

REINHOLD ENVIRONMENTAL Ltd.



**2013 NO_x-Combustion Round Table
& Expo Presentations**

February 18 & 19, 2013, in Salt Lake City, UT / Hosted by PacifiCorp

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Electric Utility Planning in an Uncertain World

Reinhold Environmental 2013 NO_x-Combustion Round Table

Salt Lake City, Utah
February 18-19, 2013

***Presented by - Rick Collins
Associate Consultant to RE Consulting***

Presentation Topics

- 1. Utility Environmental Decision Making**
- 2. Environmental Legislative and Regulatory Update**
- 3. Natural Gas Market Price and Forecast**
- 4. Current Environmental Air Pollution Control Technologies**
- 5. Methods For Addressing Uncertainties**

Decisions.....Decisions.....Decisions



Decision Impact?

- Today's Major Decisions can and likely will impact your company and your customers.
 - For the better
 - or
 - For the worse
- Therefore, is your decision process sufficient to protect your company and your customers in the future?



What Is So Difficult?

- Company Decision Making methods can *change frequently*
- Continued *Ratcheting* of Environmental Rules and Regulations
- *Technology* and *Fuel Markets* change
 - Improvements, Failures, and Problems with Existing Technologies
 - Development of New Technologies
 - Process and Equipment Vendor Markets change
 - Technology Capital Costs change
 - Shifts in Coal and Natural Gas Markets
- *World* constantly changes – Politics, major world events, etc.

LOTS OF UNCERTAINTY....
CAN'T CONTROL THE FUTURE!

What Should You Do?

1. ***Control what you can.***
2. ***For Uncertainties Beyond Your Control, Assess Sufficiently To Avoid Future Surprises And Major Regrets.***

What Can You **Control**?

- **Decision Making Process**
- **Selection of Assessment Tools**
- **Knowledge level about Environmental Rules**
- **Knowledge level about Technology and Fuel Markets**

Basic Decision Making Process

1. Gather an “**Appropriate**” Team
2. Identify the Problem
- ★ 3. Identify All **Major Issues**
- ★ 4. Identify All **Alternative Solutions**
- ★ 5. Collect **Data** and **Schedule** Information
6. Perform Initial Analysis
- ★ 7. Identify **Major Risks** and Probabilities
8. Perform Final Analysis, Including Risks
9. Make Final Recommendation/Decision

★ (Primary focus of rest of this discussion)

Basic Decision Making Process

1. Gather an “Appropriate” Team

2. Identify the Problem



3. Identify All Major Issues



4. Identify All Alternative Solutions



5. Collect Data and Schedule Information

6. Perform Initial Analysis



7. Identify Major Risks and Probabilities

8. Perform Final Analysis, Including Risks

9. Make Final Recommendation/Decision



(Primary focus of rest of this discussion)

Gather an “Appropriate” Team

- What is “**Appropriate**”
 - Not just any team will do. Limit size to 5 to 8 members.
 - Need team members with **expertise** in their area of responsibility, capable of working others, and committed to the team assignment.
 - **Personality conflicts** to avoid: overbearing, opinionated, preference for independent work versus team work, etc.
 - Preferably team members that have been on numerous successful teams before.
 - Need team **leader** with team training and/or experience. Must be organized to keep team focused, but not a driver who overpowers the team effort.
 - Everyone must be **empowered and encouraged** to contribute.
 - Team members must know the limits of their expertise and have the ability of returning to their departments for input as needed.
 - Need good team management **sponsor** to interface with executives, but one that does not “drive” the decision.

Basic Decision Making Process

1. Gather an Appropriate Team

2. Identify the Problem

- ★ 3. Identify All Major Issues
- ★ 4. Identify All Alternative Solutions
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★ (Primary focus of rest of this discussion)

Identify the Problem

- **Team** needs to develop a basic problem statement together to ensure:
 - team is focused together
 - team members all “buy-in” with equal understanding
 - team is headed in same direction with same objective.
- **Statement** needs to:
 - Be Short, Simple, Clear, Concise, and Complete
 - Be Fact Based
 - State Specific Objective(s)

Basic Decision Making Process

1. Gather an Appropriate Team
2. Identify the Problem
- ★ **3. Identify All Major Issues**
- ★ 4. Identify All Alternative Solutions
- ★ 5. Collect Data and Schedule Information
6. Perform Initial Analysis
- ★ 7. Identify Major Risks and Probabilities
8. Perform Final Analysis, Including Risks
9. Make Final Recommendation/Decision

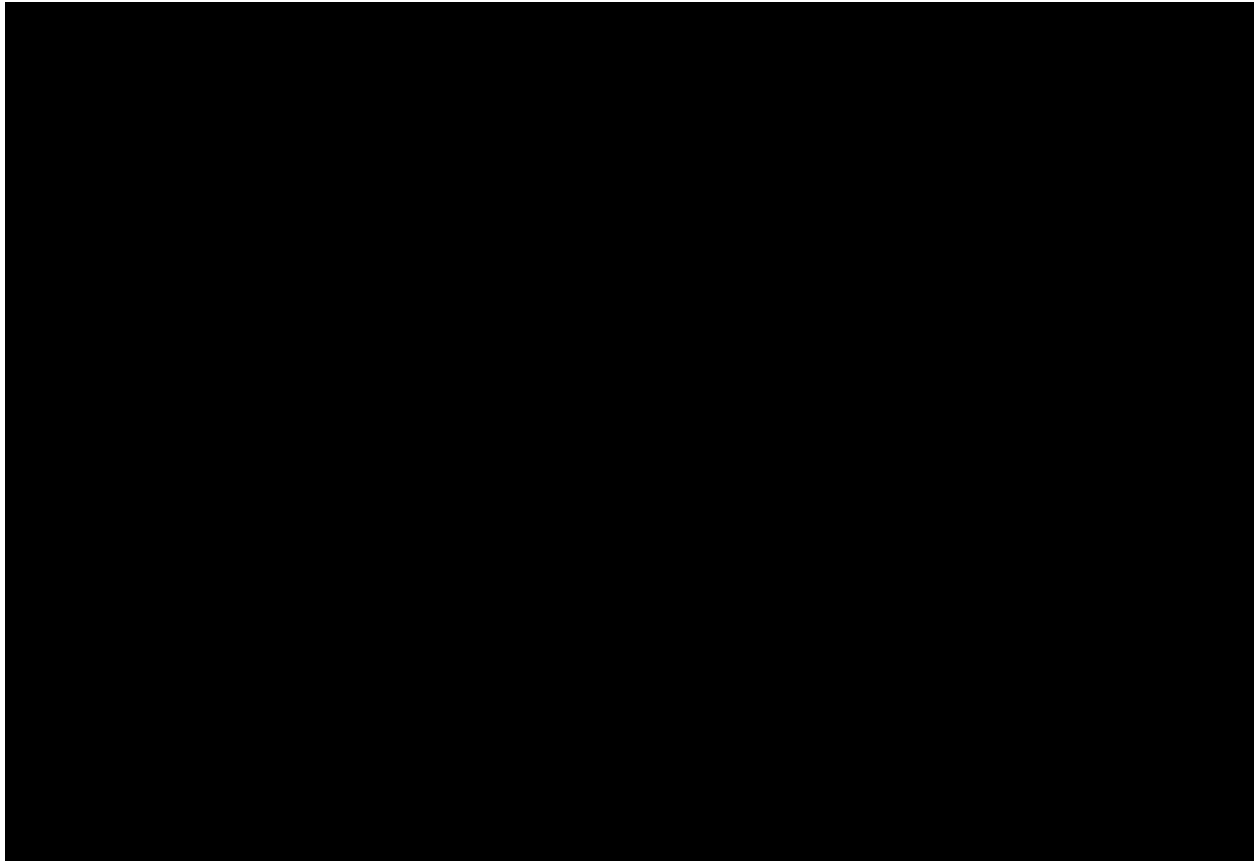
★ (Primary focus of rest of this discussion)

Major Issues – Existing & Future

- 1. Current Environmental Status***
- 2. Environmental Legislation and Regulations***
- 3. Coal and Natural Gas Markets***
- 4. Political Ramifications / Media Impact***
- 5. Technology and Economic Issues***

Issue #1: Current Environmental Status

Example: Salt Lake City Air Inversion 1/25/2013



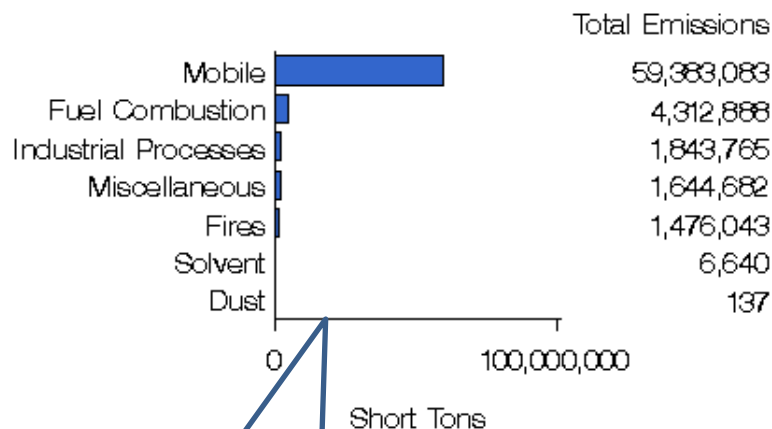
<http://www.youtu.be/kdCm4PYyWxo>

Current Air Emission Pollutants

- National Ambient Air Quality Standard (NAAQS) Criteria Pollutants for 40 CFR 60 Subpart Da
 - Carbon monoxide (CO), ground level ozone (O₃), lead (Pb), nitrogen dioxide (NO₂), particulate matter (PM), and sulfur dioxide (SO₂)
- Utility Cap and Trade Pollutants
 - SO₂ and NO_x
 - CO₂ (Potential Future Cap or Tax)
- MATS Pollutants
 - Metals (e.g., mercury, arsenic, chromium, nickel) – Mercury and PM₁₀ as surrogates
 - Acid gases (e.g., hydrochloric acid (HCl), hydrogen fluoride (HF)) – HCl as surrogate
 - Organic air toxics (dioxin, furans) – Work Practice Standards

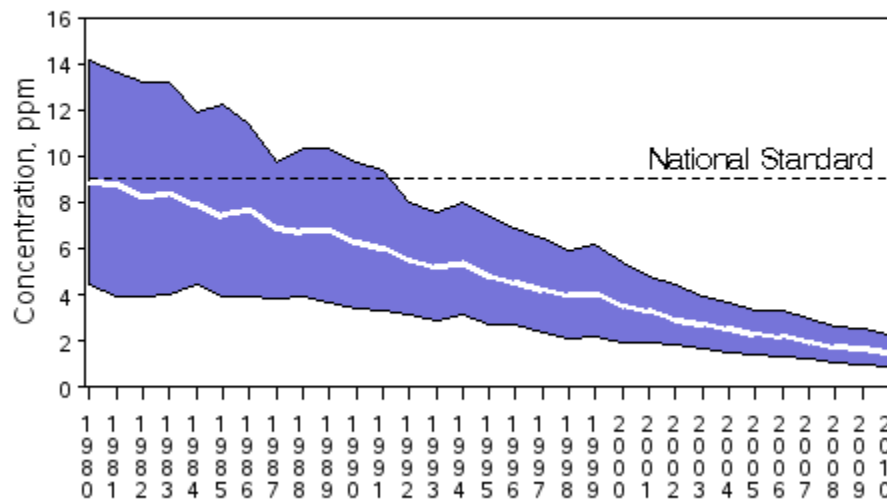
Carbon Monoxide (CO)

National Carbon Monoxide Emissions by Source Sector
(NEI 2008 v1.5 GPR)



Mobile sources have majority of contribution.

CO Air Quality, 1980 - 2010
(Based on Annual 2nd Maximum 8-hour Average)
National Trend based on 104 Sites



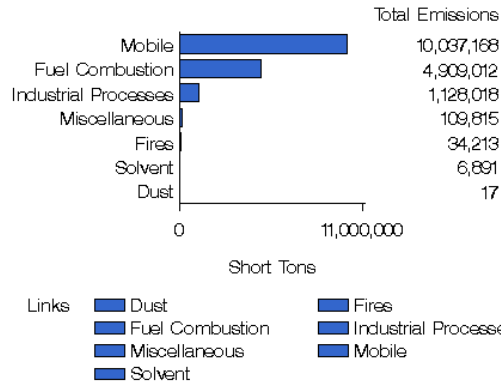
1980 to 2010 : 82% decrease in National Average

Ambient CO levels dropped significantly (82%) since 1980.

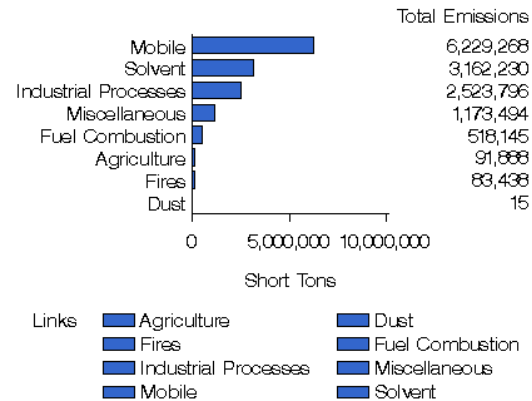
Reference: http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.national.1.sas&polchoice=CO

Ground Level Ozone (O₃)

National Nitrogen Oxides Emissions by Source Sector
(NEI 2008 v1.5 GPR)

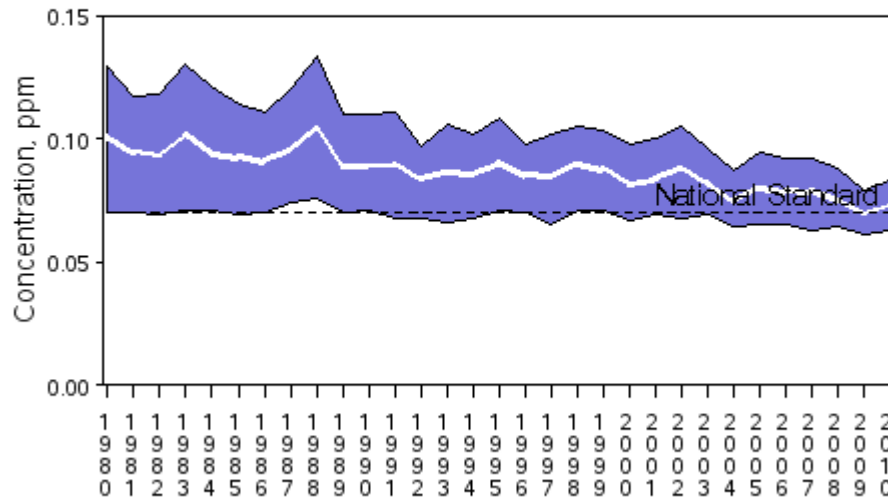


National Volatile Organic Compounds Emissions by Source Sector
(NEI 2008 v1.5 GPR)



Ground level ozone is created by chemical reactions between oxides of nitrogen (NO_x) and volatile organic compounds (VOC) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of NO_x and VOC.

