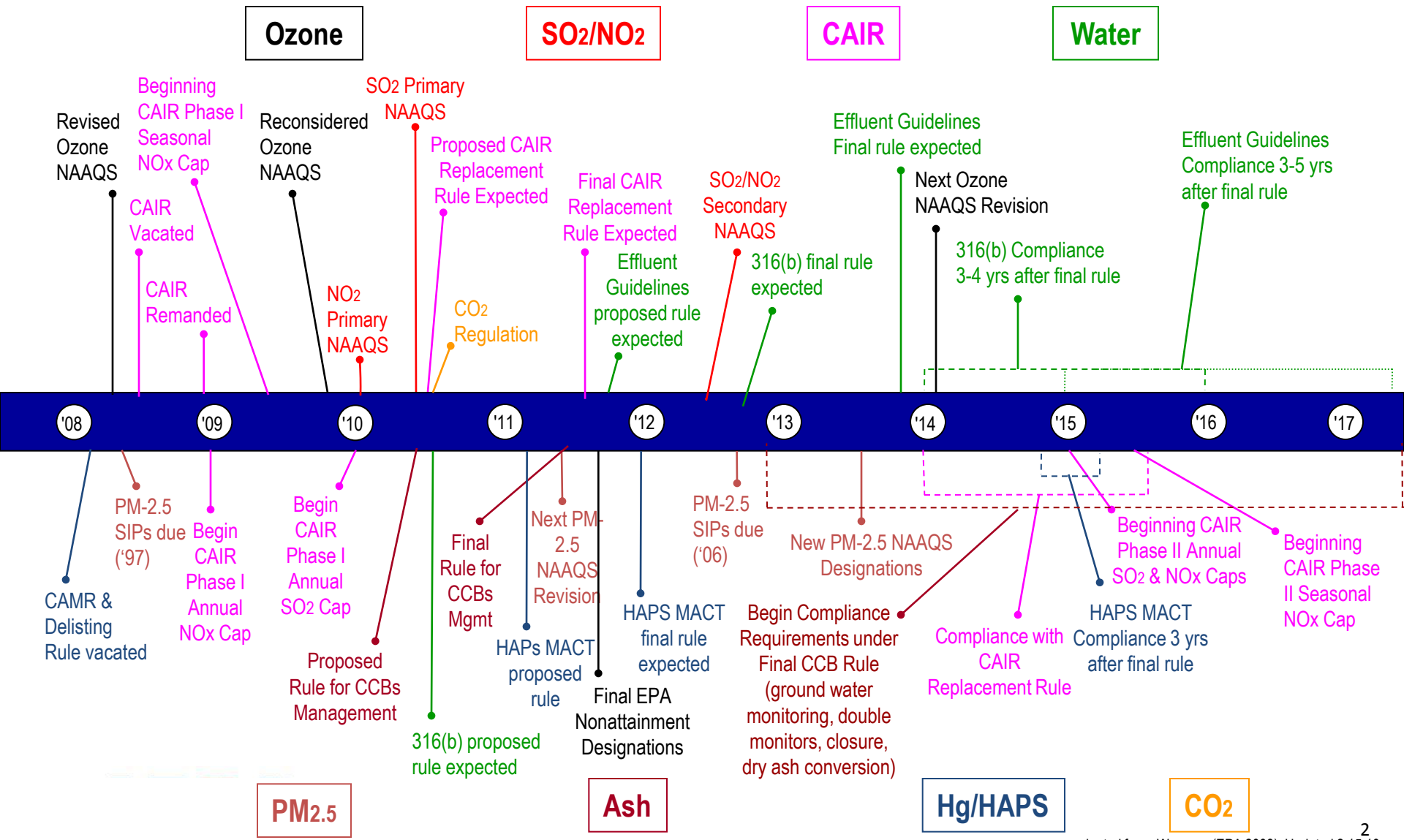
Sober Thoughts About Electric Utility Generation 2012-2017: CCS for Coal Plants, Natural Gas Conversions and Generation Retirement

Theresa Pugh
Director, Environmental Services

Carbon Management Strategies and Technologies Hot Topic Webinar
Thursday June 24, 2010

