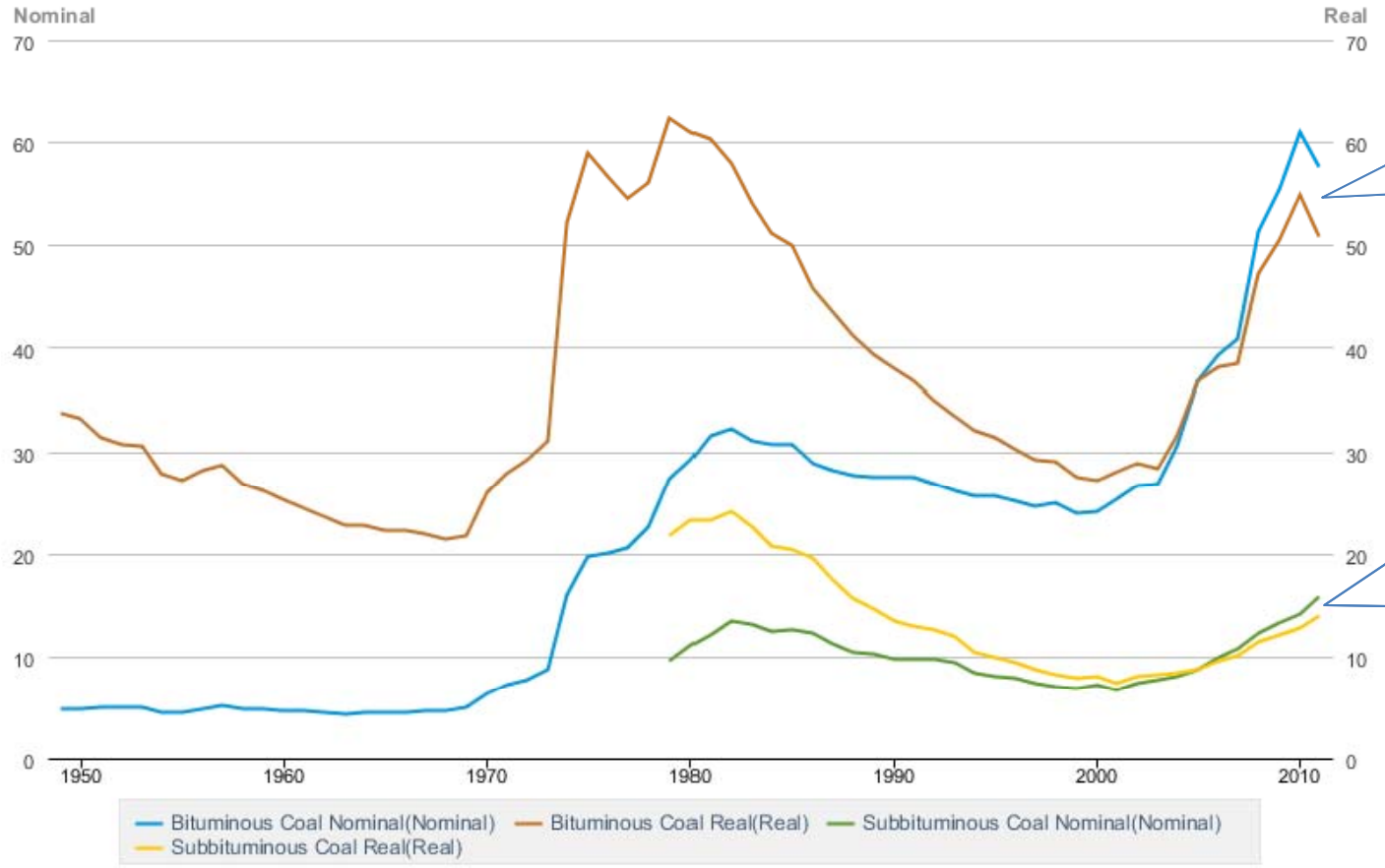
2012 Natural Gas Prices



http://www.eia.gov/todayinenergy/detail.cfm?id=8190

Historical Coal Prices

Table 7.9 Coal Prices, 1949-2011 (Dollars per Short Ton)