Ozone Air Quality, 1980 - 2010
(Based on Annual 4th Maximum 8-Hour Average)
National Trend based on 247 Sites



Not much National change since 1980 (~25%).

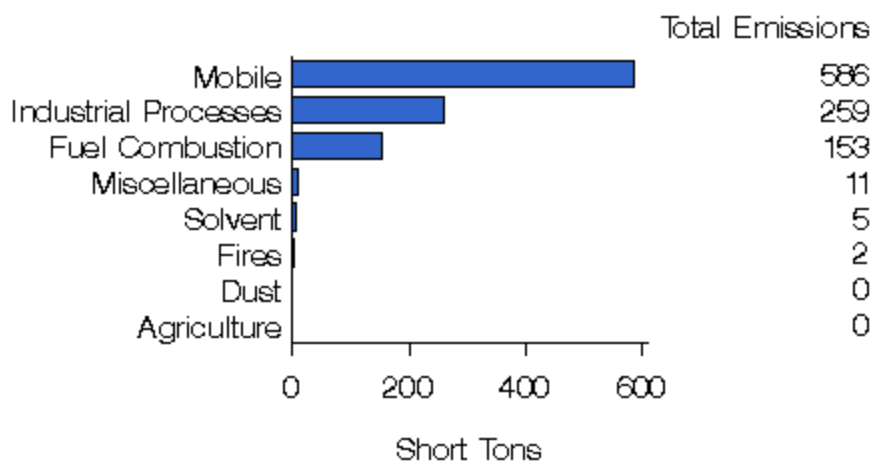
1980 to 2010 : 28% decrease in National Average

Reference: http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.national_1.sas&polchoice=VOC

Lead (Pb)

National Lead Emissions by Source Sector

(NEI 2008 v1.5 GPR)

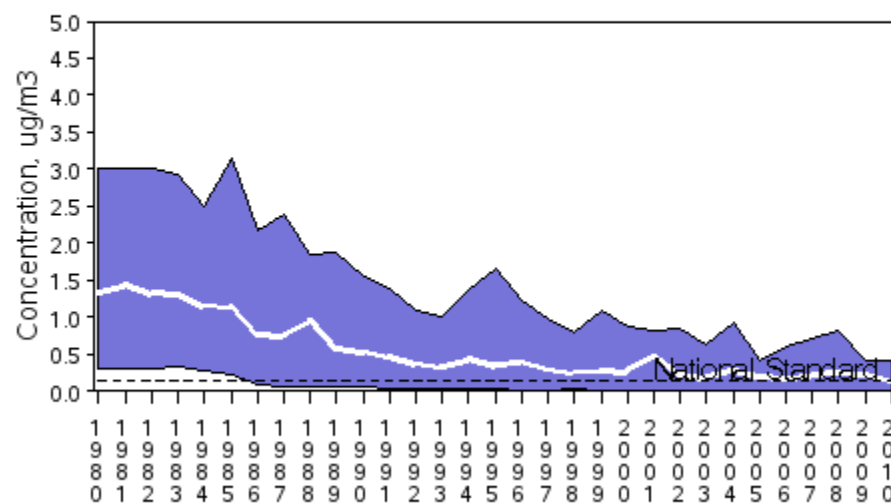


- Links
- Agriculture
 - Dust
 - Fires
 - Fuel Combustion
 - Industrial Processes
 - Miscellaneous
 - Mobile
 - Solvent

Lead Air Quality, 1980 - 2010

(Based on Annual Maximum 3-Month Average)

National Trend based on 31 Sites



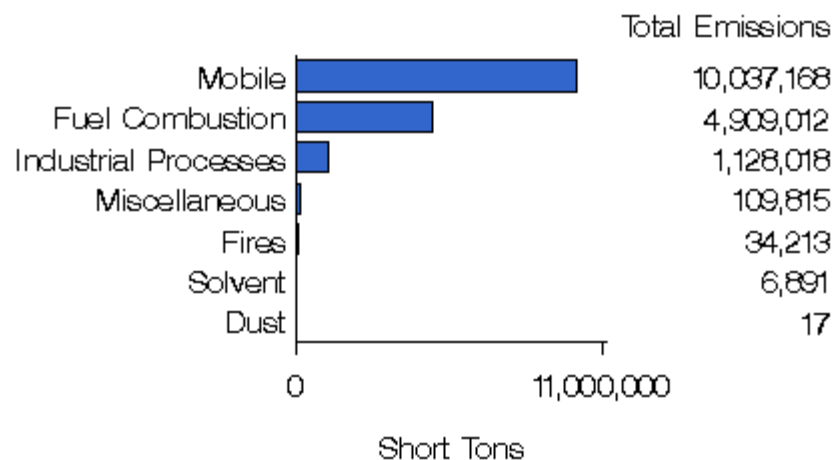
1980 to 2010 : 89% decrease in National Average

Significant reductions (89%) in ambient lead levels since since 1980.

Reference: http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.national.1.sas&polchoice=Pb

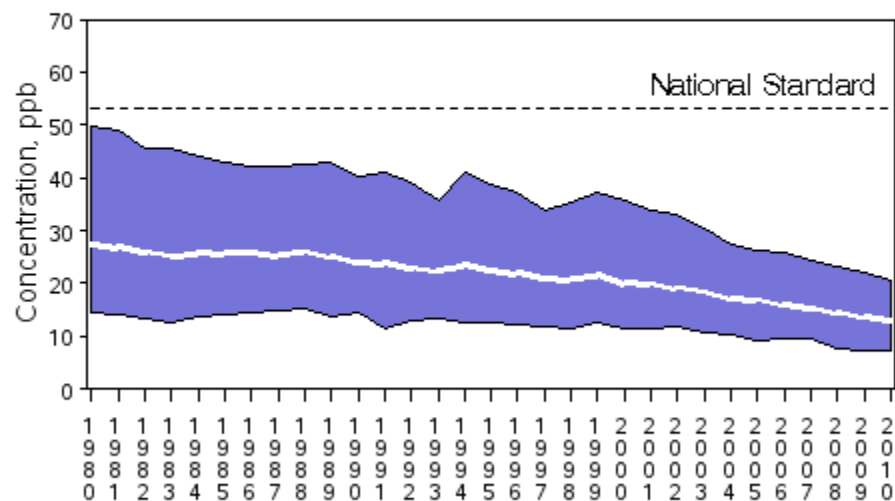
Nitrogen Oxides (NO₂)

National Nitrogen Oxides Emissions by Source Sector
(NEI 2008 v1.5 GPR)



- Links
- Dust
 - Fires
 - Fuel Combustion
 - Industrial Processes
 - Miscellaneous
 - Mobile
 - Solvent

NO₂ Air Quality, 1980 - 2010
(Based on Annual Arithmetic Average)
National Trend based on 81 Sites



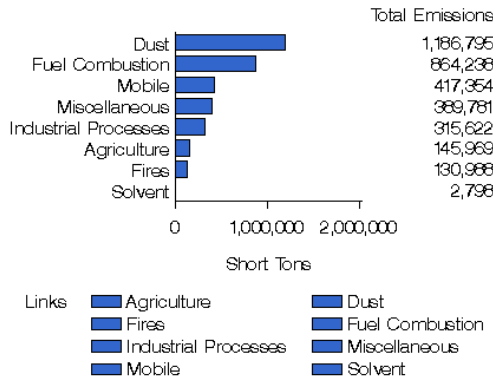
1980 to 2010 : 52% decrease in National Average

Limited reduction (52%) in national NO₂ ambient levels since 1980.

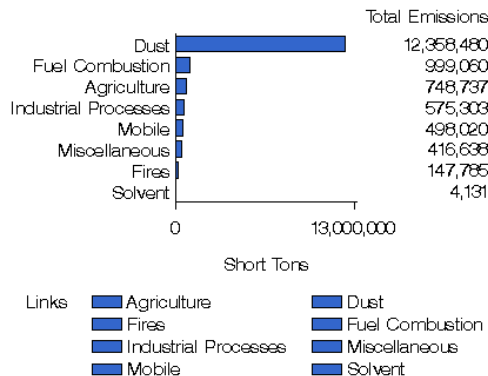
Reference: http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.national_1.sas&polchoice=NOX

Particulate Matter (PM)

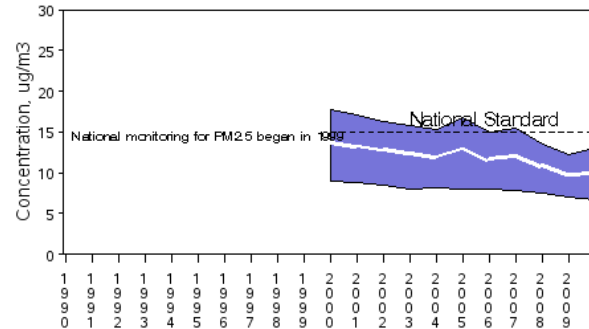
National PM_{2.5} Emissions by Source Sector
(NEI 2008 v1.5 GPR)



National PM₁₀ Emissions by Source Sector
(NEI 2008 v1.5 GPR)



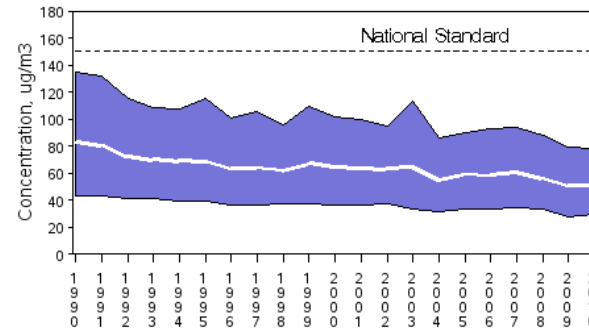
PM_{2.5} Air Quality, 2000 - 2010
(Based on Seasonally-Weighted Annual Average)
National Trend based on 646 Sites



2000 to 2010 : 27% decrease in National Average

PM_{2.5} is under NAAQS limit and dropping.

PM₁₀ Air Quality, 1990 - 2010
(Based on Annual 2nd Maximum 24-Hour Average)
National Trend based on 279 Sites



1990 to 2010 : 38% decrease in National Average

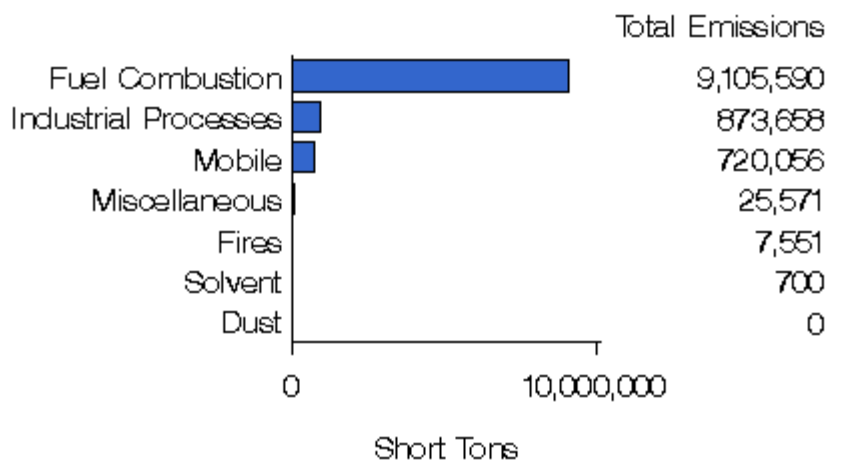
PM₁₀ is well under standard and dropping.

Reference: http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.national_1.sas&polchoice=PM

Sulfur Dioxide (SO₂)

National Sulfur Dioxide Emissions by Source Sector

(NEI 2008 v1.5 GPR)

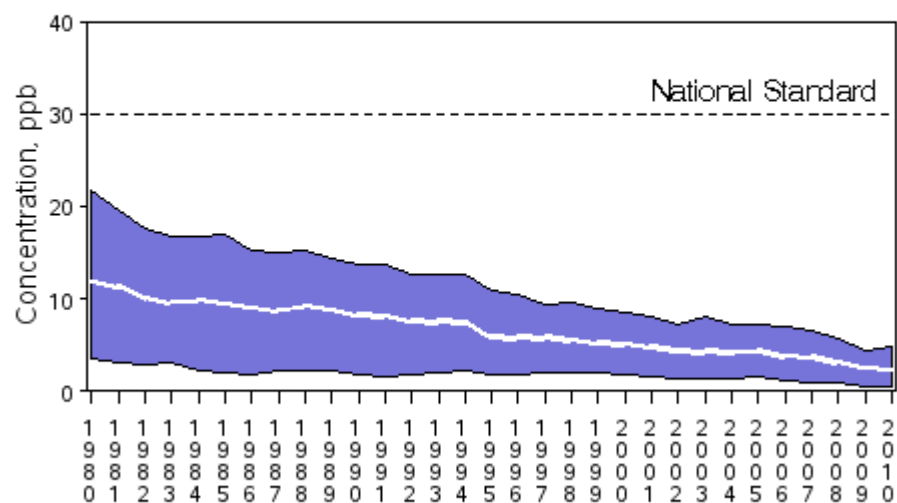


- Links
- Dust
 - Fires
 - Fuel Combustion
 - Industrial Processes
 - Miscellaneous
 - Mobile
 - Solvent

SO₂ Air Quality, 1980 - 2010

(Based on Annual Arithmetic Average)

National Trend based on 121 Sites



Significant reductions (83%) in ambient SO₂ levels since since 1980.