APPA® American Public Power Association

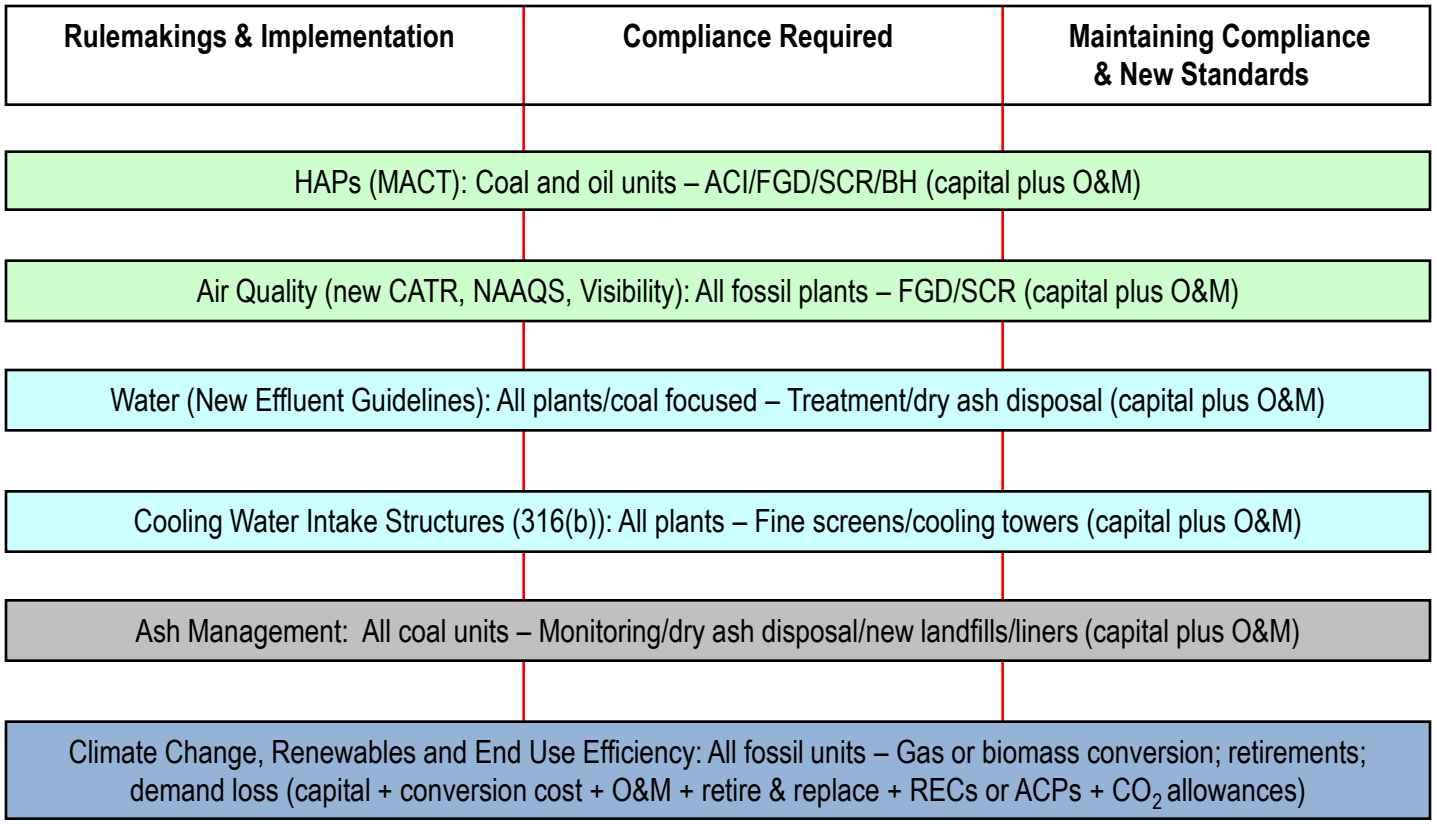
Possible Timeline for Environmental Regulatory Requirements for the Utility Industry