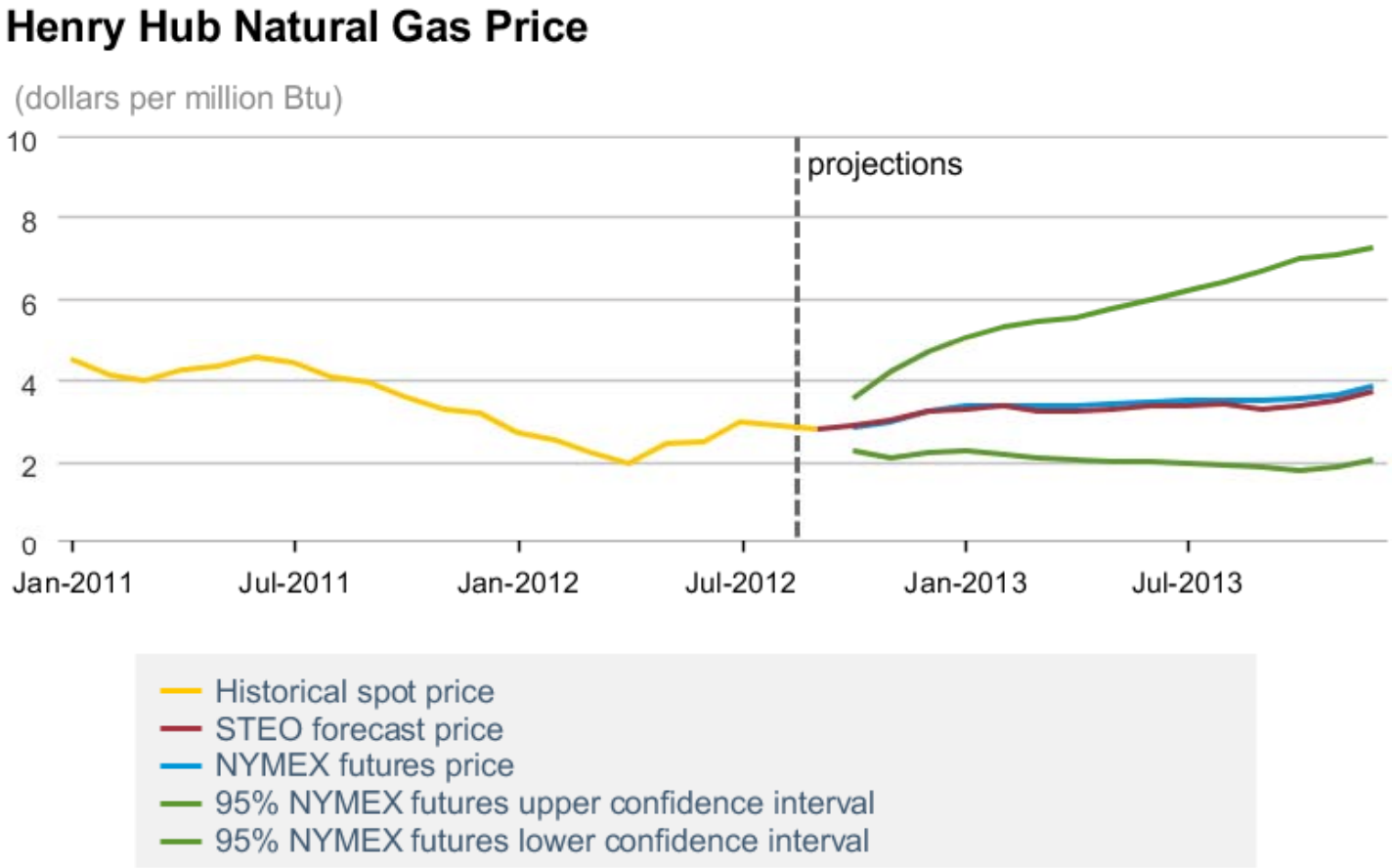
Bituminous coal **Nominal** and **Real** (2005) dollars.

Subbituminous coal **Nominal** and **Real** (2005) dollars.

eia Source: U.S. Energy Information Administration

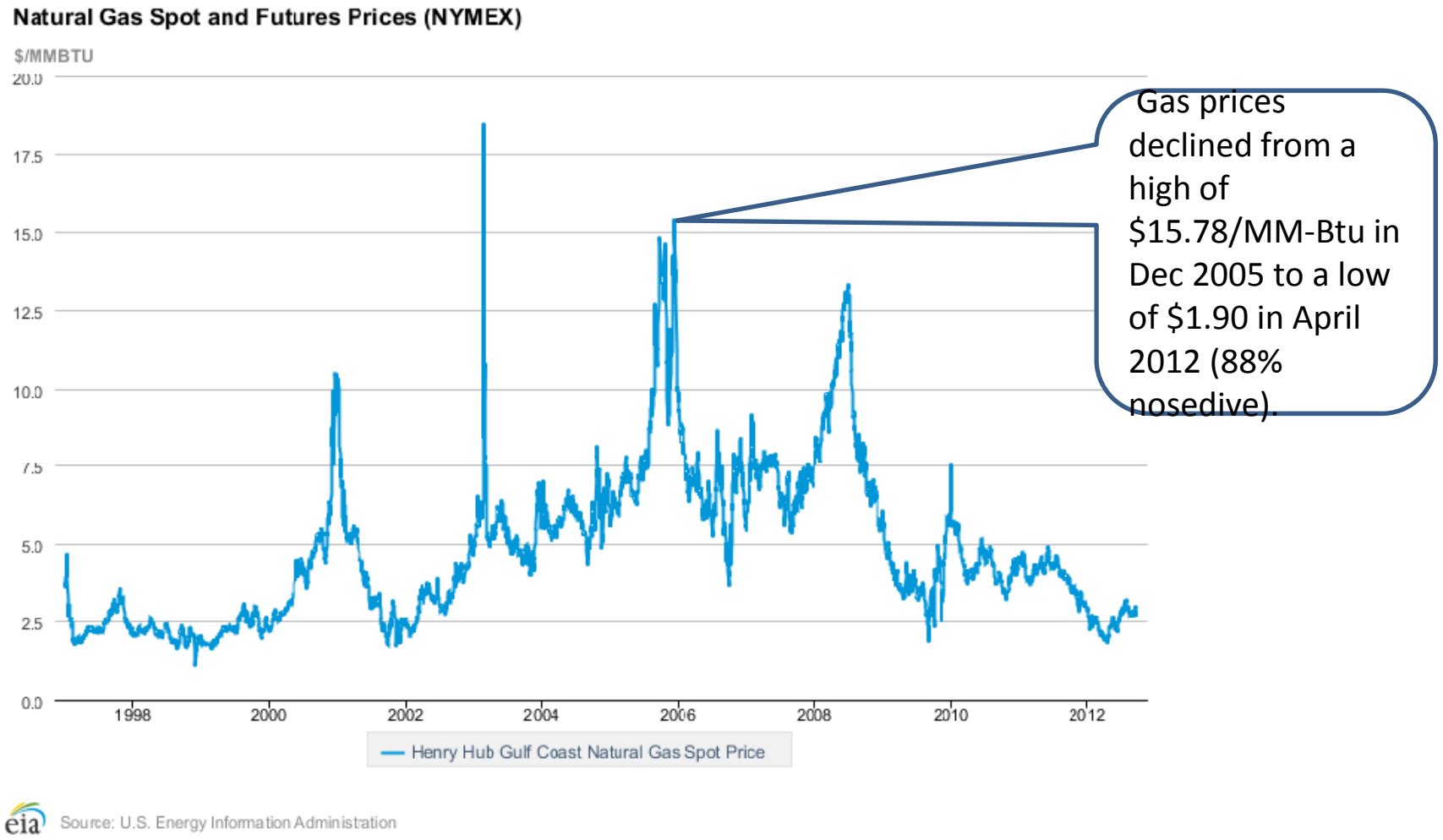
http://www.eia.gov/totalenergy/data/annual/