Reference: http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.national.1.sas&polchoice=SO2

Change in National Air Quality

Percent Change in Emissions Versus Time

	1980 vs 2010	1990 vs 2010	2000 vs 2010
Carbon Monoxide (CO)	-82	-73	-54
Ozone (O ₃) (8-hr)	-28	-17	-11
Lead (Pb)	-90	-83	-62
Nitrogen Dioxide (NO ₂) (annual)	-52	-45	-38
PM ₁₀ (24-hr)	---	-38	-29
PM _{2.5} (annual)	---	---	-27
PM _{2.5} (24-hr)	---	---	-29
Sulfur Dioxide (SO ₂) (24-hr)	-76	-68	-48

Notes:

1. --- Trend data not available
2. Negative numbers indicate improvements in air quality

All NAAQS pollutant levels have improved since 1980.

Reference: <http://www.epa.gov/airtrends/agtrends.html>

Change in National Emissions

Percent Change in Emissions

	1980 vs 2010	1990 vs 2010	2000 vs 2010
Carbon Monoxide (CO)	-71	-60	-44
Lead (Pb)	-97	-60	-33
Nitrogen Oxides (NO _x)	-52	-48	-41
Volatile Organic Compounds (VOC)	-63	-52	-35
Direct PM ₁₀	-83	-67	-50
Direct PM _{2.5}	---	-55	-55
Sulfur Dioxide (SO ₂)	-69	-65	-50

Notes:

1. --- Trend data not available
2. Direct PM10 emissions for 1980 are based on data since 1985
3. Negative numbers indicate reductions in emissions

Emission reductions supporting NAAQS pollutant level improvement.

Reference: <http://www.epa.gov/airtrends/agtrends.html>

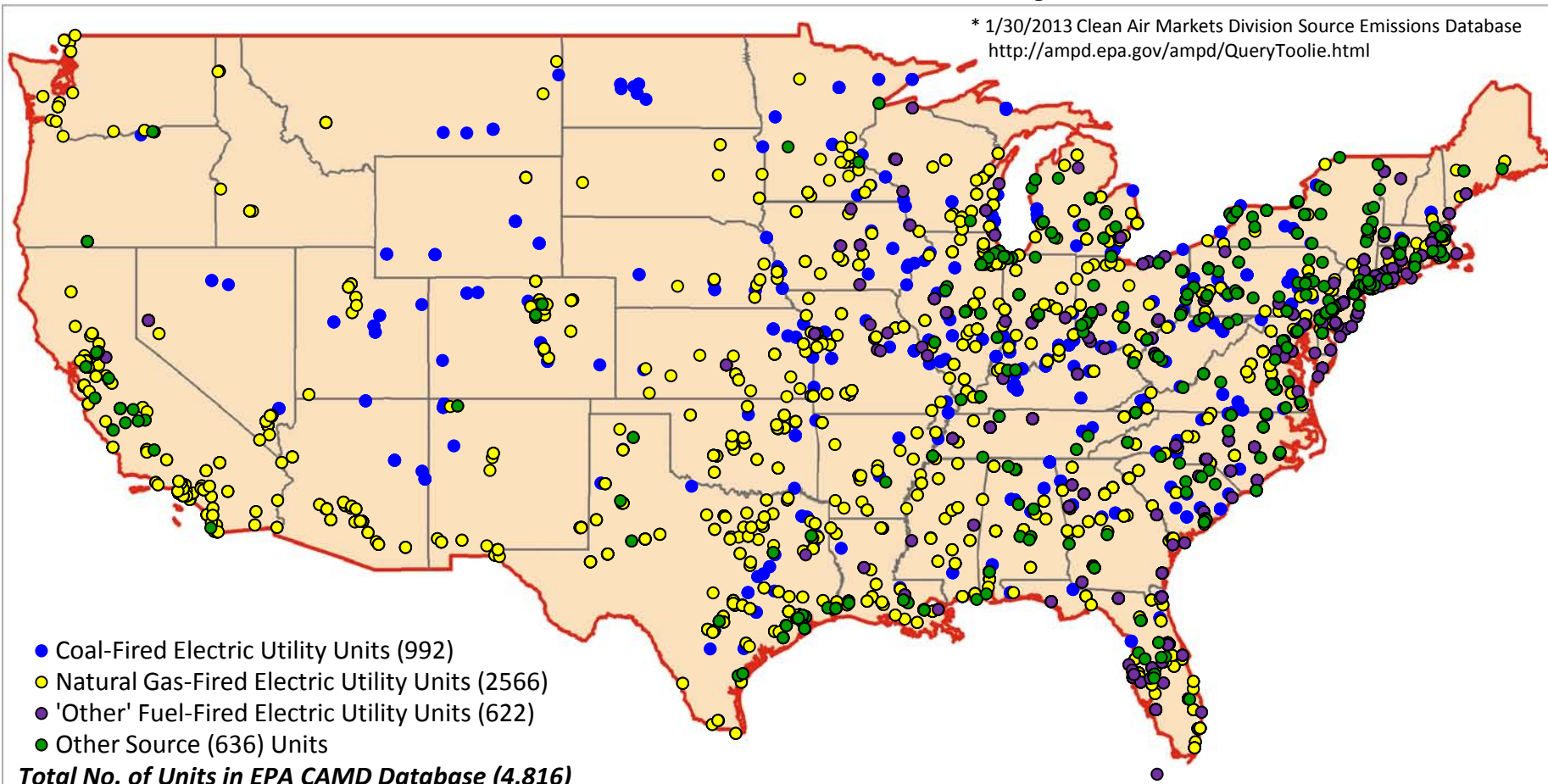
SO₂, NO_x, and CO₂ Emissions

- Best Source for SO₂, NO_x, and CO₂ emissions on all major emitting units is the following EPA's Clean Air Marketing Division (CAMD) website:
<http://ampd.epa.gov/ampd/QueryToolie.html>
 - Provides unit specific hourly, monthly, quarterly, and annual **historical stack emission** information through 2012 for 4,816 units

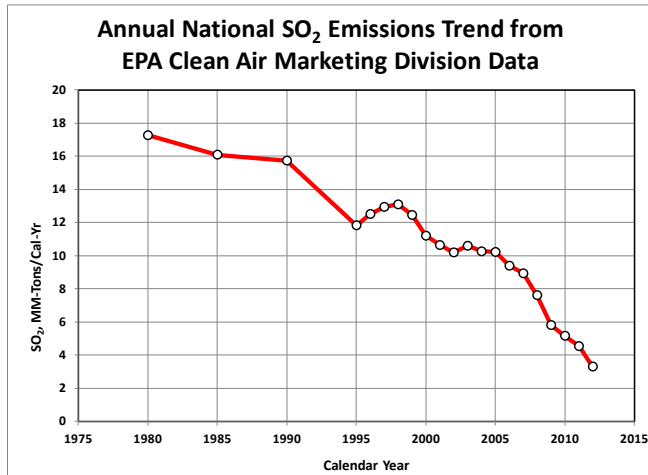
4,816 Sources tracked by EPA CAMD

U.S. Emission Sources Identified by EPA CAMD*

* 1/30/2013 Clean Air Markets Division Source Emissions Database
<http://ampd.epa.gov/ampd/QueryToolie.html>

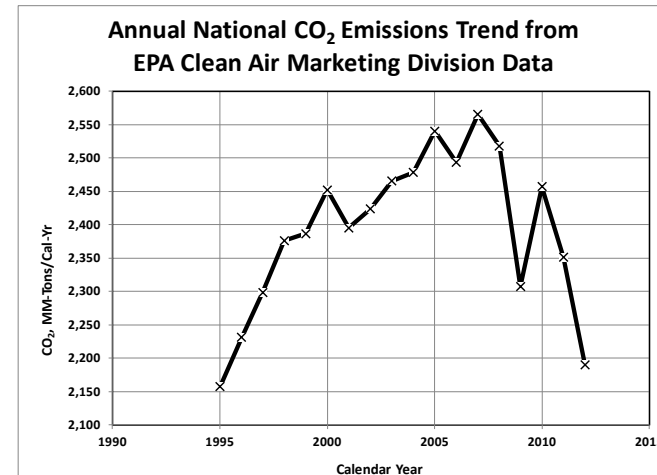
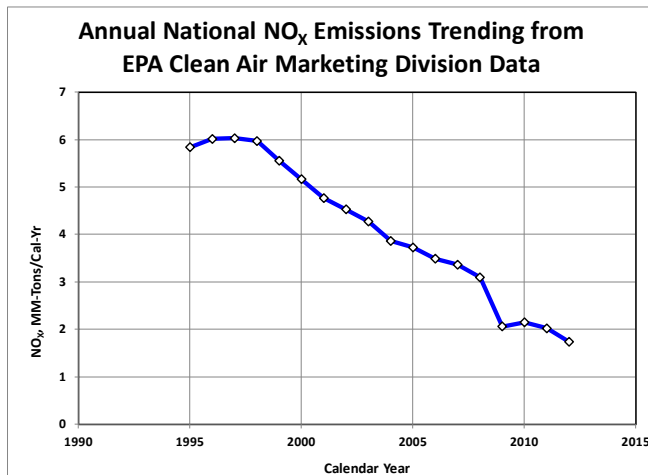


National SO₂, NO_x, and CO₂ Trends



Annual National Emission Trends from EPA Clean Air Marketing Division Data

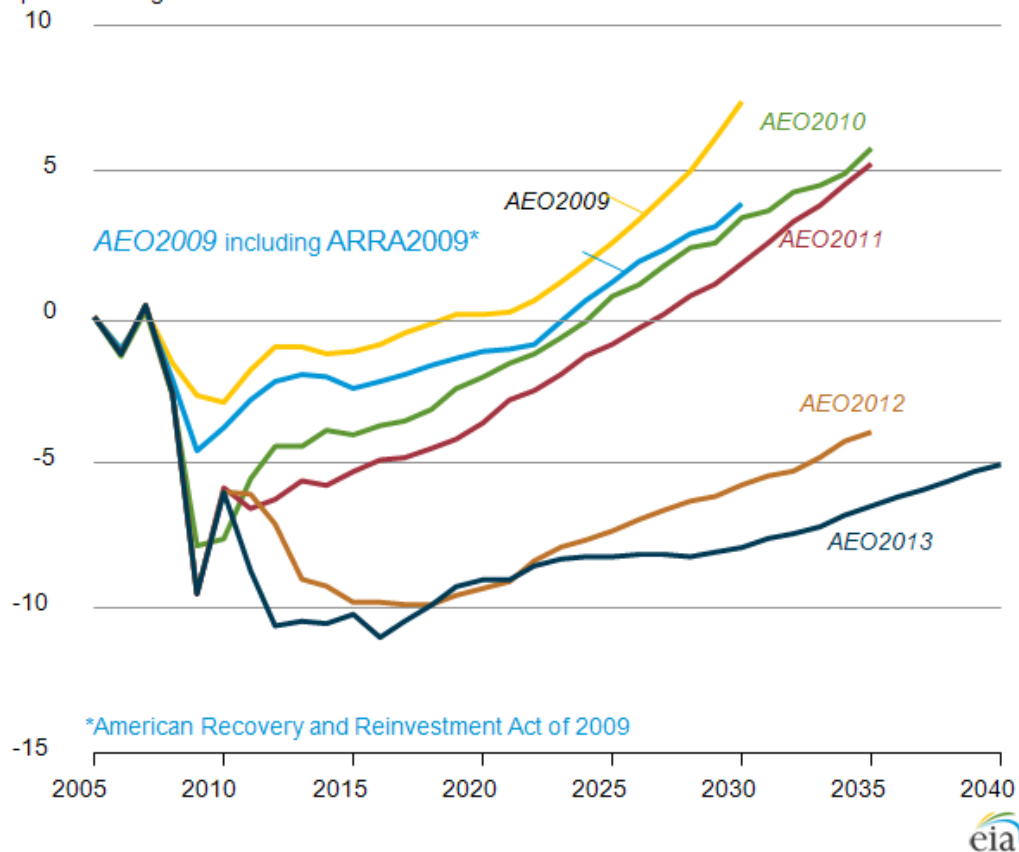
Period	% Reduction		
	SO ₂	NO _x	CO ₂
1980-2012	81%	-	-
1995-2012	72%	70%	-2%
2000-2012	70%	66%	11%



Energy Related CO₂ Forecast from EIA Annual Energy Outlook (AEO) 2013 Early Release

Figure 13. U.S. energy-related carbon dioxide emissions in recent AEO Reference cases

percent change from 2005



http://www.eia.gov/forecasts/aeo/er/early_carbonemiss.cfm

CO₂ Emission forecasts (relative to 2005) have been dropping with each and every EIA Annual Energy Outlook.