-- adapted from Wegman (EPA 2003) Updated 2.15.10

Multi-Media Compliance Challenges over the Next Decade*

2010 ⟷ 2020

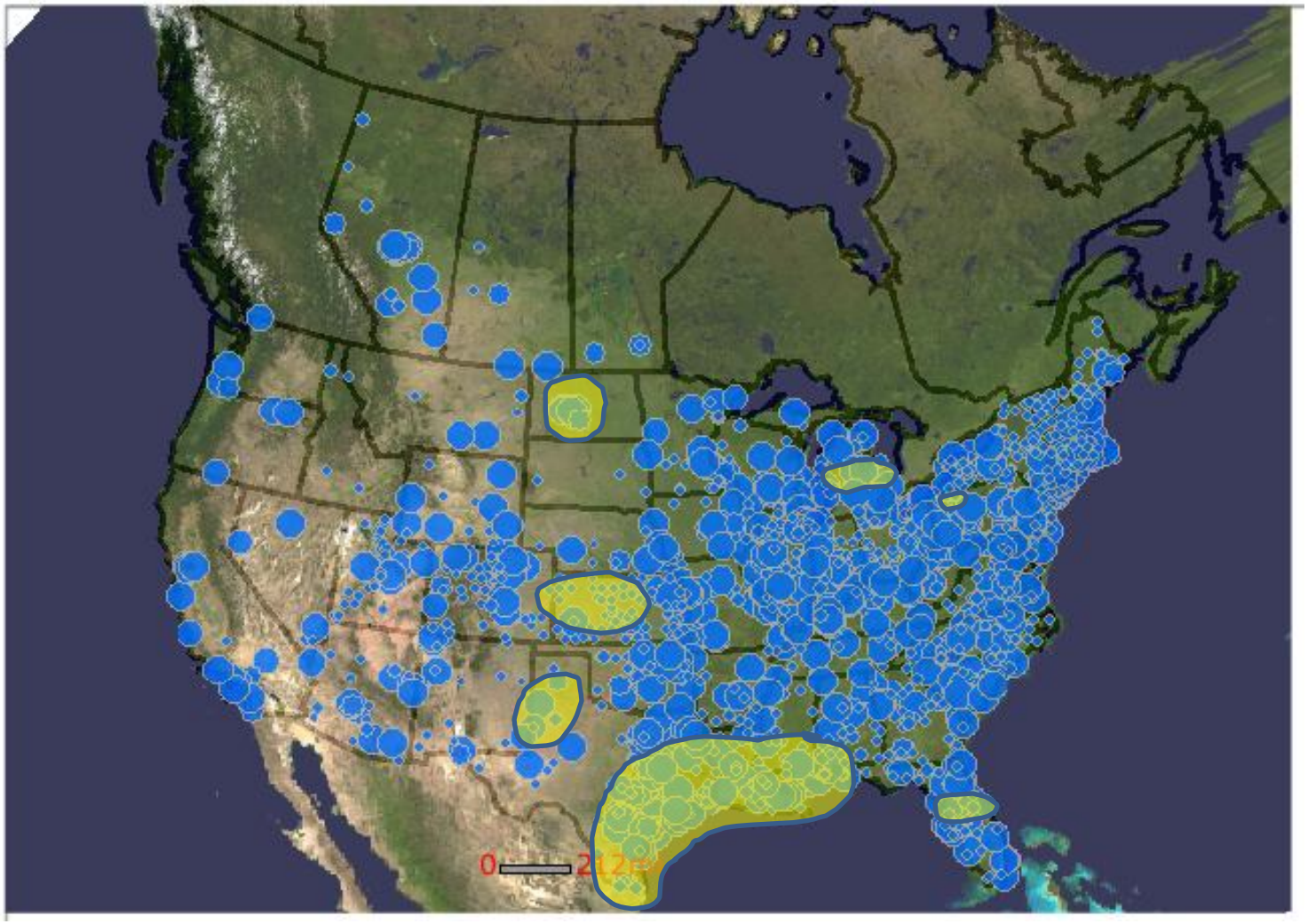


- Need final rules to commit to a specific technology or compliance strategy.
- Retrofit technologies, selection and cost, are dependent on unit design, fuels, age, & location.
- Technologies to reduce GHGs (e.g., CCS) are in early development.

There is a cumulative impact to power plants from multiple regulations.

* These slides excerpted from a presentation by a group of utilities to EPA on 2/10/10

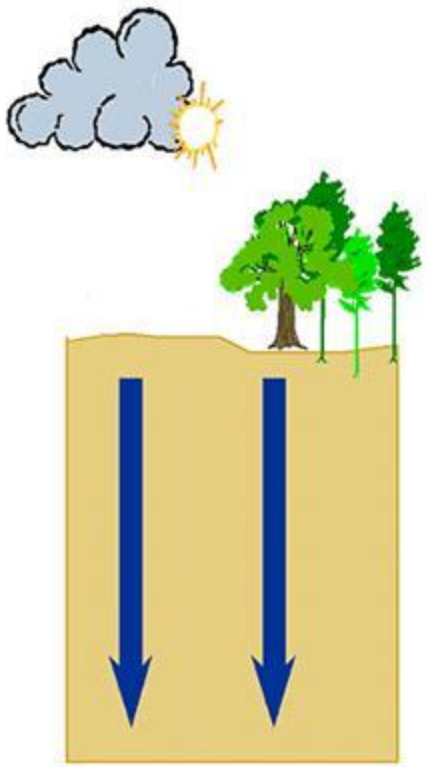
Existing Fossil Generation & Optimal CCS Locations Without Any Drinking Water Resource Location Analysis