Forecasted Henry Hub Gas Prices

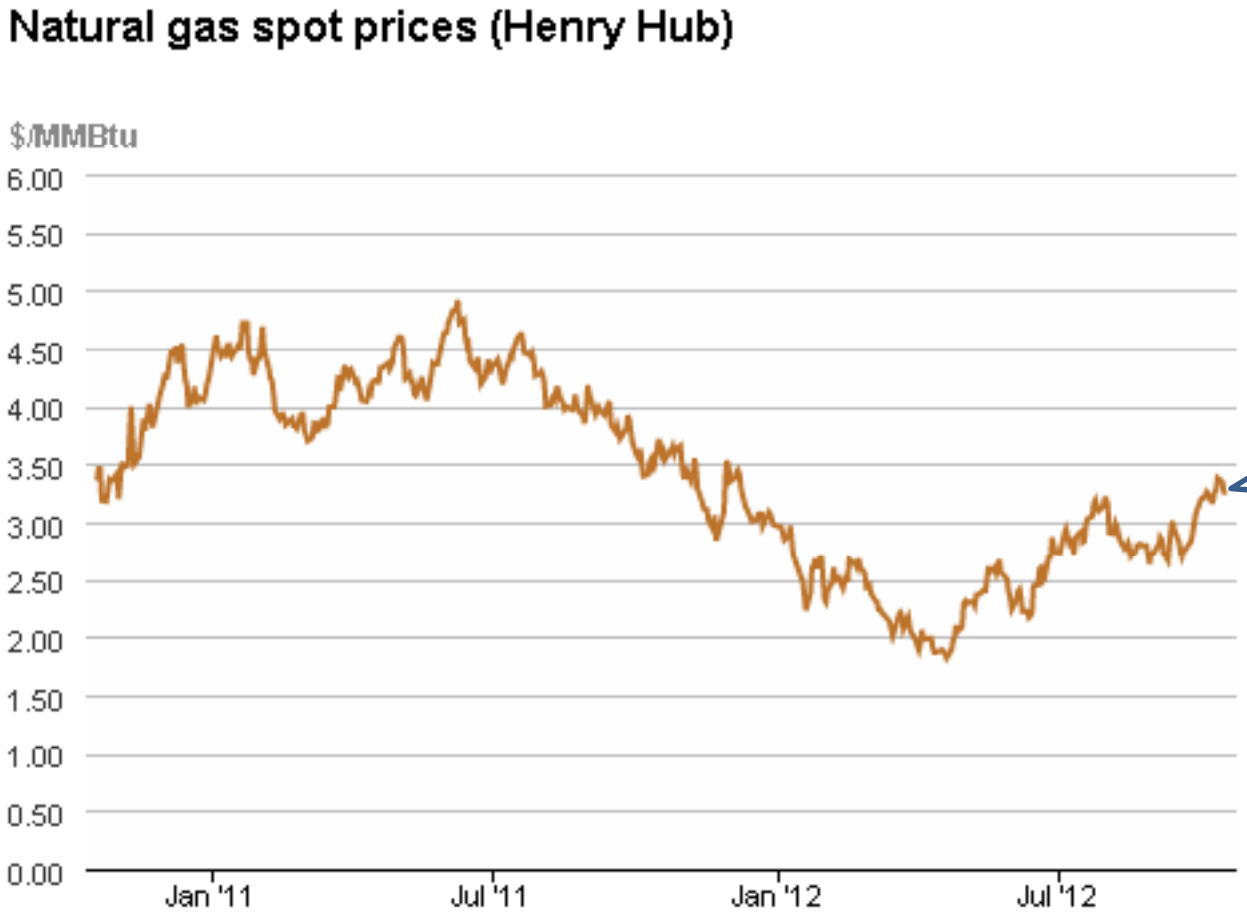


eia Source: Short-Term Energy Outlook, September 2012 http://www.eia.gov/forecasts/steo/report/natgas.cfm