Issue #2: Environmental Legislation and Regulation

- What are today's requirements, those for tomorrow, and those possibly in the future?
- All environmental legislation and regulation eventually evolves into requirements involving rule **Form, Severity, and Timing**
 - Form Examples:
 - Cap and Trade (market based) – CAIR/CSAPR
 - Emission rate based limits – NAAQS rate, rate averaging
 - Differences
 - What time period is important for regulation?
 - » Long periods favor cap and trade or tax
 - » Short periods favor rate based limit setting

Issue #2: Environmental Legislation and Regulation (Cont'd)

- **Coal Issues**

- Mercury & Air Toxic Standards ([MATS](#)) Rule for Coal and Oil Fired Power Plants
 - Final Revised Rules for New Plant Rules expected March 2013
- Cross State Air Pollutant Rule (CSAPR) / Clean Air Interstate Rule (CAIR)
 - August 21, 2012 – U.S Court of Appeals [stayed](#) the 2011 CSAPR and reinstated CAIR
 - October 5, 2012 – EPA [petitioned](#) for an “en banc” (full court) rehearing of the August decision
 - January 24, 2013 – U.S Court of Appeals denied EPA full court rehearing
- Greenhouse Gas (GHG) New Source Performance Standards (NSPS)
 - March 27, 2012 – EPA proposed GHG NSPS for new fossil-fired power plants
 - Final rule expected sometime in 2013

Issue #2: Environmental Legislation and Regulation (Cont'd)

- **Coal Issues (Continued)**
 - Prevention of Significant Deterioration (PSD) impact on Precipitators using **Duct Sorbent Injection** for MATS
 - **Other** environmental issues (e.g., Ozone and PM_{2.5} NAAQS, FGD effluent guidelines, coal derived waste/refuge)
 - Cooling water intake screen issues (**316B**)
 - Solid waste coal ash waste **hazardous waste** classification
 - December 21, 2012 – EPA released (**Industrial**) Boiler Hazardous Air Pollutant Standard (HAPS) regulation
 - **Mining regulation** impact on coal prices

Final MATS Rule for Coal and Oil Fired Power Plants

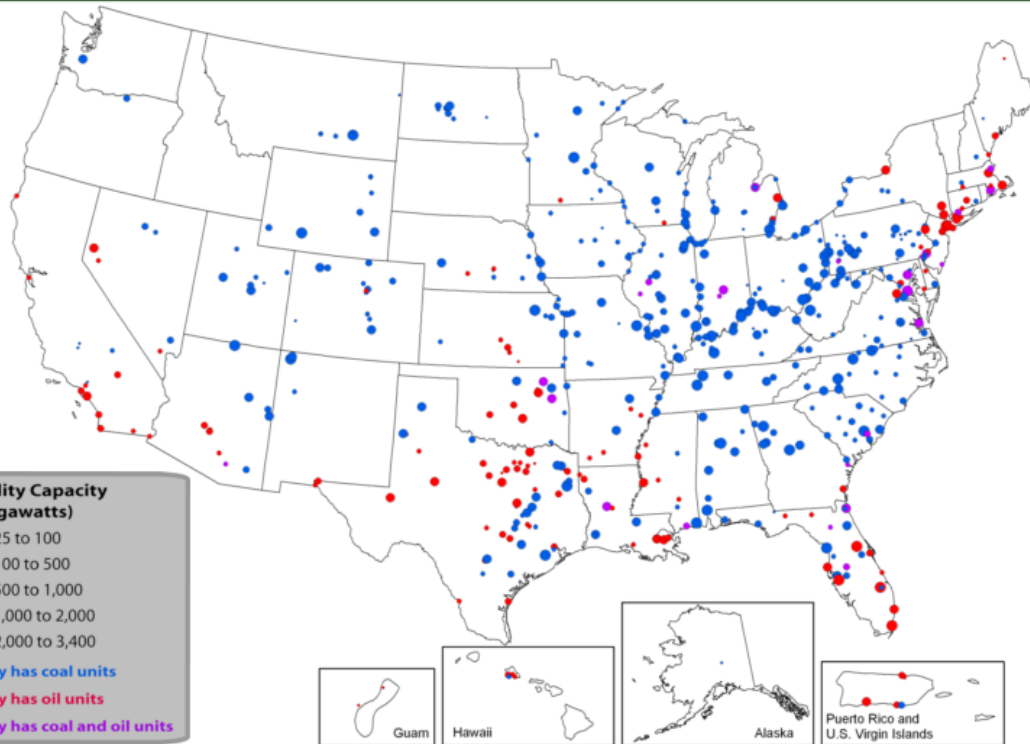
- On Dec 21, 2011, EPA announced the final Utility MATS rule and revision of New Source Performance Standards (NSPS) PM, SO₂ and NO_x.
 - [Notice of Final Rule \(PDF\)](#) (210pp, 1.28 MB) - Federal Register - Feb 16, 2012
- In spring 2012, EPA received 20 petitions for reconsideration of the MATS rule.
- On July 20, 2012, EPA issued a letter stating its intent to **reconsider Emission Limits for New Power Plants** issued under the MATS rule. The reconsideration did not cover existing power plants.
 - [Notice of Partial Stay \(PDF\)](#) (2pp, 212k) - Federal Register - Aug 2, 2012
- Nov 16, 2012 - [EPA Proposed Update of MATS for New Power Plants](#). EPA also proposed to revise startup and shutdown requirements.
 - [Proposed Rule \(PDF\)](#) (22pp, 383k) - Federal Register - Nov 30, 2012
- Dec 12, 2012 – EPA extended 30 day public comment period to Jan 7, 2013
- New Power Plant MATS rule is scheduled for release in March 2013.

(Reference: <http://www.epa.gov/mats/where.html>)

MATS National Map



The Toxics Rule Facilities National Electric Energy Data System (NEEDS 4.10 MATS) (EPA, December 2011)



Source: National Electric Energy Data System (NEEDS 4.10 MATS) (EPA, December 2011) and EPA's Information Collection Request (ICR) for New and Existing Coal- And Oil-Fired Electric Utility Steam Generation Units (2010)

Note: This map displays facilities that are included in the NEEDS 4.10 MATS data base and that contain at least one oil-fired steam generating unit or one coal-fired steam generating unit that generates more than 25 megawatts of power. This includes coal-fired units that burn petroleum coke and that turn coal into gas before burning (using integrated gasification combined cycle or IGCC). NEEDS reflects available capacity on-line by the end of 2011; this includes committed new builds and committed retirements of old units. Only coal and oil-fired units are covered by this rule. Some of the oil units displayed on the map are capable of burning oil and/or gas. If a unit burns only gas, it will not be covered in the rule. In areas with a dense concentration of facilities, the facilities on the map may overlap and some may be impossible to see. IPM modeling did not include generation outside the contiguous U.S., where EPA is aware of only two facilities that would be subject to the coal-fired requirements of the final rule. Given the limited number of potentially impacted facilities, limited availability of input data to inform the modeling, and limited connection to the continental grid, EPA did not model the impacts of the rule beyond the contiguous U.S. Facilities outside the contiguous U.S. are displayed based on data from EPA's 2010 ICR for the rule.

Reference: Both static and 3D maps are located at following:
<http://www.epa.gov/mats/where.html>

3D maps use Google Earth for zoom and detail.

This map shows facilities that are included in the NEEDS 4.10 MATS data base and that contain at least one oil-fired steam generating unit or one coal-fired steam generating unit that generates more than 25 megawatts of power. NEEDS reflects available capacity on-line by the end of 2011; this includes committed new builds and committed retirements of old units. Only coal and oil-fired units are covered by this rule.

Issue #2: Environmental Legislation and Regulation (Cont'd)

- **Natural Gas Issues**
 - Shale Gas Environmental Issues
 - Natural Gas Pipeline Permitting and Safety Issues
 - Environmental controls needed
- **Greenhouse Gas (GHG) Regulation**
 - New power plants – GHG NSPS – final in 2013?
 - Existing power plants – future regulations?
 - Form (Cap & Trade, Carbon Tax, Efficiency Limits?)
 - Severity (How low will limits be?)
 - Timing (When? 2015, 2020, 2025, later?)
- **Water Consumption**
 - Cooling water consumption is issue for some utilities

Future Greenhouse Gas Regulation?

- Greenhouse Gas/Global Warming/Climate Change
 - **Truth** about Climate Change and impact from human activity?
 - Climategate 1 (2009) and 2 (2011)?
 - Background: Nov 2009 – Someone hacked University of East Anglia (GBr) Climatic Research Unit (CRU) servers and put thousands of questionable emails and files on the Internet.
 - Created controversy, questions, and public distrust of scientists.
 - Latest Update – Oct 31, 2012 BBC Radio release: (28 min.)
<http://www.bbc.co.uk/programmes/b01nl8gm>
 - **Media influence** on Climate Change is extremely powerful
 - Example – Jan 23, 2013 CNN Meteorologist Chad Myers – Truth?
<http://www.youtube.com/watch?v=KqvjvziJwYA> (1:19)
 - **Political** direction?
 - 2013 State of the Union – “We must do more to combat Climate Change.”
www.youtube.com/watch?v=2iyILN7xlyU (1:50)
 - Congress focus is on the deficit – some people say carbon tax is solution

Enforcement Settlement Listing

Several Utilities have settled environmental Enforcement lawsuits with EPA. These are the settlements listed on EPA's settlement website as of 1/30/2013:

Coal-Fired Power Plant Settlements:

- 1) [Wisconsin Public Service Corporation Settlement](#) (01/04/13)
- 2) [Louisiana Generating Settlement](#) (11/21/12)
- 3) [Dairyland Power Cooperative Settlement](#) (06/29/12)
- 4) [Tennessee Valley Authority Clean Air Act Settlement](#) (04/14/11)
- 5) [Northern Indiana Public Service Company Air Act Settlement](#) (01/13/11)
- 6) [Hoosier Energy Rural Electric Cooperative, Inc.](#) (07/23/10)
- 7) [American Municipal Power](#) (05/18/10)
- 8) [Westar Energy, Inc. Settlement](#) (01/25/10)
- 9) [Duke Energy Gallagher Plant Settlement](#) (12/22/09)
- 10) [Ohio Edison Company, W.H. Sammis Power Station, Clean Air Act Settlement](#) (08/11/09)
- 11) [Kentucky Utilities Company](#) (02/03/09)
- 12) [Salt River Project Agricultural Improvement and Power District](#) (8/12/08)
- 13) [American Electric Power Service Corporation Settlement](#) (10/09/07)
- 14) [East Kentucky Power Cooperative](#) (07/2/07)
- 15) [Nevada Power Company](#) (06/13/07)
- 16) [Alabama Power Company Settlement](#) (04/25/06)
- 17) [Minnkota Power Cooperative and Square Butte Electric Cooperative Settlement](#) (04/24/06)
- 18) [Ohio Edison Company, W.H. Sammis Power Station Settlement](#) (03/18/05)
- 19) [Illinois Power Company and Dynegy Midwest Generation Settlement](#) (03/07/05)
- 20) [South Carolina Public Service Authority \(Santee Cooper\) Settlement](#) (03/16/04)
- 21) [Southern Indiana Gas and Electric Company \(SIGECO\) Settlement](#) (06/06/03)
- 22) [Wisconsin Electric Power Company \(WEPCO\) Settlement](#) (04/29/03)
- 23) [Virginia Electric and Power Company \(VEPCO\) Settlement](#) (04/17/03)
- 24) [ALCOA, Inc. Settlement](#) (03/27/03)
- 25) [PSEG Fossil L.L.C. Civil Judicial Settlement](#) (01/24/02)
- 26) [Tampa Electric Company \(TECO\) Settlement](#) (02/19/00)

<http://www.epa.gov/compliance/resources/cases/civil/caa/coal/index.html>

Issue #3: Coal and Natural Gas Markets

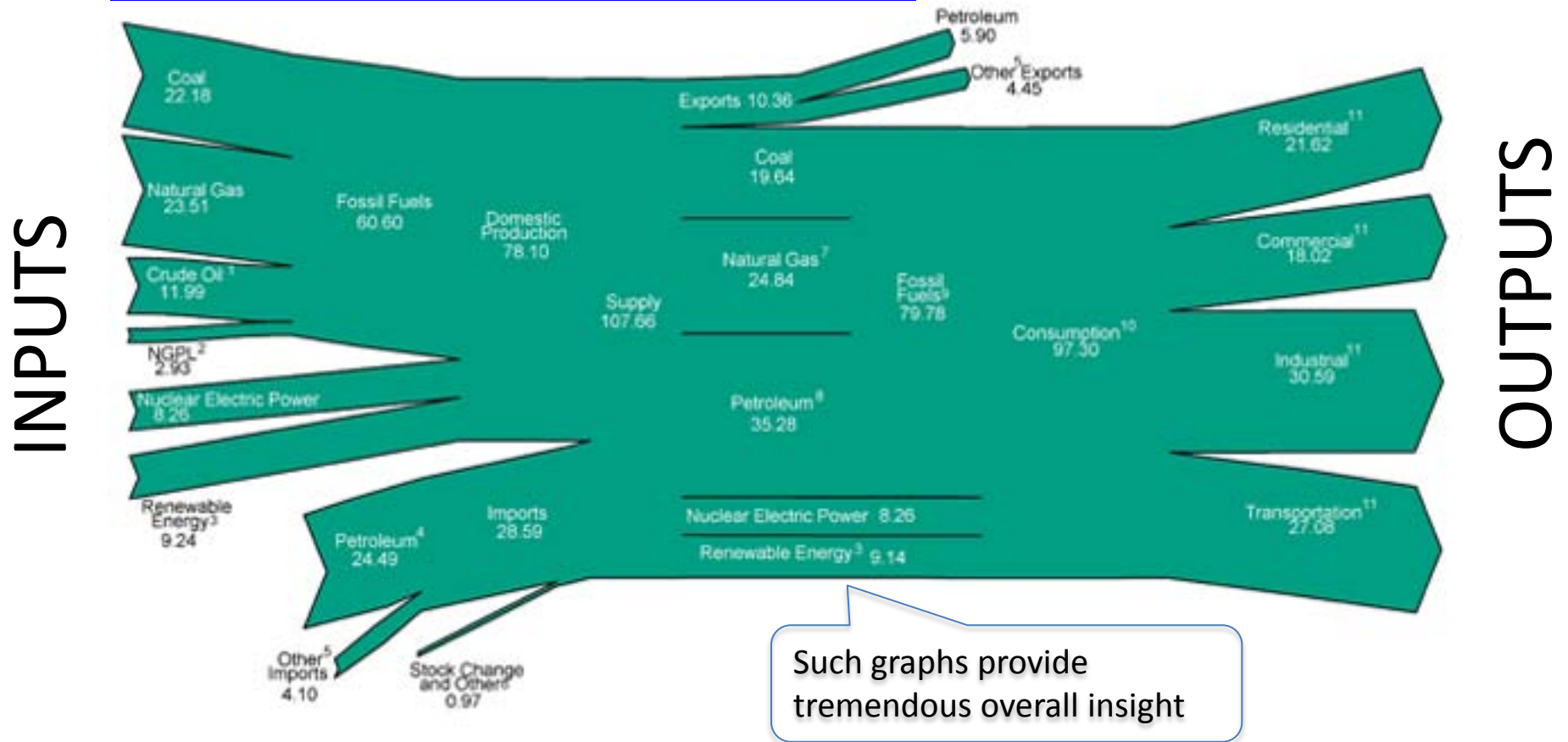
- **Markets are impacted by:**
 - Overall **Demand and Supply**
 - Short and Long Term Issues
 - Domestic and International **Market Timing**
 - Changes to Domestic and International **Transportation Markets**
 - Relative fuel pricing impact on Electric Utility Unit **Dispatching**

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)