Source of Map: NatCarb Atlas; Overlay: APPA Optimal Location Criteria Maps without CO_2 pipelines

Note: Optimal Locations are for new plants, not retrofit of existing power plants

Subsurface Space Required to Sequester 40% of the Carbon Dioxide from Approximately Nine 500 MW Plants Over Their 40-year Lifetime:



2,580 square miles

Roughly 1.5 times the size of Rhode Island

Roughly half the size of Connecticut

"Best Guess" Timeline for Baseload (<600 MW) CCS Plant in Non-EOR/EGR States

2011

UIC Rule Finalized

2012-2015

States Finalize UIC Rules for Class VI and II Injection

States in non-oil & gas locations pass laws dealing with property, ownership, trespass, state liability, drinking water, pore space ownership, and subsurface non-mineral injection & storage of commodities or waste

2015-2018

Reports from pilot and pioneer CCS projects in U.S., Australia, & South Africa for parasitic improvement and sequestration

Non-Extractive industry states look at subsurface for orphan wells, abandoned wells, and other "leak" pathways (State Geologist Dept.) (5 years)

OR

- A tabulation of all wells within the area of review which penetrate the injection or confining zone(s)
- Maps and stratigraphic cross sections indicating the general vertical and lateral limits of all USDW's, water wells and springs within the AOR
- Baseline Geochemical data on subsurface formations including all USDW's in the AOR

2018

Permit applications begin. Expected 5-10 year process to review all subsurface reports, studies given before final permit issued.

Plume Management 5 yr. modeling results used for permit applications

2018-2020

- Proposed testing & Monitoring Plan
- Proposed Injection Well Plugging Plan
- Proposed Post-injection Site Care and Site Closure Plan
- Proposed Emergency and Remedial Response Plan
- Any other info requested by State Director

Pipeline Construction for Chemical Delivery?

- Proposed procedure to outline steps necessary to conduct injection operations
- Schematic or other appropriate drawings of the surface and subsurface construction details of the wells
- Injection well construction procedures that meet the requirements regulation
- Proposed Area of Review and corrective action plan
- Status of corrective action on wells in the Area of Review
- All available logging and testing program data on the well
- Demonstration of Mechanical Integrity & Financial Responsibility

2018-2025

Based on results of pilots, more non-EOR sites submit permit applications. But, none based on 5+ years of data on subsurface and plume

2022

UIC Permit Granted (every 5 years)

Air Permit Approval

2028-2030

Construction of:

- Exploratory wells ($1 million each)
- Observation wells ($1 million each)

Construction of Power Plant (3 years?)

2030-203?

Other Issues:

Which comes first? The pipeline or the plant?

Backup for on-site storage of CO_2

- Tank, Pipelines, Wells??