Historical Gas Price Volatility



Recent Gas Price Variability

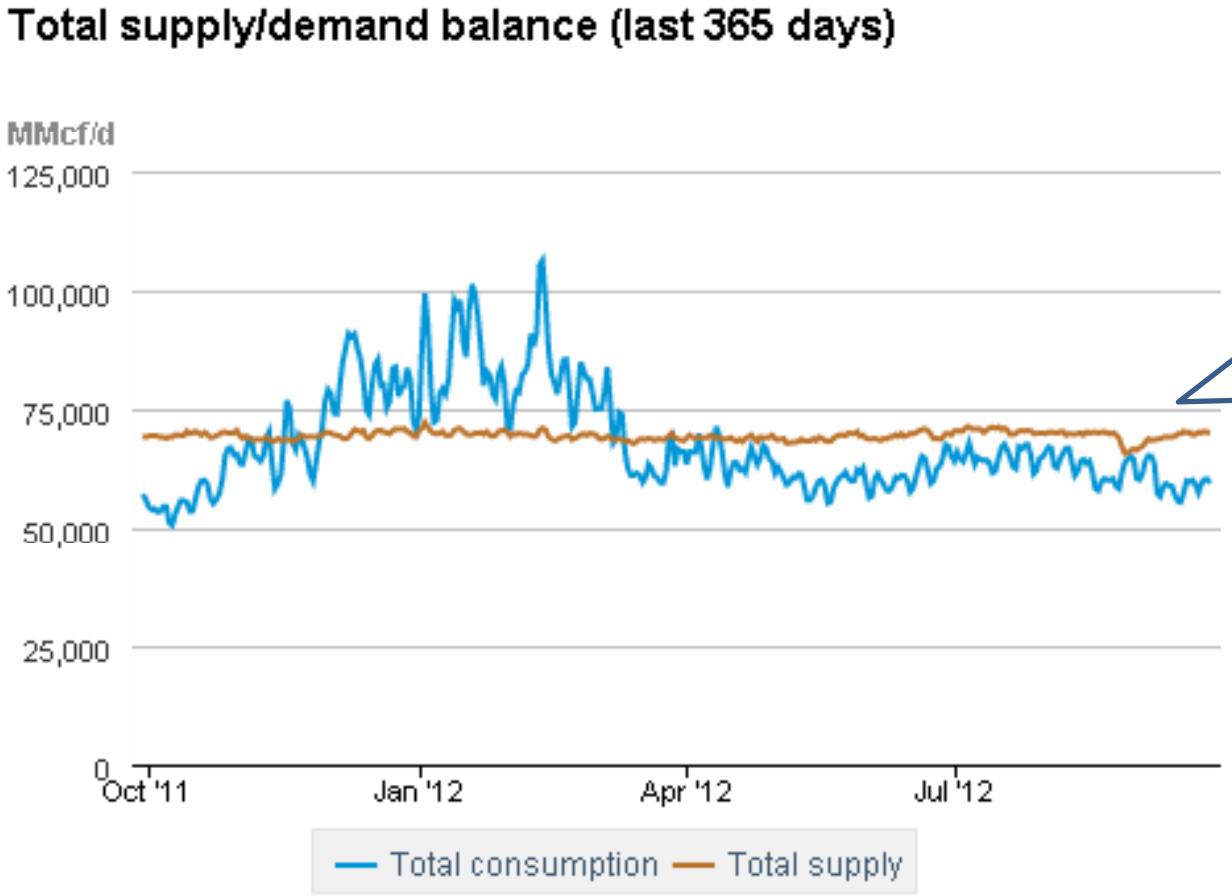


79% gas price increase since April

eia Source: Natural Gas Intelligence

http://www.eia.gov/naturalgas/weekly/

Recent Gas Supply vs. Consumption

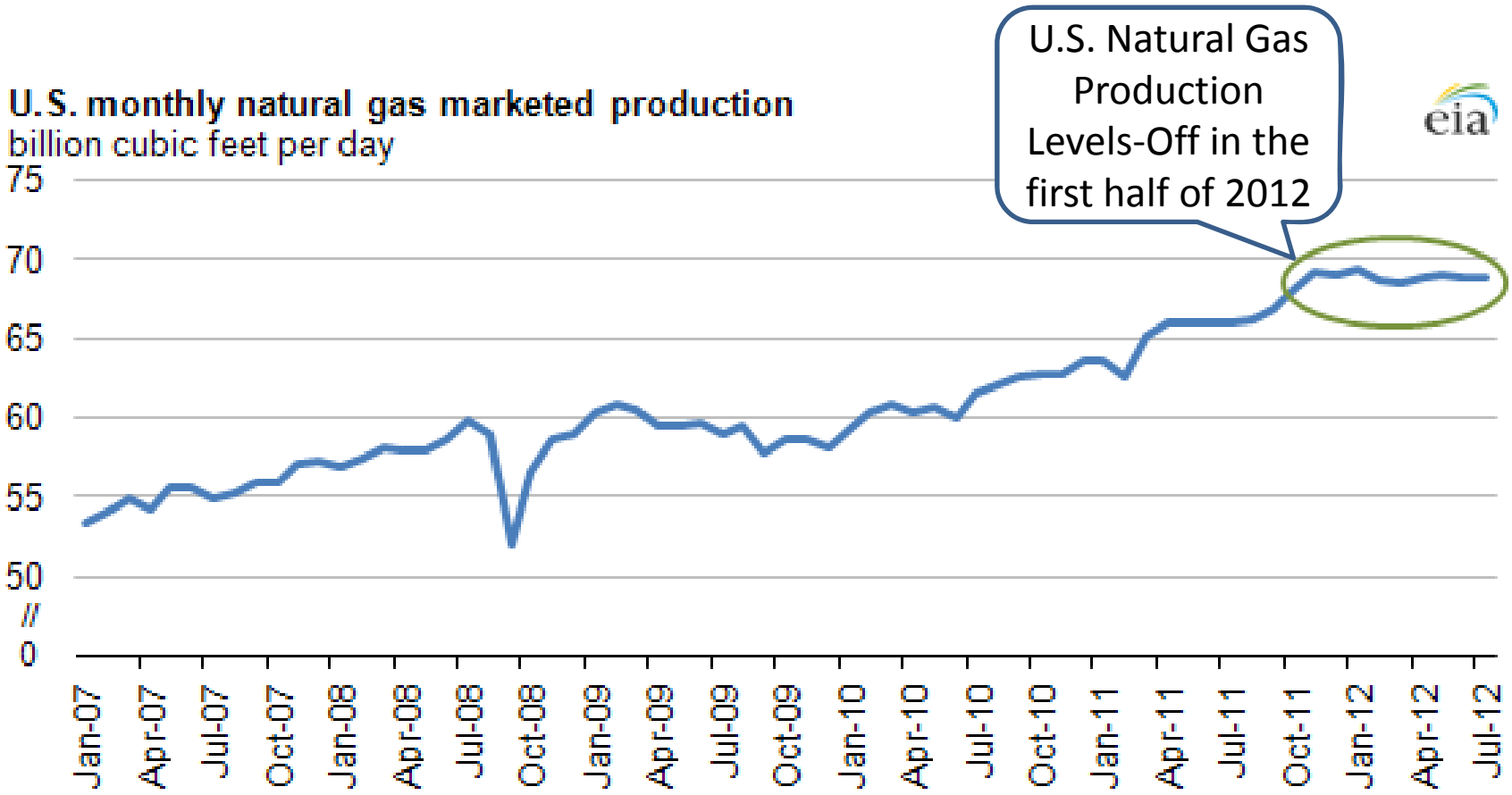


Relatively flat supply curve with seasonal consumption variation.