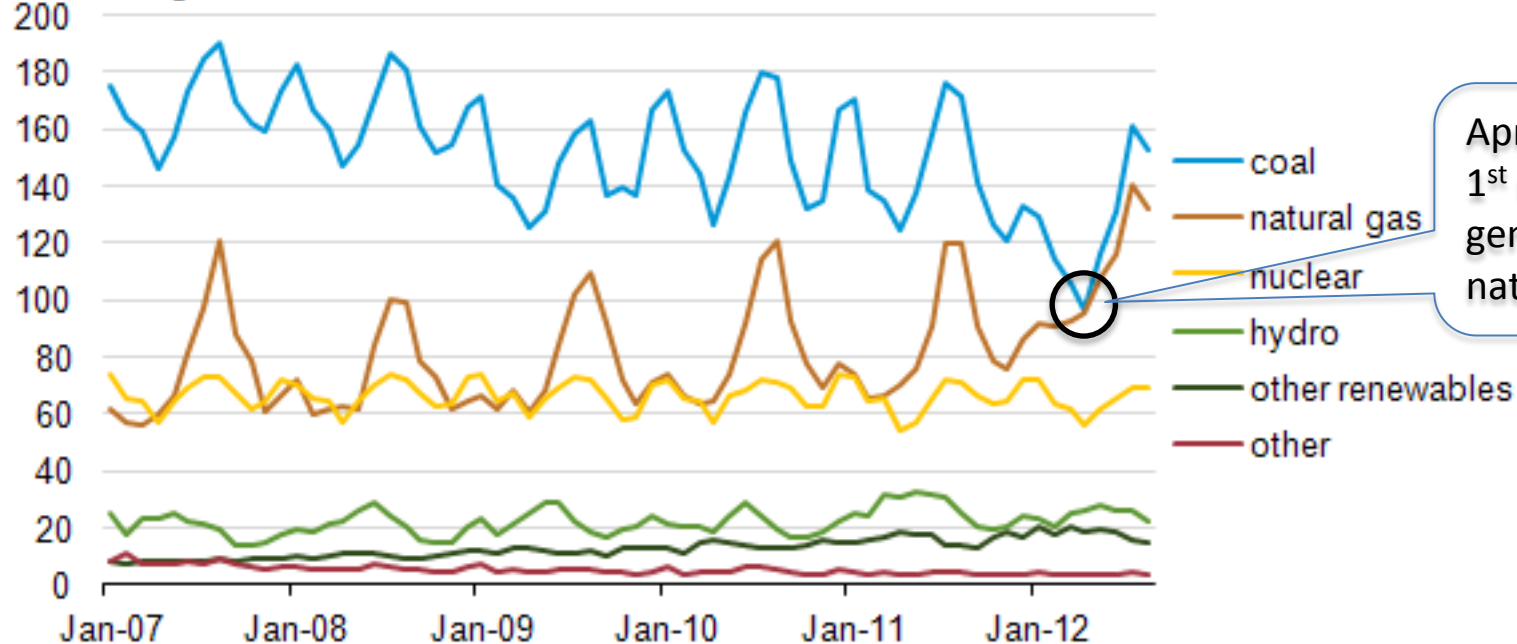


<http://www.eia.gov/totalenergy/data/annual/diagram1.cfm>

Electric Generation Fuel Breakdown

U.S. monthly net electric power generation, January 2007 – August 2012

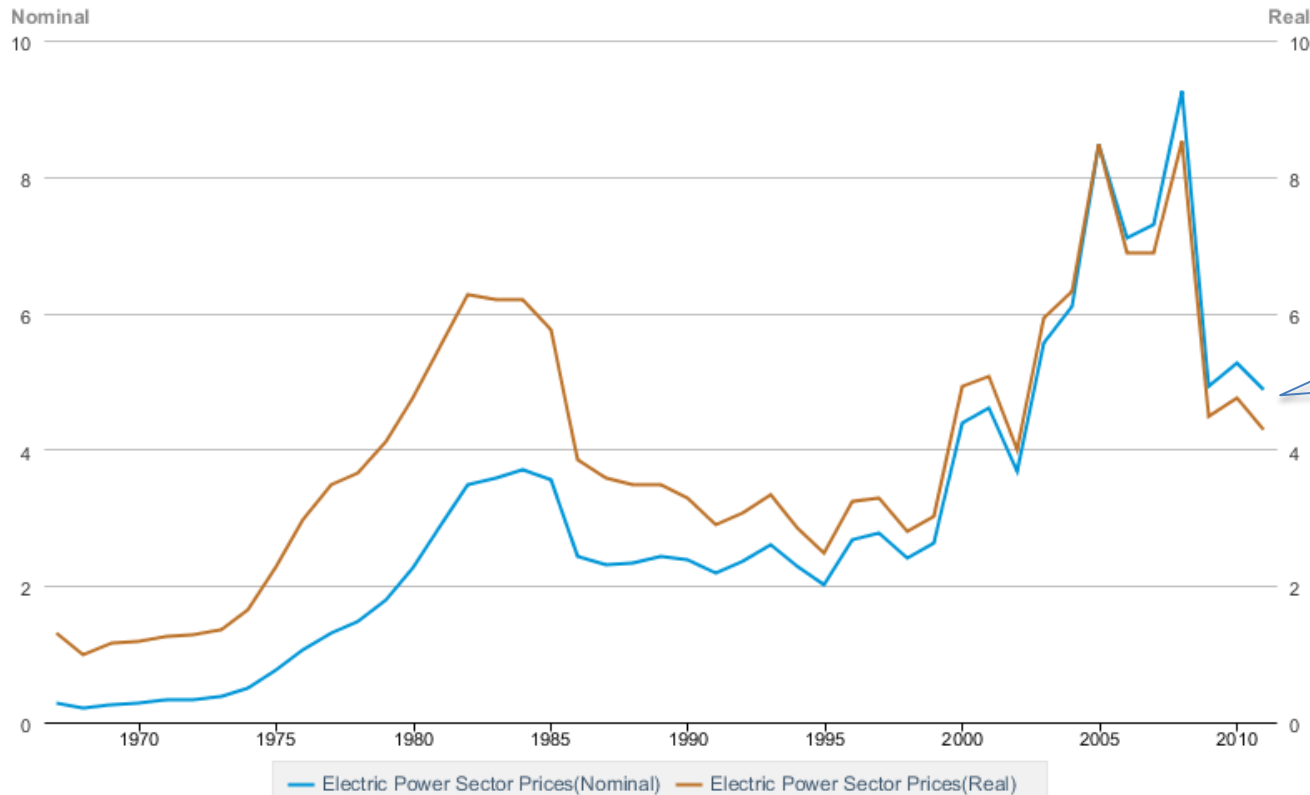
million megawatthours



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

Historical Natural Gas Prices

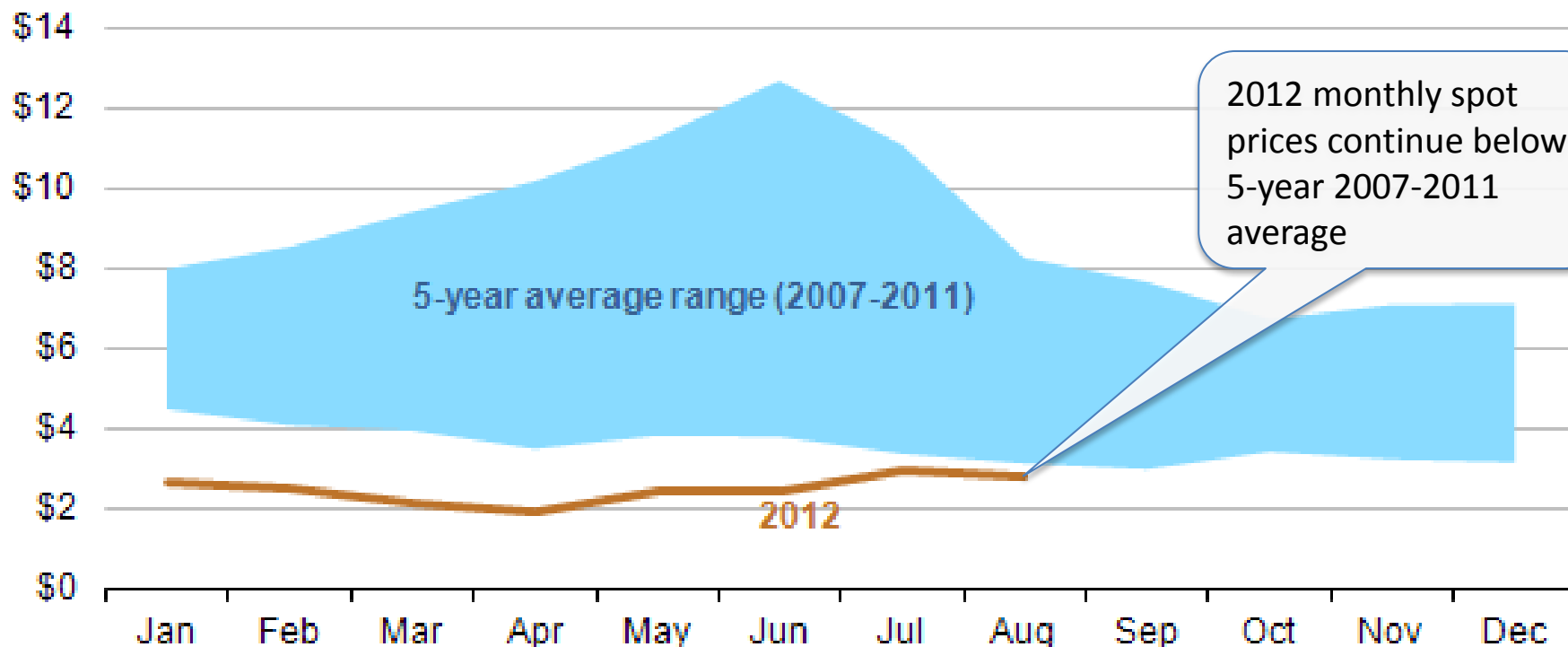
Table 6.8 Natural Gas Prices by Sector, 1967-2011 (Dollars per Thousand Cubic Feet, Except as Noted)



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

2012 Natural Gas Prices

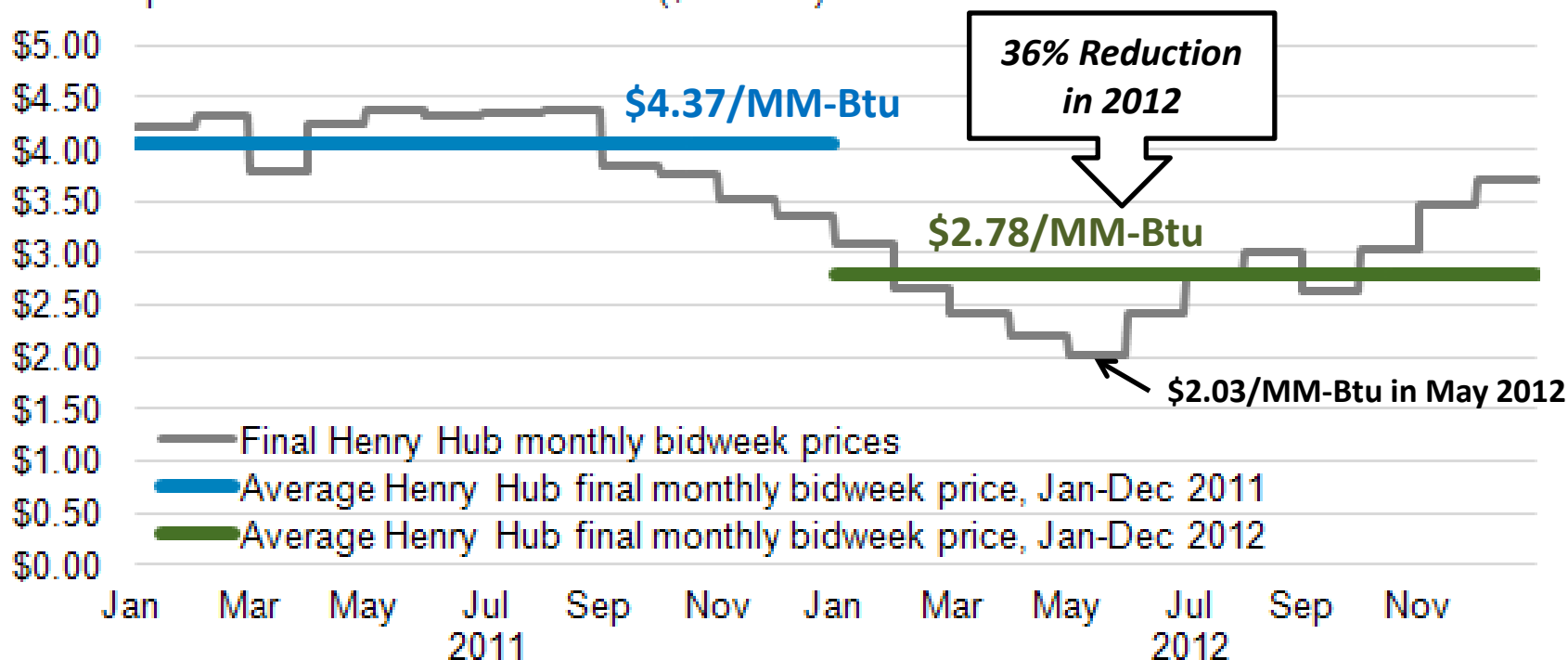
Henry Hub monthly natural gas spot price
dollars per million MMBtu