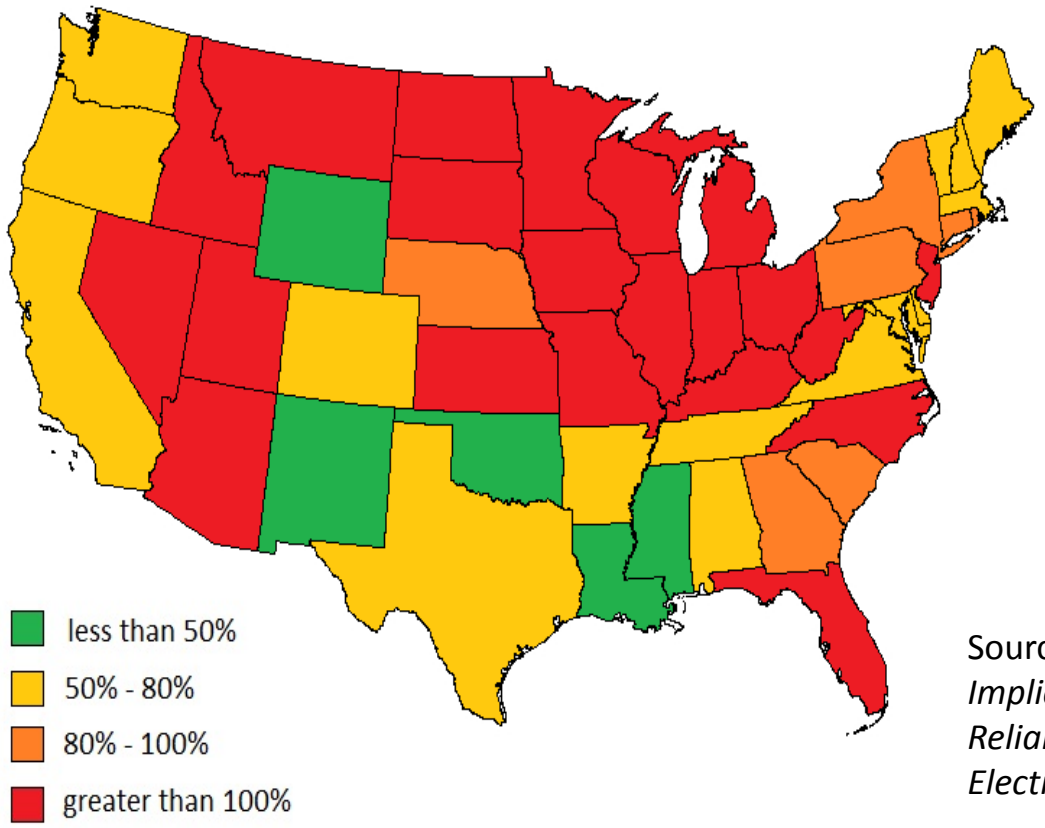
APPA's White Papers on CCS

Available at http://www.appanet.org/files/htm/ccs.html

- Marianne Horinko, "Carbon Capture and Sequestration Legal and Environmental Challenges Ahead," August 2007
- L.D. Carter, "Carbon Capture and Storage From Coal-based Power Plants: A White Paper on Technology for the American Public Power Association (APPA)," May 2007
- L.D. Carter, "Retrofitting Carbon Capture Systems on Existing Coal-fired Power Plants," November 2007
- Jonathan Gledhill, Policy Navigation Group; James Rollins, Policy Navigation Group; Theresa Pugh, APPA, White Paper, "Will Water Issues/Regulatory Capacity Allow or Prevent Geologic Sequestration for New Power Plants? A Review of the Underground Injection Control Program and Carbon Capture and Storage," November 2007
- Carbon Capture and Storage: Analysis of Potential Liabilities Associated with Groundwater Contamination Due to Geological Sequestration Operations, September 10, 2008, *Prepared by Fredric P. Andes and Kari A. Evans, members of the Barnes & Thornburg LLP Water Team, for the American Public Power Association (APPA)*
- Timothy Gablehouse, White Paper, "Geologic CO_2 Issue Spotting and Analysis" July 2009

OK, so if CCS is not the easy answer between now and 2030—then fuel switching to natural gas must be the answer, right?

Interstate Pipeline Capacity Utilization if An Individual State Switched its Coal-Fired Generation to Natural Gas