Source: BENTEK Energy LLC

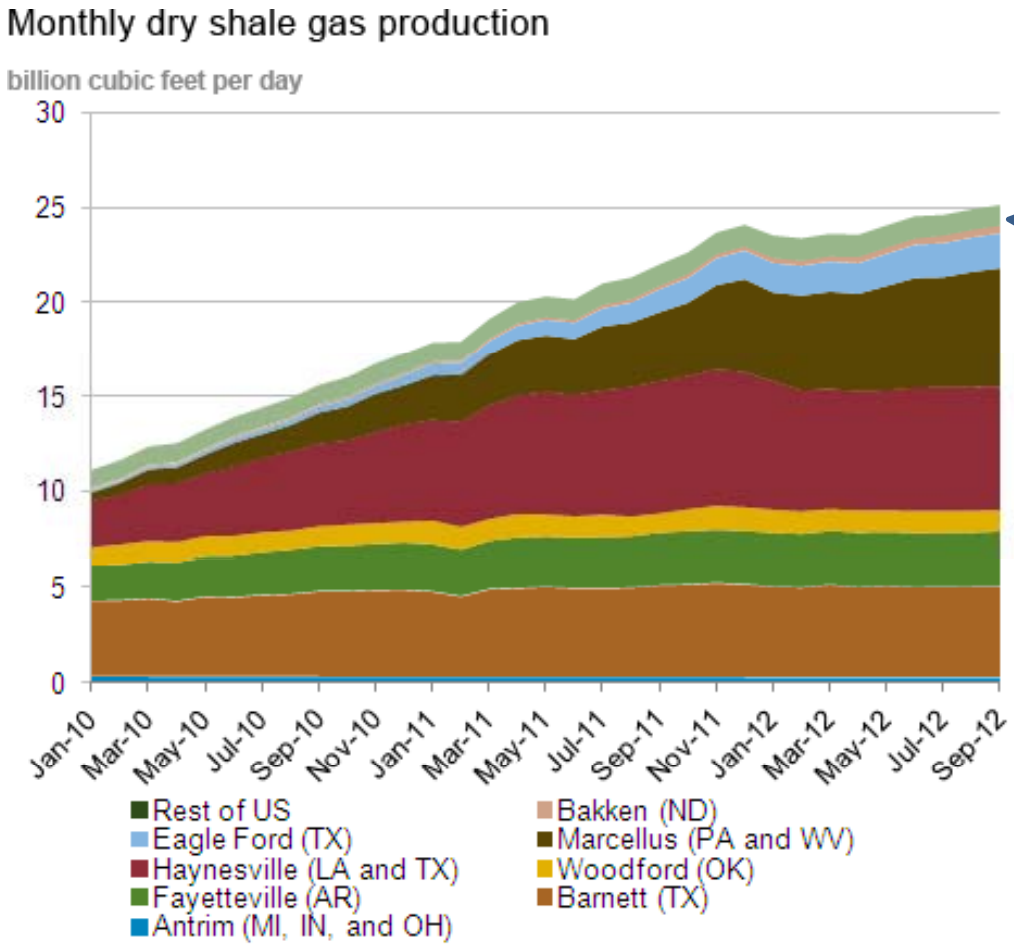
http://www.eia.gov/naturalgas/weekly/

Recent "Flattening" of Natural Gas Production



http://www.eia.gov/todayinenergy/detail.cfm?id=8190#

Shale Gas Production 2010-2012

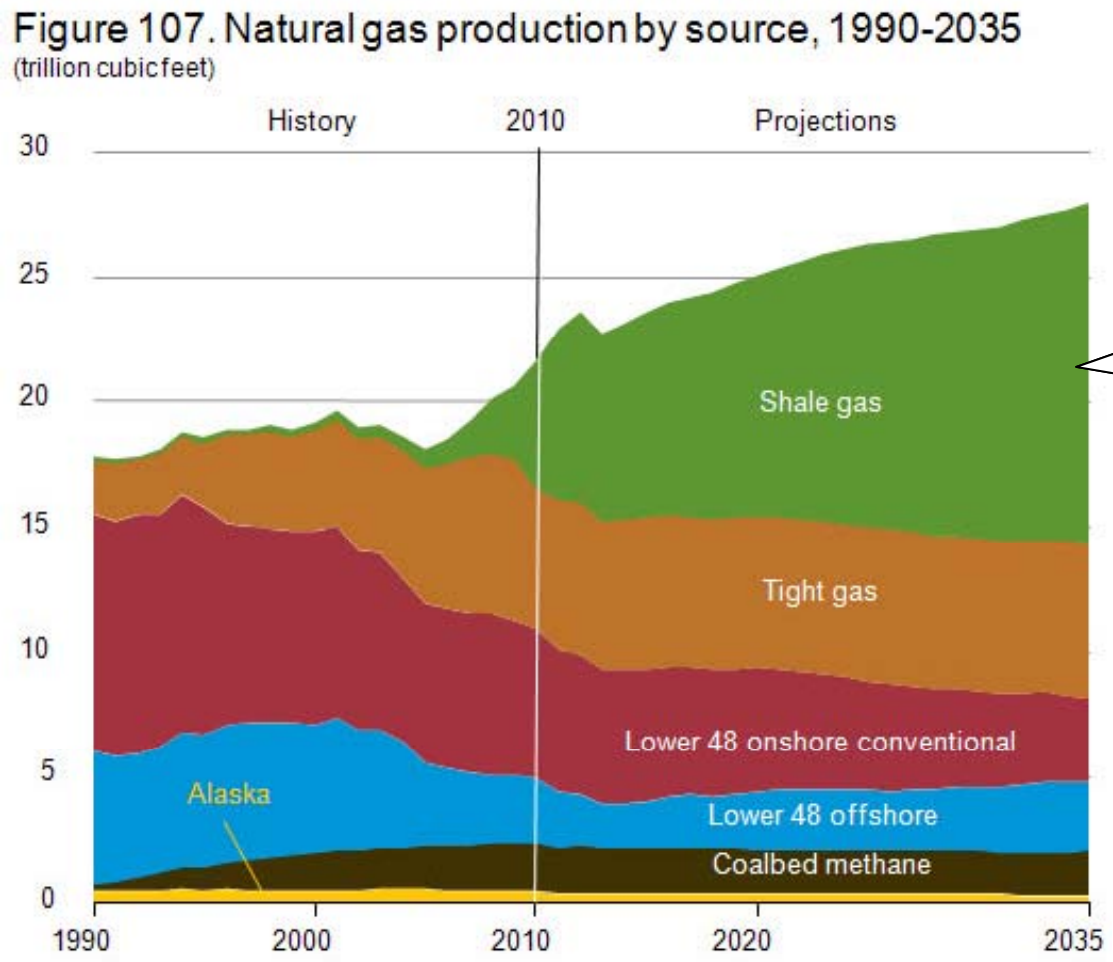


~150% increase in shale gas production over last 3 years

Source: Lippman Consulting, Inc. Gross withdrawal estimates are as of