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

2011 / 2012 Natural Gas Prices

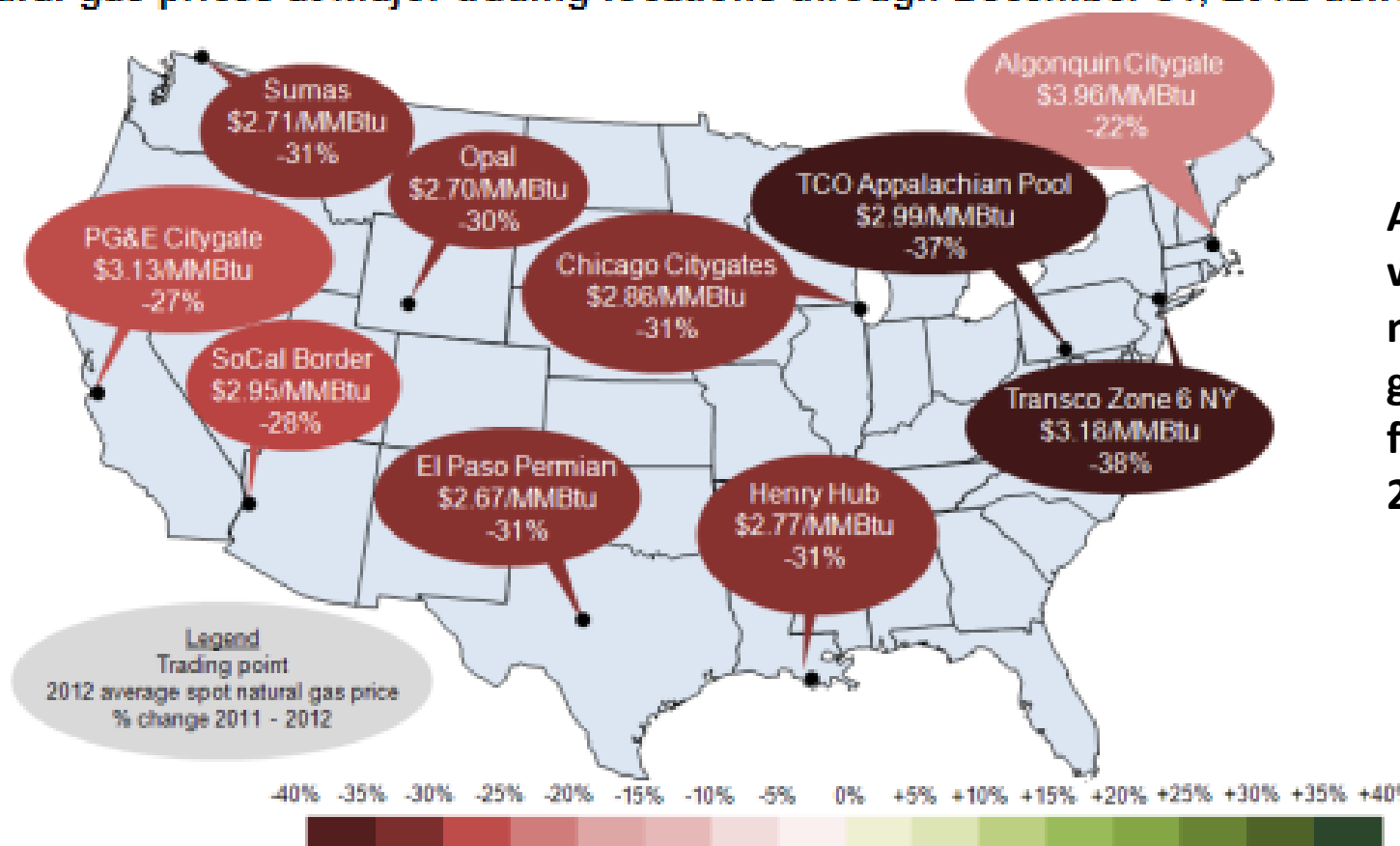
Final monthly bidweek prices at Henry Hub, January 2011-December 2012
dollars per million British thermal units (\$/MMBtu)



<http://www.eia.gov/todayinenergy/detail.cfm?id=9490>

2012 Wholesale Natural Gas Prices

Spot natural gas prices at major trading locations through December 31, 2012 delivery date



Average wholesale natural gas prices fell 31% in 2012.

<http://www.eia.gov/todayinenergy/detail.cfm?id=9490#>

Latest Weekly Natural Gas Prices

Natural gas spot prices (Henry Hub)

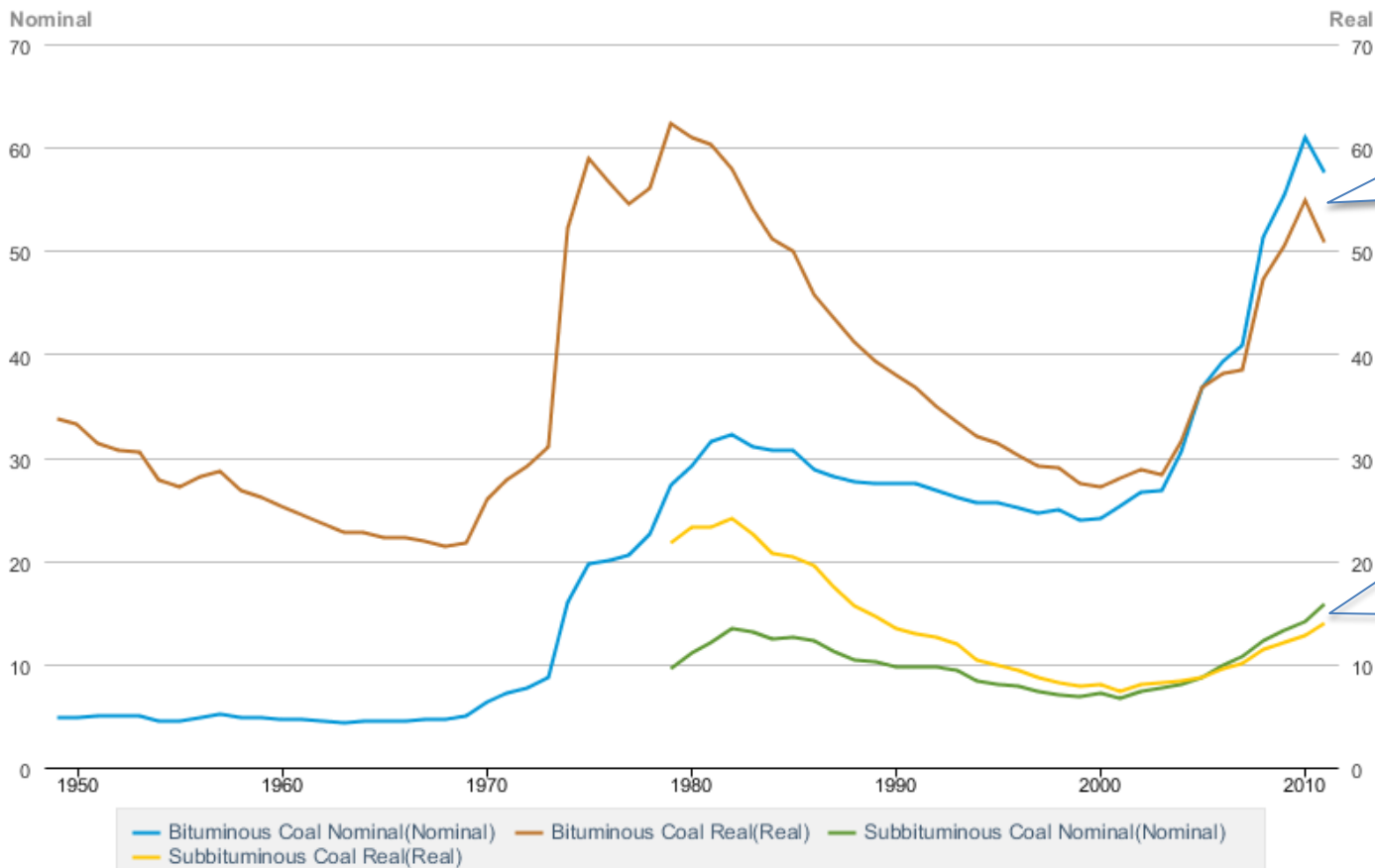


 Source: Natural Gas Intelligence

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

Historical Coal Prices

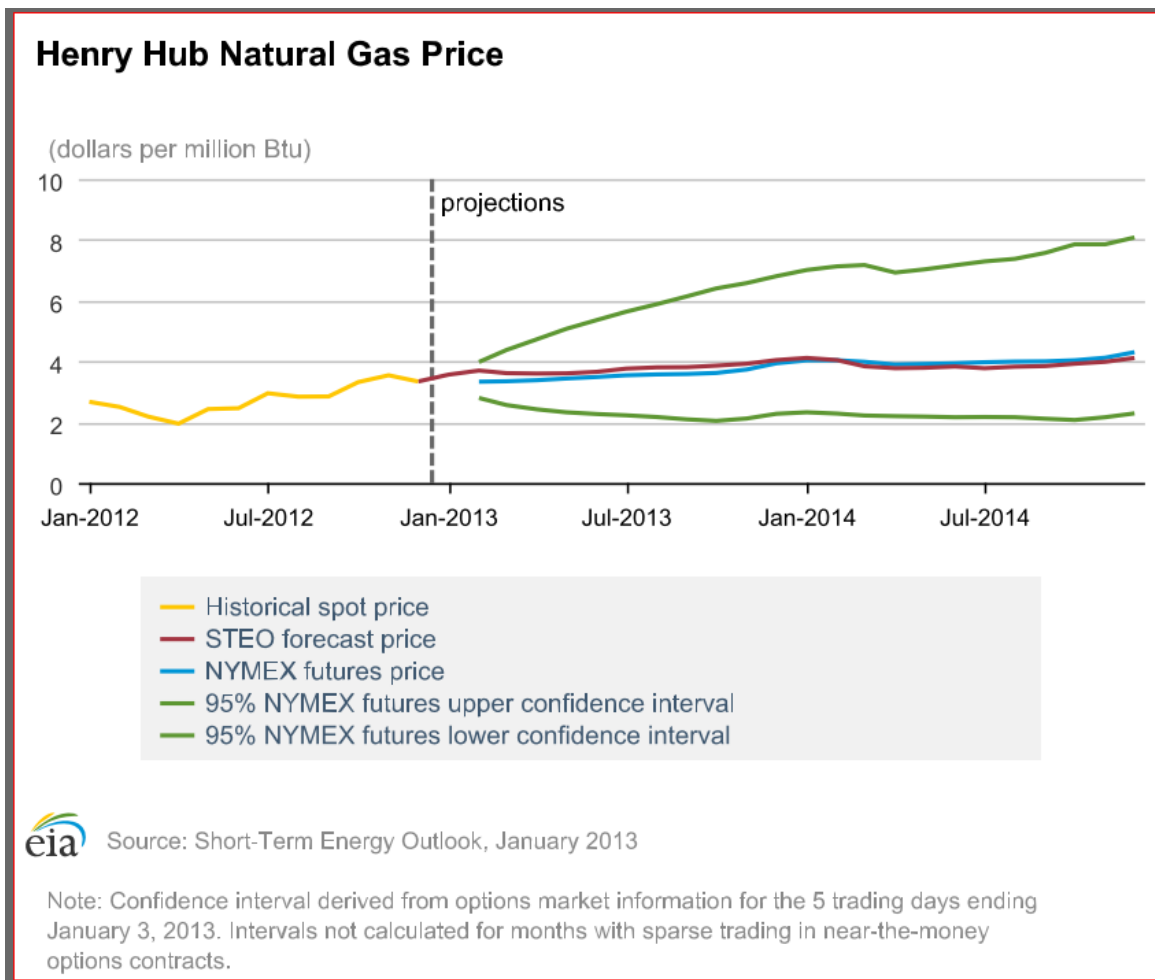
Table 7.9 Coal Prices, 1949-2011 (Dollars per Short Ton)



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

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

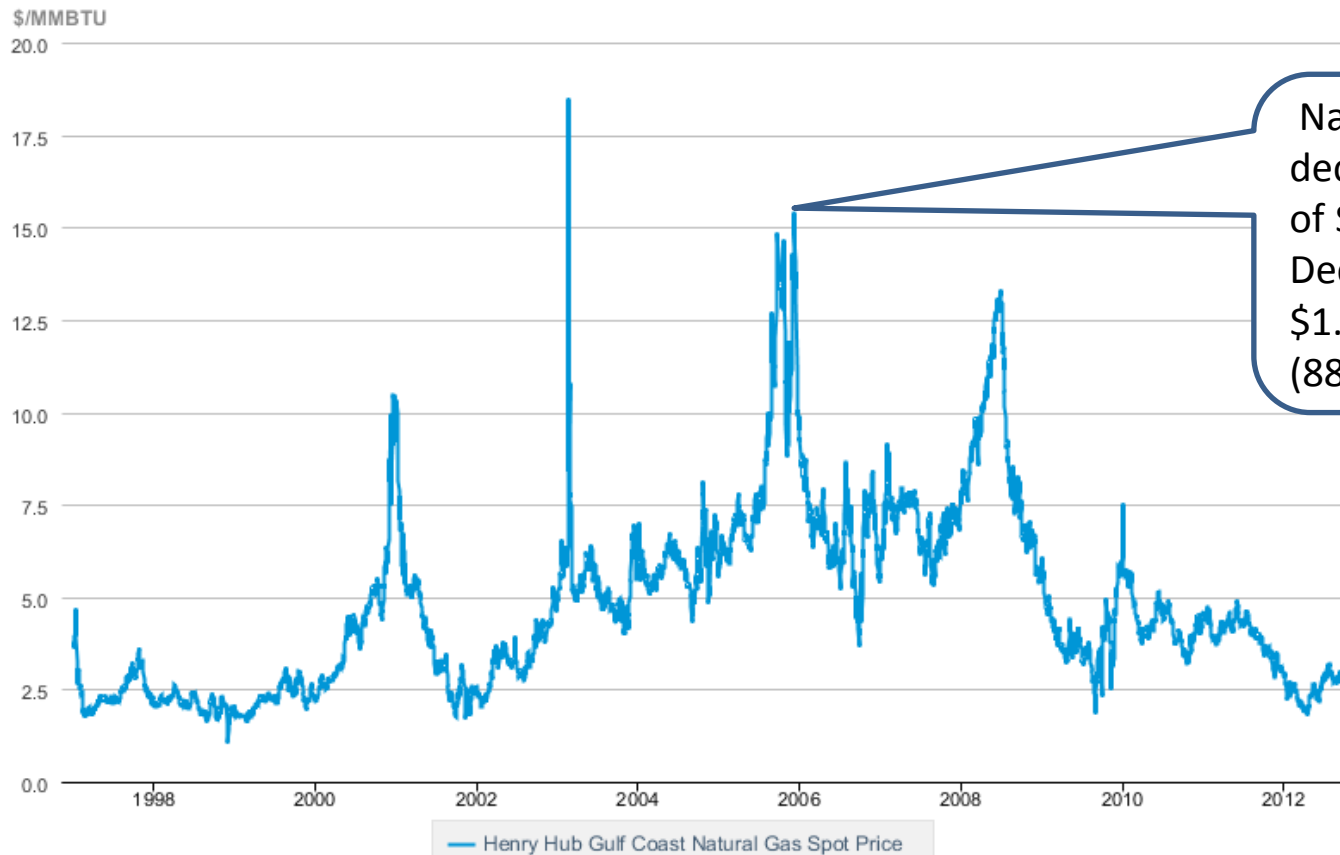
Forecasted Henry Hub Gas Prices



<http://www.eia.gov/forecasts/steo/report/natgas.cfm>

Historical Natural Gas Price Volatility

Natural Gas Spot and Futures Prices (NYMEX)