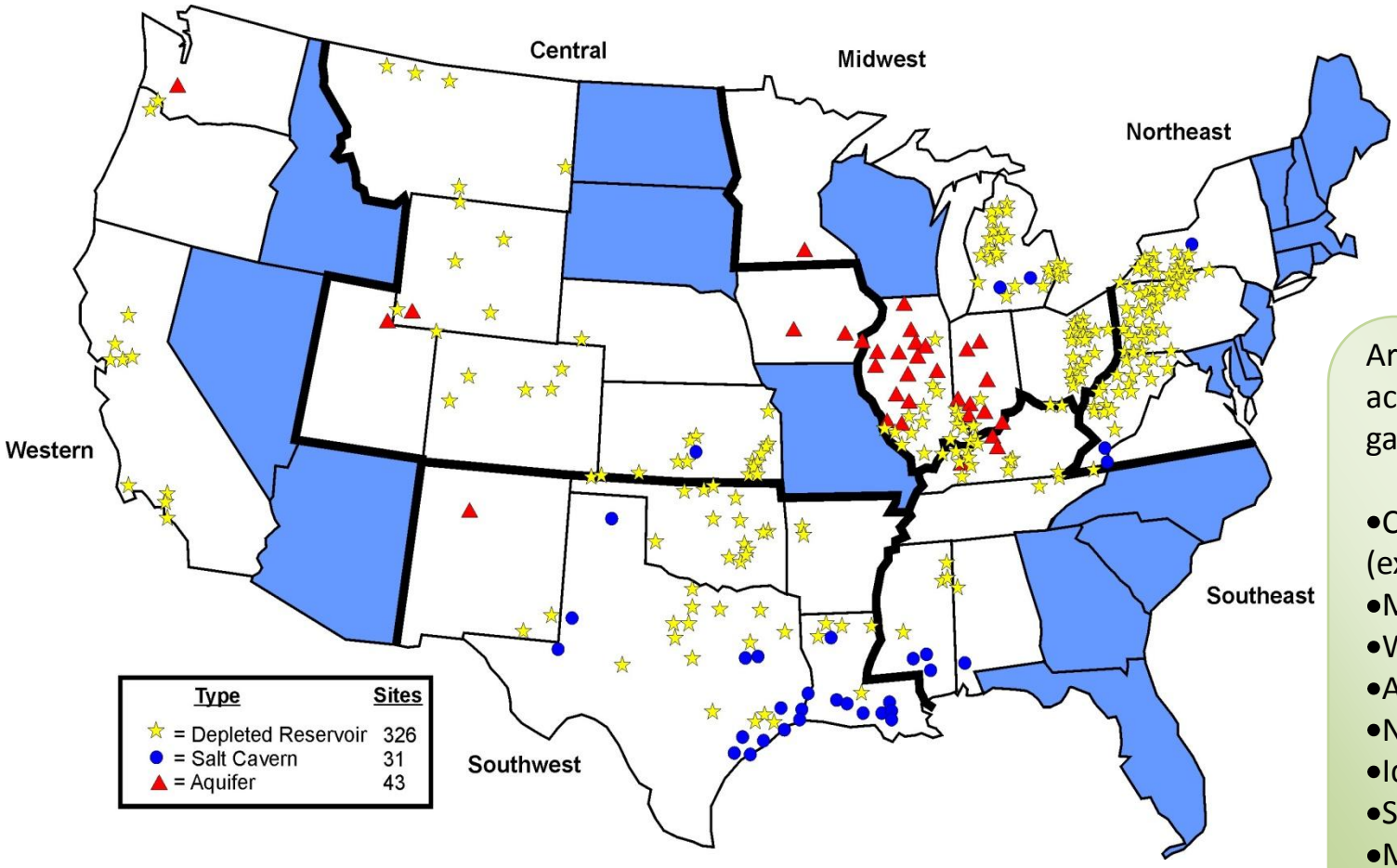
Source: APPA Study, *Implications of Greater Reliance on Natural Gas for Electricity Generation*

Natural Gas Demand if All Coal-Fired Generation Replaced with Gas at Current Electricity Market Size/No Growth

	Tcf
2008 EG Gas Burn	6.9
EG Gas Burn if All Existing Coal-Fired Generation Replaced	14.1
Subtotal EG Gas Burn	21.0
All Other Sectors	16.1
Total Annual Natural Gas Demand if All Existing Coal-Fired Generation Replaced	37.1

Source: APPA Study, *Implications of Greater Reliance on Natural Gas for Electricity Generation*

Geographic Distribution of Underground Gas Storage Facilities



Areas without easy access to underground gas storage to include:

- Central Plains states (except Kansas)
- Missouri
- Wisconsin
- Arizona
- Nevada
- Idaho
- Southeastern states
- Most of Mid-Atlantic
- Northeastern states