September 2012 and converted to dry production estimates with EIA-calculated average

http://www.eia.gov/naturalgas/weekly/

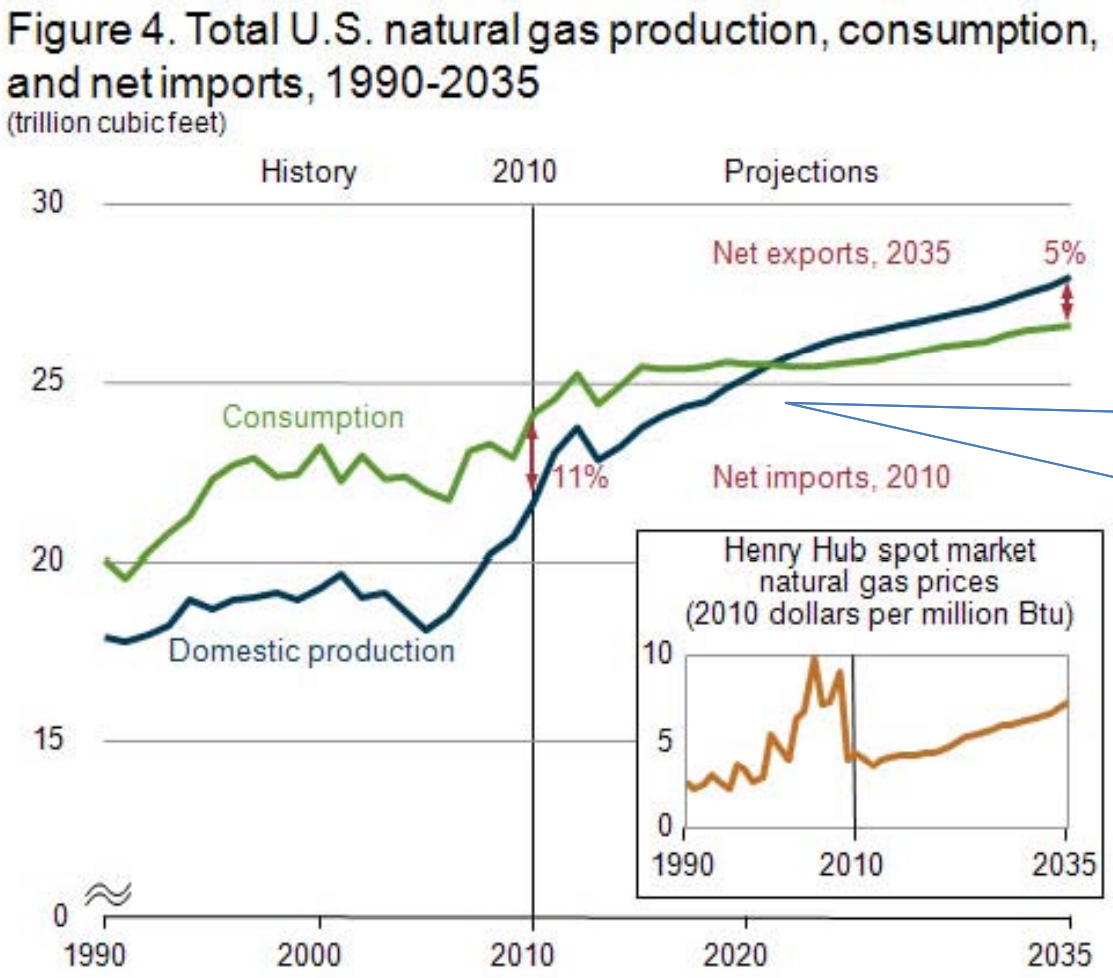
Long Term Gas Production Forecast



EIA Annual Energy Outlook 2012 forecasts significant growth in shale gas productions over next 20 years.

http://www.eia.gov/forecasts/aeo/source_natural_gas_all.cfm#recovery

U.S. Natural Gas Net Exporter by 2021?