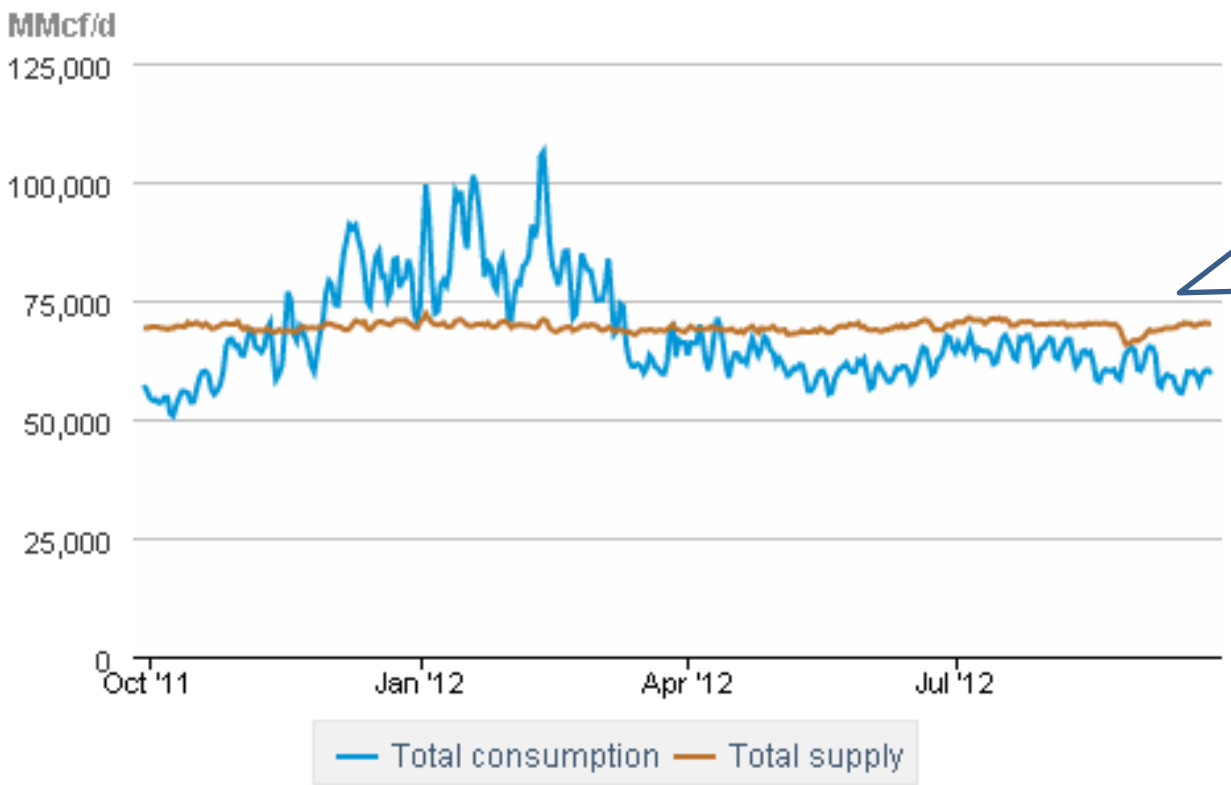


Natural Gas prices declined from a high of \$15.78/MM-Btu in Dec 2005 to a low of \$1.90 in April 2012 (88% nosedive).

eia Source: U.S. Energy Information Administration

Recent Gas Supply vs. Consumption

Total supply/demand balance (last 365 days)



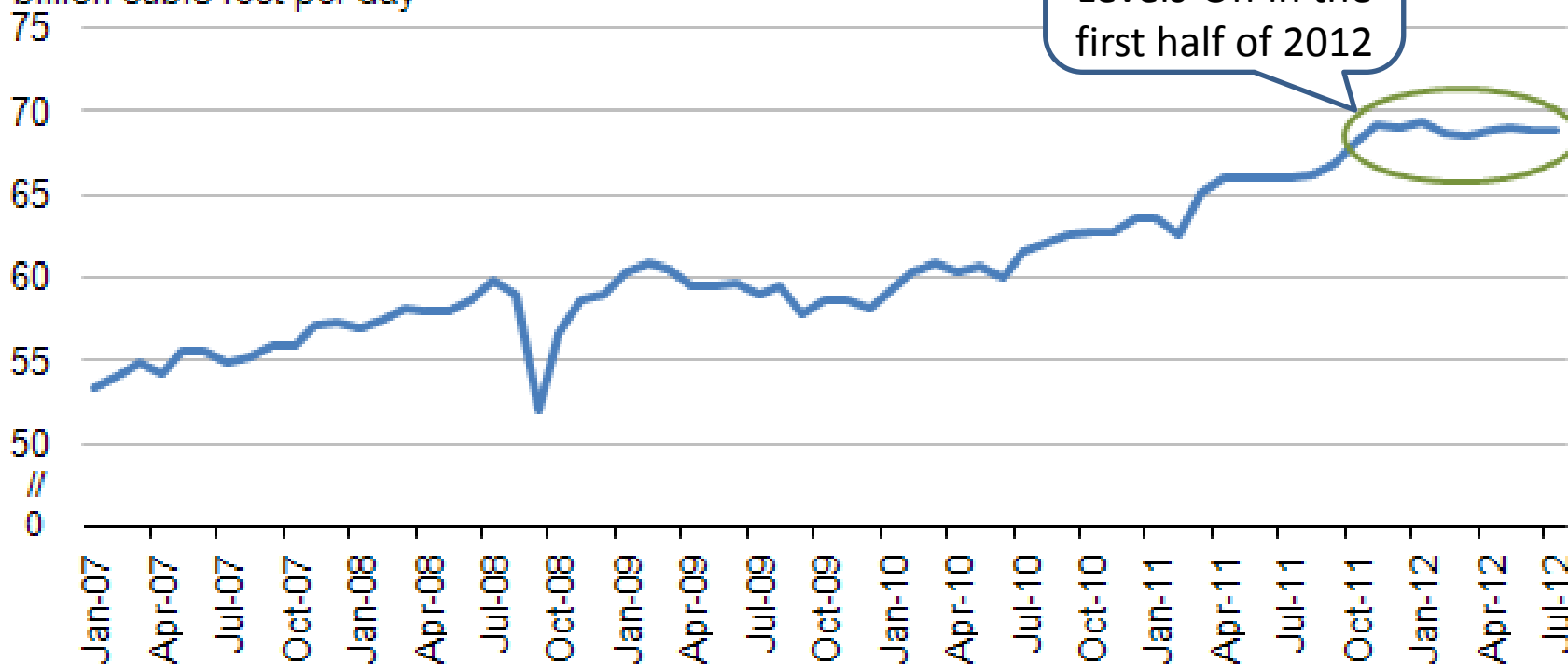
Relatively flat supply curve with seasonal consumption variation.

eia Source: BENTEK Energy LLC

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

Recent “Flattening” of Natural Gas Production

U.S. monthly natural gas marketed production
billion cubic feet per day

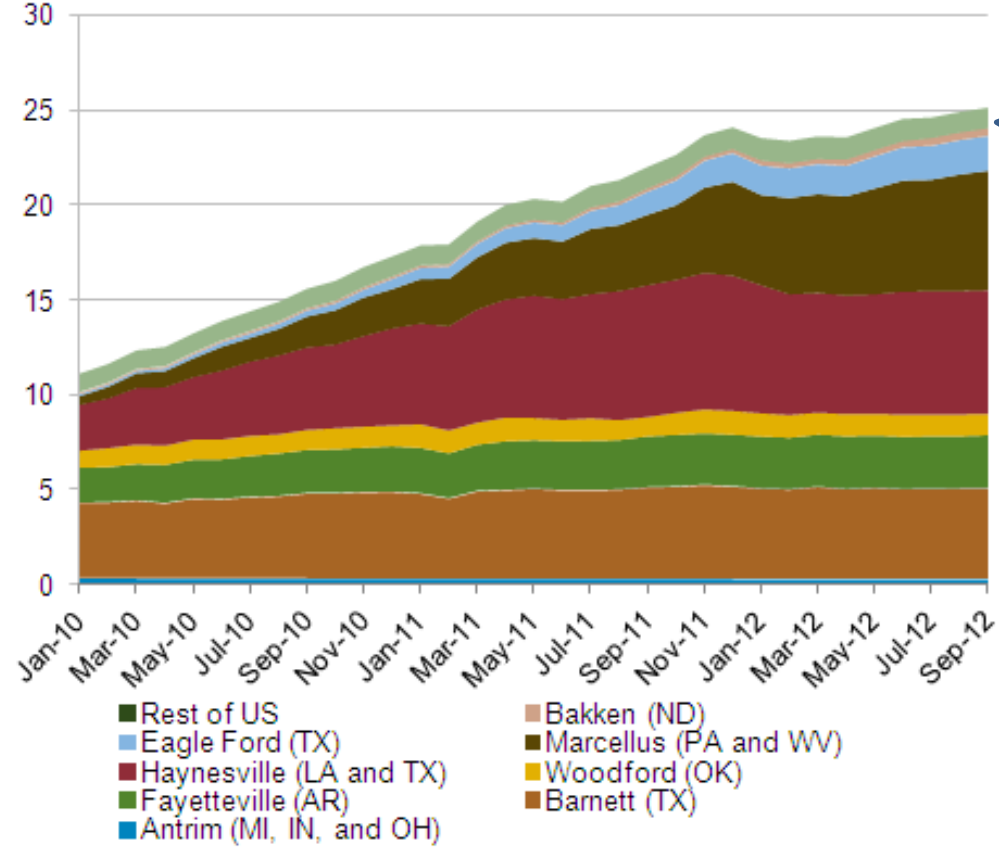


<http://www.eia.gov/todayinenergy/detail.cfm?id=8190#>

Shale Gas Production 2010-2012

Monthly dry shale gas production

billion cubic feet per day



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

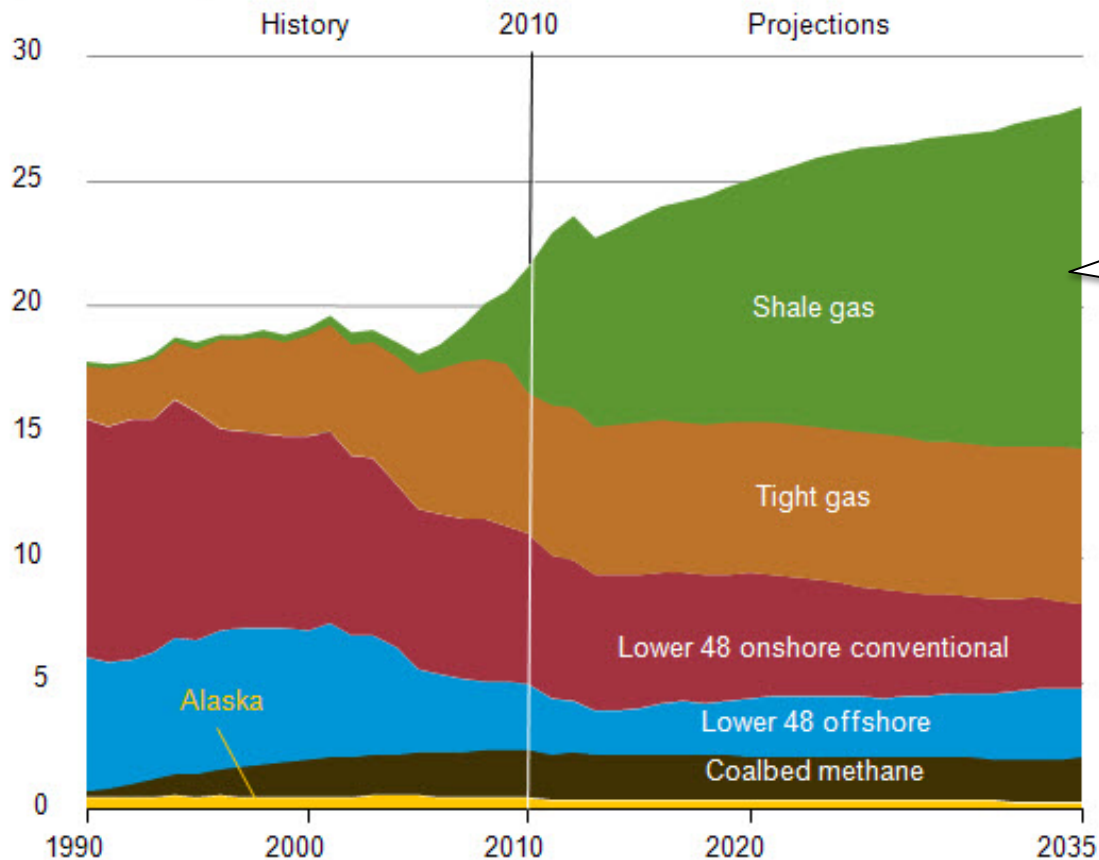


Source: Lippman Consulting, Inc. Gross withdrawal estimates are as of September 2012 and converted to dry production estimates with EIA-calculated average

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

Long Term Gas Production Forecast

Figure 107. Natural gas production by source, 1990-2035
(trillion cubic feet)