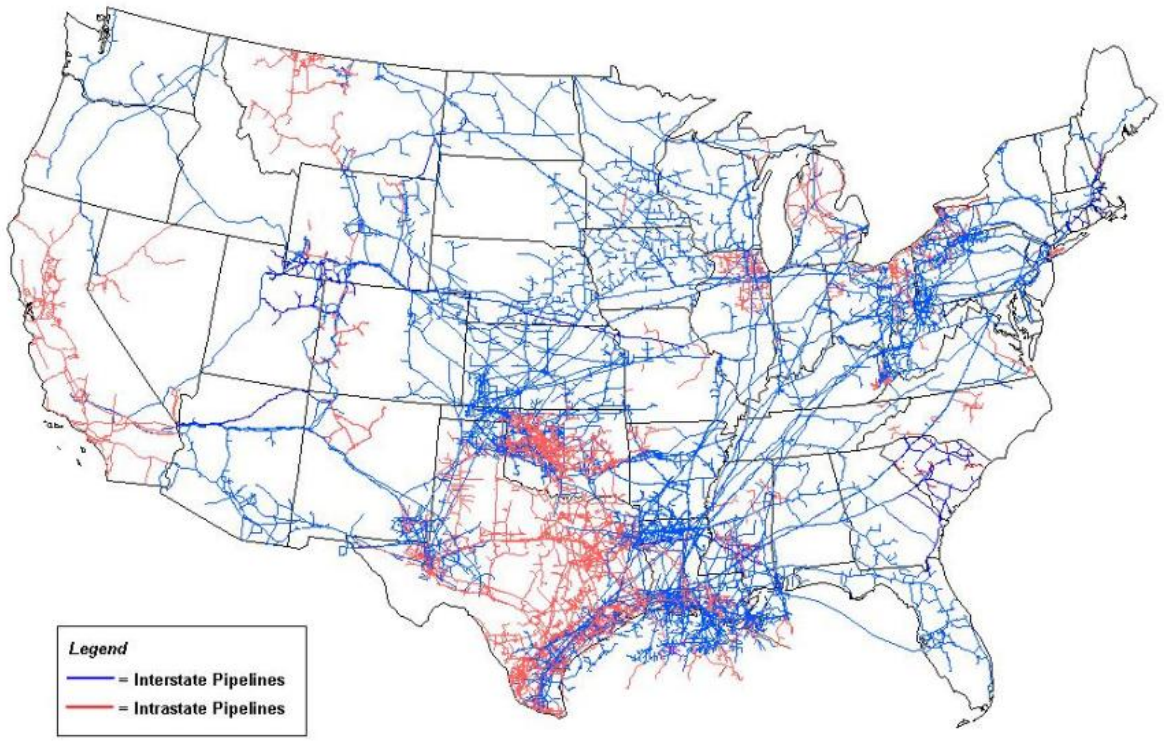
Natural Gas Pipeline Map – Showing Areas with Limited Accessibility to Natural Gas

Energy Information Administration
Official Energy Statistics from the U.S. Government

Home > Natural Gas > About U.S. Natural Gas Pipelines > U.S. Natural Gas Pipeline Network Map

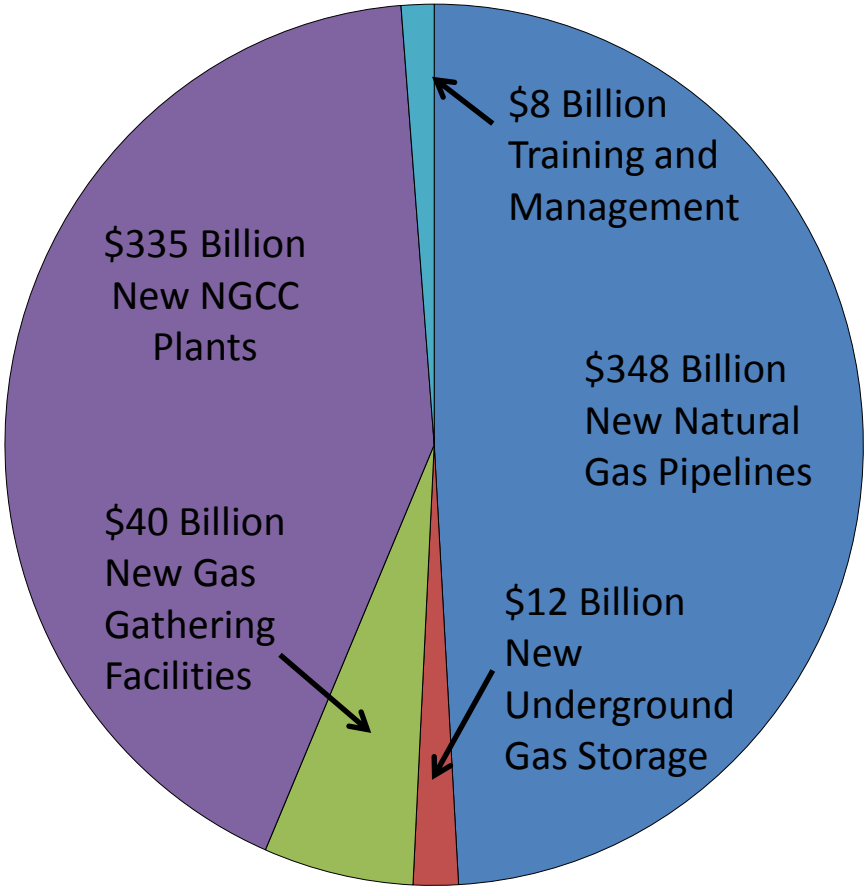
About U.S. Natural Gas Pipelines - Transporting Natural Gas