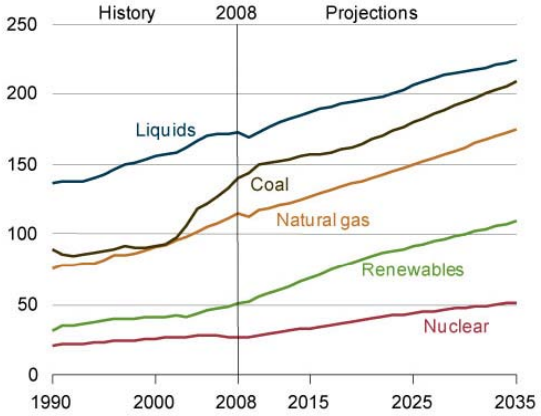


EIA 2012 Outlook forecasts U.S. will transition from a net importer to a net exporter of natural gas by 2021.

http://www.eia.gov/forecasts/aeo/source_natural_gas_all.cfm#natgas

Issue #2: World Fuel Markets

Figure 15. World energy consumption by fuel, 1990-2035
(quadrillion Btu)



INTERNATIONAL ENERGY OUTLOOK 2011

SEPTEMBER 19, 2011 (Next Release 2013)

http://www.eia.gov/forecasts/ieo/world.cfm

Growing Demand

Figure 17. World net electricity generation by fuel type, 2008-2035
(trillion kilowatthours)

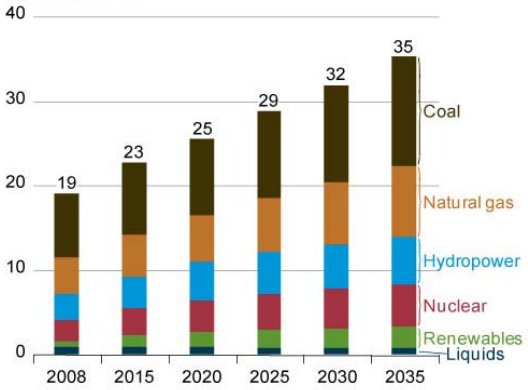


Figure 13. Energy consumption in the United States, China, and India, 1990-2035
(quadrillion Btu)

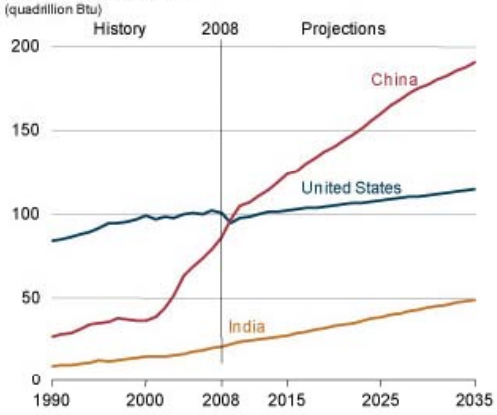
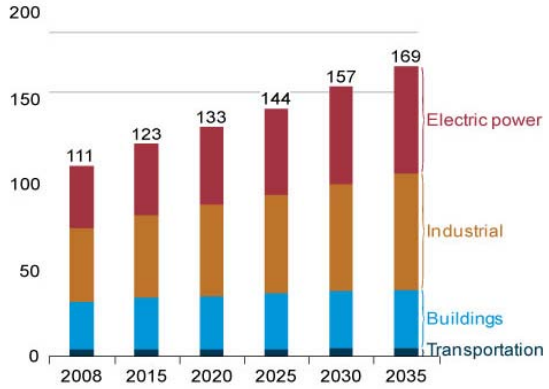


Figure 16. World natural gas consumption by end-use, sector, 2008-2035
(quadrillion Btu)



World Natural Gas Market

- 9/25/12 Bloomberg article by Eric Roston reported:
  - Export infrastructure is needed to liquefy natural gas.
  - Alaska has only operating LNG export plant in U.S.
  - LNG exporting/importing isn't easy. Gas fields and pipeline systems have to be developed – U.S. has advantage.
  - DOE approved one new LNG export terminal, at Cheniere Energy Inc.'s import terminal in Cameron Parish, Louisiana. DOE reviewing a dozen others.
  - Fleet of specialized tankers must be expanded to transport LNG by sea.
  - Importing countries need facilities to re-gasify the fuel and pipelines to distribute the gas.

http://www.bloomberg.com/news/2012-09-26/shale-fracking-makes-u-s-natural-gas-superpower-now-what-.html

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World Natural Gas Market

- What LNG export prices could U.S. companies see? Major question!
- Policymakers are studying the impact of U.S. exports on gas prices at home.
- Future world market prices will change as countries develop their own natural gas reserves.