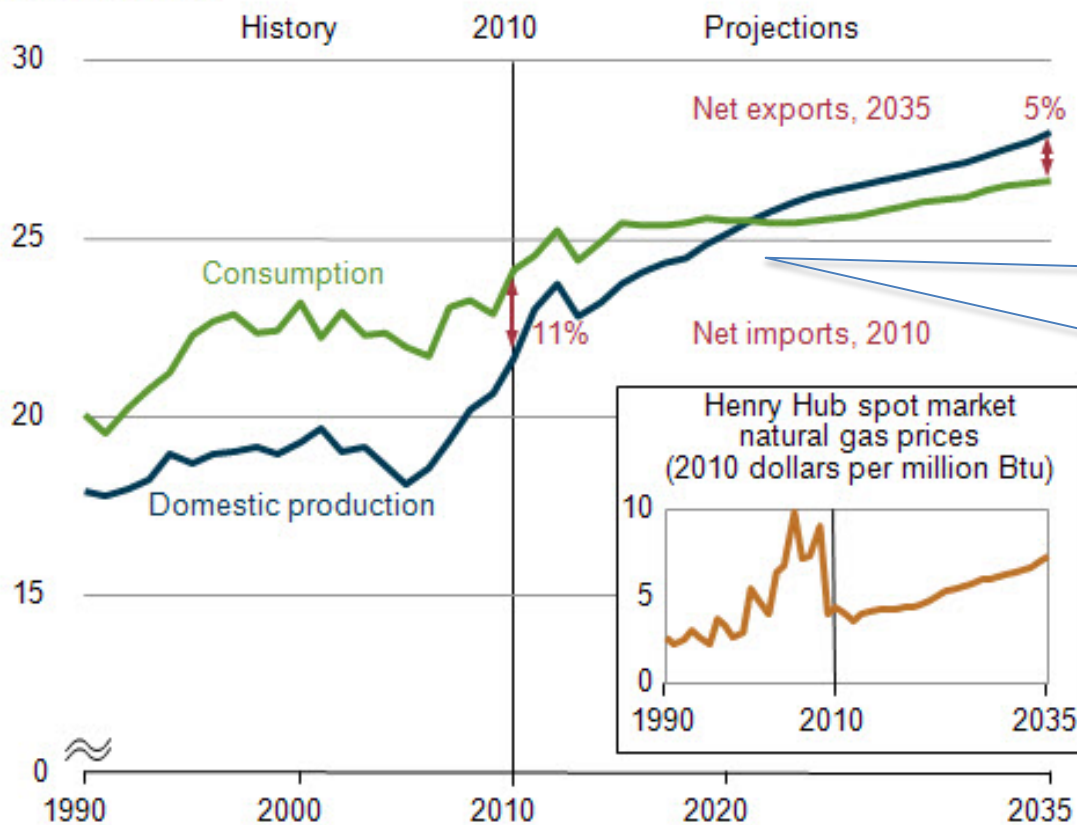


EIA Annual Energy Outlook 2012 forecasts significant growth in shale gas productions over next 20 years.

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

U.S. Natural Gas Net Exporter by 2021?

Figure 4. Total U.S. natural gas production, consumption, and net imports, 1990-2035
(trillion cubic feet)

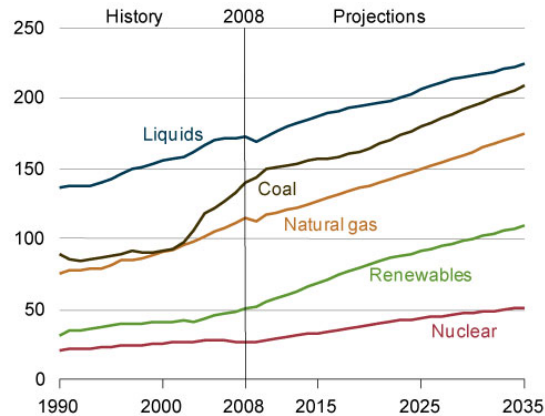


EIA 2012 Outlook forecasts U.S. will transition from a net importer to a net exporter of natural gas by 2021.

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

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)

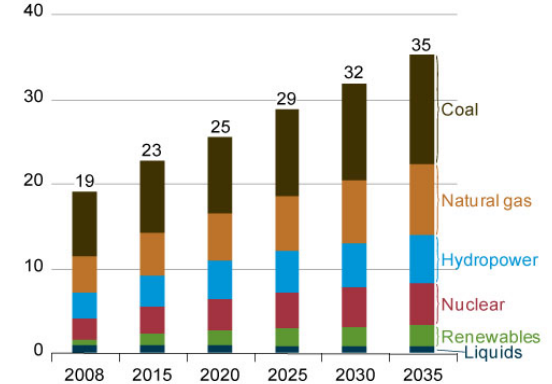


Figure 13. Energy consumption in the United States, China, and India, 1990-2035 (quadrillion Btu)

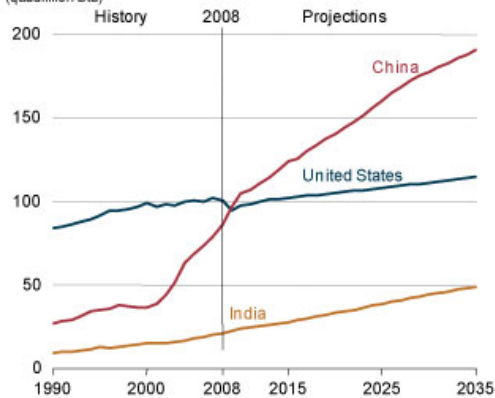
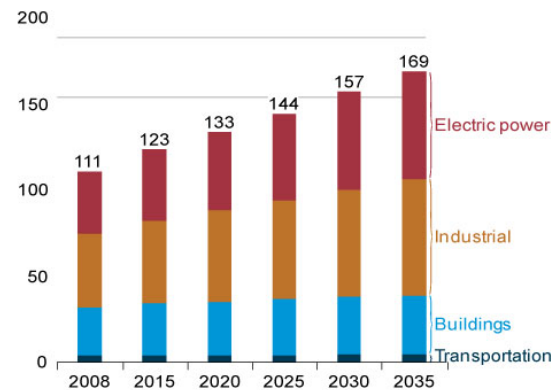


Figure 16. World natural gas consumption by end-use, sector, 2008-2035 (quadrillion Btu)



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>

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>

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: Political Ramifications/Media Impact

- Impact(s) of November 6th Presidential Election
 - Overall **Energy Policy**.....Any place for Coal?
 - Focus on U.S. energy (fuel) **independence**?
 - Any U.S. fuel market export limitations?
 - **Greenhouse gas** actions?
- Media Impact
 - So powerful! But how Truthful?
 - Fact or Frenzy? / Must we “Follow the Money”?
- World political and economic implications from U.S. natural gas boon?

Issue #5: Technology & Economic Issues

- Low cost (high risk?) PPTR DSI Technology Potential
- Rising capital cost for FGD and SCR
- **Boiler Conversion** Project Scoping Issues
- 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
- New Recommendations from **Vendors?**

Basic Decision Making Process

1. Gather an Appropriate Team
2. Identify the Problem
- ★ 3. Identify All Major Issues
- ★ **4. Identify All Alternative Solutions**
- ★ 5. Collect Data and Schedule Information
6. Perform Initial Analysis
- ★ 7. Identify Major Risks and Probabilities
8. Perform Final Analysis, Including Risks
9. Make Final Recommendation/Decision

★ (Primary focus of rest of this discussion)

Technology Alternatives

1. Coal-Fired Unit Environmental Control
2. Boiler Conversion (e.g., 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, SNCR, 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: Boiler 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

- Timing limitations
 - New IGCC Projects
 - Any “New” Control or Generating Technologies on the horizon?
 - Technologies are needed now through end of decade
 - Risks with using developmental versus commercial technologies
 - Time has almost past for further demonstration and testing

Basic Decision Making Process

1. Gather an Appropriate Team
2. Identify the Problem
- ★ 3. Identify All Major Issues
- ★ 4. Identify All Alternative Solutions
- ★ 5. **Collect Data and Schedule** Information
6. Perform Initial Analysis
- ★ 7. Identify Major Risks and Probabilities
8. Perform Final Analysis, Including Risks
9. Make Final Recommendation

★ (Primary focus of rest of this risk discussion)

Collect Data

- Data needs to be collected for each specific alternative. Such data ought to consider:
 1. **Performance** information for each alternative
 - Operating capability sufficient to confirm with relatively high likelihood that performance objectives can be achieved.
 - Operating impacts sufficient for development of operating costs for new technology alternatives.
 2. All capital and operating costs and associated **cash flows** sufficient for evaluating economics of each technology alternative.
 3. Capital cost cash flows should reflect **project specific procurement plan**(s). (Avoid using “generic” capital costs)
 4. **Cost ranges** for each cost mentioned above for each alternative technology.

Schedule Information

- Determine overall **procurement methods** to be used
 - For conceptual engineering, detailed design, permitting, equipment/material procurement, and construction
 - Consider Project cost saving alternatives, where appropriate
- Determine overall **project milestone schedules** for each alternative
 - Include milestone contract preparation, bid, and award times
 - Consider VALUE of delaying decisions for decision Flexibility versus advancing decisions to get through project “learning curve”
- Determine “float” needed for each alternative schedule to address desired level of **acceptable project schedule risk**
 - Include “float” needed for first project commitment decision
- Establish **decision dates** for each major project decision with a focus on when first project commitment decision must be made

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

Basic Decision Making Process

1. Gather an Appropriate Team
2. Identify the Problem
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- ★ 4. Identify All Alternative Solutions
- ★ 5. Collect Data and Schedule Information
- 6. Perform Initial Analysis**
- ★ 7. Identify Major Risks and Probabilities
8. Perform Final Analysis, Including Risks
9. Make Final Recommendation

★ (Primary focus of rest of this discussion)

Perform Initial Analysis

- Screen alternatives only to eliminate those that do not meet stated team objective(s).
- Identify what additional benefits may be provided by the remaining alternatives.
- Should only minimize from “many” to “few” alternatives. Do **NOT** analyze to preferred solution here.

Basic Decision Making Process

1. Gather an Appropriate Team
 2. Identify the Problem
 - ★ 3. Identify All Major Issues
 - ★ 4. Identify All Alternative Solutions
 - ★ 5. Collect Data and Schedule Information
 6. Perform Initial Analysis
 - ★ 7. Identify **Major Risks and Probabilities**
 8. Perform Final Analysis, Including Risks
 9. Make Final Recommendation
- ★ (Primary focus of rest of this discussion)

Identification of Major Risks

1. Environmental **Legislative and Regulatory Risks**
2. Environmental **Technology Control Risks**
 - a) Existing Technology Costs and Performance Risks
 - b) New Technology Cost and Performance Savings
 - c) New Technology Probability of Demo Success
3. Process and **Equipment Vendor Market** Fluctuations
4. **Fuel Market** Risks
5. Risks from Potential “**World Changes**”
6. **Ranges** for each uncertainty mentioned above
7. Other?

Decisions needed for Risk Assessment

- Determine **what risks** will be assessed
- Determine **how far** into the future to extend the risk assessment
- Establish **confidence level range** (e.g., 10%, 50%, 90%) needed for all uncertainties to be assessed.
- Establish how risks will be assessed
 - What **Metric**, PV, IRR Cash flow, etc. will be used for analysis result comparison
- Assign to each uncertainty, the **individual probability** of occurrence and associated impact

Perform Final Analysis, Including Risks

- Consider carefully using some form of **decision analysis tool** to compare alternatives against risks or uncertainties. Examples of such tools are:
 - Kepner-Tregoe Decision Analysis
 - Palisades Risk Management Software
 - Frontline Risk Solver Software
 - Applied Decision Analysis DPL Software
 - Oracle Crystal Ball Risk Analysis
 - Enterprise Risk Analysis
- Just using such a tool isn't enough. **Training or vendor oversight** or assistance may be needed to ensure operation of tool is correctly being applied.

Risk Analysis

- Need to **consider Risks** on a **balanced basis** - both good and bad
 - 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 uncertainty risk
- Consider Project “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

Basic Decision Making Process

1. Gather an Appropriate Team
2. Identify the Problem
- ★ 3. Identify All Major Issues
- ★ 4. Identify All Alternative Solutions
- ★ 5. Collect Data and Schedule Information
6. Perform Initial Analysis
- ★ 7. Identify Major Risks and Probabilities
8. Perform **Final Analysis**, Including Risks
9. Make Final Recommendation

★ (Primary focus of rest of this discussion)

Perform Final Analysis, Including Risks

- Perform **probabilistic analysis** ranking all alternatives in their “best to least” recommended order.
- Be very careful where probabilistic weighted point systems are used to combine risks and uncertainties. Make sure that weighting is “**relatively equivalent**” in at least order of magnitude of potential economic value to your company.
- Assess the risks for the “**Best Alternative**” to ensure the risks for the alternative in **all identified uncertain worlds** are acceptable, relative to other alternatives.
- Assess **value related to delaying decision(s)** as much as possible.
- Refine recommendation until **agreement** is reached by entire team.
- Check for “**Common Sense**” understanding.
- Keep final recommendation as simple as possible.

Basic Decision Making Process

1. Gather an Appropriate Team
2. Identify the Problem
- ★ 3. Identify All Major Issues
- ★ 4. Identify All Alternative Solutions
- ★ 5. Collect Data and Schedule Information
6. Perform Initial Analysis
- ★ 7. Identify Major Risks and Probabilities
8. Perform Final Analysis, Including Risks
9. Make **Final Recommendation**

★ (Primary focus of rest of this discussion)

Make Final Recommendation

- Keep Simple, Concise, and Clear
 - State Problem
 - Acknowledge team contribution and effort
 - Mentioned alternatives considered uncertainties addressed
 - State Concluding Recommendation
 - Develop recommendation presentation as an “**Onion**” with capability of being peeled away for more depth as questions arise

Conclusion

- Utility Environmental Control decision making doesn't have to be a **gamble**.
- You can stack the odds in your favor by doing your **decision making homework**.
- Assess risks and use the resulting knowledge to frame final team based recommendation and decision.

Questions?

- Contact:

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Cell Phone: (423) 280-9459

Backup Slides

Abstract

The ever changing environmental regulations, increasing control technology costs, and major shifts in coal and natural gas prices significantly complicate major utility decision making. Wrong decisions can lead to the loss of millions of dollars for utilities and/or their rate payers. This presentation will discuss various aspects which need to be addressed to avoid future regrets from those decisions.

Included will be an environmental legislative and regulatory update, a look at current environmental technologies, an update of natural gas prices and price forecasts, and methods for addressing uncertainties.