U.S. Natural Gas Pipeline Network, 2009



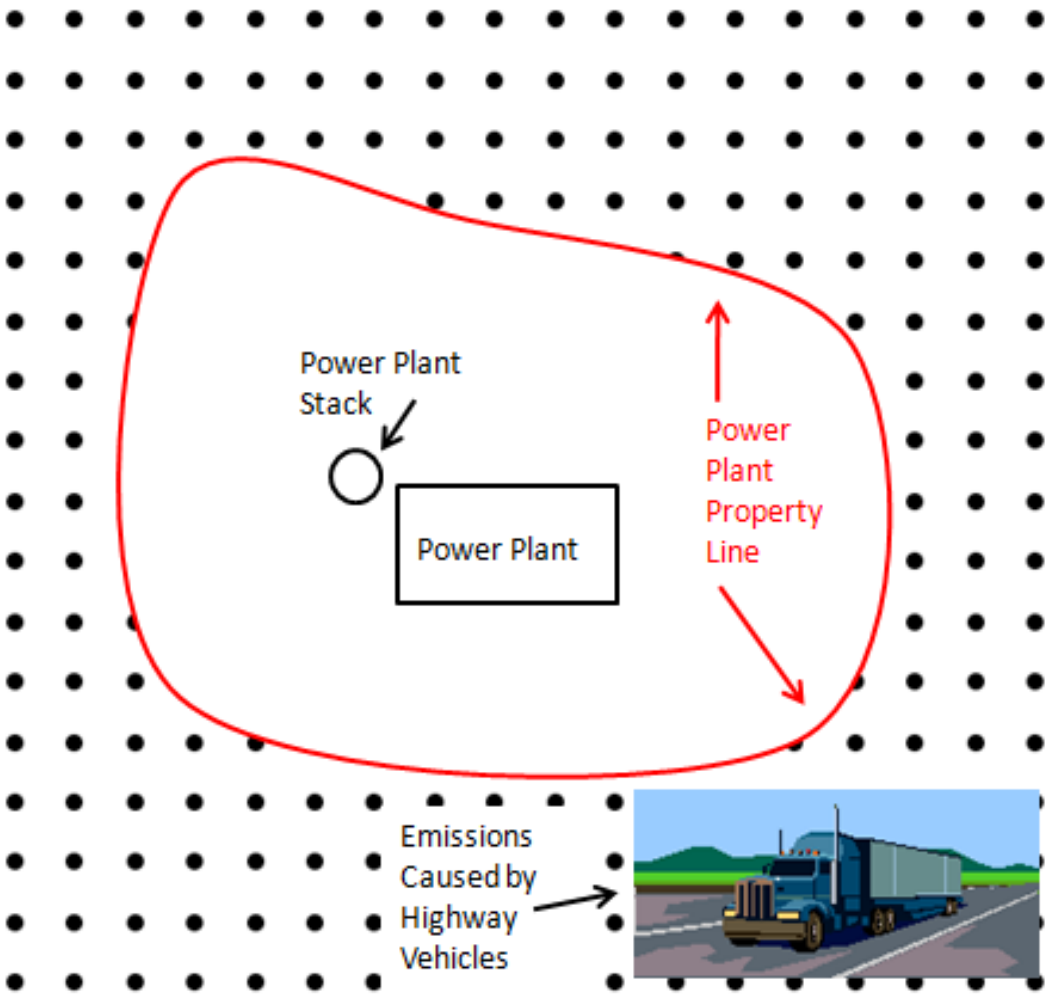
Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System

Total Cost to Implement Switch from Coal to Natural Gas



Boilers designed to burn coal are different from the ones designed to burn gas. Retrofitting would involve installing a new combustion system and a new heating surface. Due to these changes, the retrofitted unit would operate at a lower rate of efficiency, which GAO cites as 10 to 12%.

Dispersion Model Receptor Grid Used for Proposed EPA 1-hour NOx NAAQS



Theresa Pugh

Director, Environmental Services

202-467-2943

TPugh@APPAnet.org