World Natural Gas Prices

Data in $US/MMBtu. Updated September 7, 2012. Source: Federal Energy Regulatory Commission

http://www.bloomberg.com/news/2012-09-26/shale-fracking-makes-u-s-natural-gas-superpower-now-what-.html

Issue #3: U.S. Transportation Market

- **Infrastructure** is needed for distribution of compressed natural gas (CNG)
  - Initially for Fleet vehicles
  - Followed by gas supply for remainder of public
- **Development** is needed for CNG Vehicles
- Both of above **take time** – many years to bring CNG and CNG fueled vehicles to mass market

Issue #4: Environmental

- Coal Issues
  - Mercury & Air Toxic Standards (MATS) Rule - Appeals Court Challenges
  - Mining regulation impact on coal prices
  - Duct Injection success with Electrostatic Precipitators / PSD limitations
  - Other multimedia environmental issues (e.g., Ozone and $PM_{2.5}$ NAAQS, FGD effluent guidelines, coal derived waste/refuge)
  - 316B intake screen issues
  - Solid waste coal ash waste hazardous waste classification

Issue #4: Environmental (cont'd)

- Natural Gas Issues
  - Shale Gas Environmental Issues
  - Natural Gas Pipeline Permitting and Safety Issues
  - Environmental controls needed
- Greenhouse gas regulation
  - Cap & Trade Legislative delay impact
  - Natural gas leakage regulation impact
- Water Consumption
  - Cooling water consumption is issue for some utilities

Issue #5: Political Ramifications

- Impact(s) of November 6th Presidential Election
  - Executive or Congressional action to overturn HAPs rule or other EPA rules?
  - Overall Energy Policy……Place for Coal?
  - Focus on U.S. energy (fuel) independence?
  - Any fuel market restrictions – domestic or international?
  - Greenhouse gas actions?
- World political and economic implications from U.S. natural gas boon?

Issue #6: Technology & Economic Issues

- Boiler Conversion (e.g., generating capacity impact, boiler surface modifications, startup/shutdown and cycling enhancements, NFPA code impacts, DCS modifications, and Environmental Controls (e.g., NOx, VOC, CO, etc.)
- Other Natural Gas Technology Alternatives to consider
- Natural Gas Pipeline Issues
- Boiler Capacity Replacement and Turndown Capability
- Transmission and System Load Impacts (e.g., changing base load units to peaking units)
- Dramatic Dispatch Impact with Gas Price Variation
- Recommendations from Boiler Vendors?

Alternatives

1. Coal-Fired Unit Environmental Control
2. Boiler Coal-to-Gas Conversion
3. Repowering
4. Unit Retirement
5. Other Alternatives?

Alternative #1: Coal Unit Environmental Control

- Coal-Fired Unit Multi-Media Environmental Controls
  - Air: Wet or Dry FGD, SCR, Baghouse, ACI/DSI, etc.
  - Water:
    - Wet FGD Effluent treatment; elimination or minimization of ponds
    - Intake Screen Modifications
    - Cooling tower addition for reduced water consumption or reducing unit derates during hot summer months
  - Solid Waste (Coal Combustion Waste):
    - Wet-to-Dry fly ash conversion
    - Separation of fly ash from FGD waste

Alternative #2: Coal-to-Gas Conversion

- Convert Boiler to ***Natural Gas-Fired Peaking Unit***
  - Gas-Fired Unit **Environmental Controls**
    - NOx: SCR, Hybrid SCR, SNCR, additional Air Staging, Advanced Boiler Controls
    - CO or VOC Controls: SCR CO catalyst, Advanced Combustion Controls
  - Adverse ***heat rate impact***
  - Operation may be very limited (***poor peaking dispatching characteristics***)
- Convert Boiler to ***Co-Fire*** Coal and Gas
  - Requires **BOTH** Coal-Fired Unit Multi-Media Environmental Controls and Gas-Fired Unit Environmental Controls

Alternative #3: Repowering

- New Combustion Turbine (CT) addition using existing boiler (for heat recovery) ***and*** existing steam turbine generator
- New CT and Heat Recovery Steam Generator (**HRSG**) addition using existing steam turbine generator

Alternative #4: Unit Retirement

- Shut down existing coal-fired steam unit(s)
- Onsite/Offsite replacement of capacity and energy by addition of:
  - New Combined Cycle units
  - New Simple Cycle CT(s)
  - Purchase Power Contracts

Alternative #5: Other Alternatives

- Coal fired boiler oil igniter system conversion to ***gas ignition***
- Other?

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Decision Timing

- Consider ***VALUE*** of ***delaying decisions for decision Flexibility*** versus ***advancing decisions to get through "learning curve"***
  - Some people fear the uncertainties of the future and ***refuse to make decisions until it is too late***, when many alternatives are no longer available.
  - Others ignore uncertainties, ***doing just what they have to do at that time***, and letting tomorrow's issues bring whatever they will.
  - Then, there are those who at the time ***when various decisions need to be made***, consider future uncertainties against alternatives, and simply make the best decision they can.
    - Some already have pulled all necessary information together
    - Others wait and try to pull information together when needed

Risk Assessments

- Need to **consider Risks** - both good and bad – on a **Fleet Basis**
  - Risk Assessment **Types** (e.g., Decision Tree, Cumulative Risk Curve, Scenario Planning, etc.)
  - Identify risks according to **potential impact** on outcome and establish probabilities of occurrence for each risk
- Time Risks
  - Delaying Decision to "**Late as Possible**"
    - **Schedule and cost risks**
      - Permitting, Design and/or Equipment Supply, Labor, and Construction Risk
      - Transmission system impact for late project startup
      - Impact of Operating Issues during Startup and Commissioning
  - "**Early**" Decision
    - Risk of spending capital and O&M early and **not finding** any lessons learned
- Consider risk assessment accuracy **limitation**
- Realize possibility of **"unanticipated"** remaining risks

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Conclusion

- Planning for the future is a gamble.
- Reduce the odds. Do your work beforehand.
- Assess risks, expect value to generation diversity and avoid "wholesale decision jumps" due to paradigm shifts.