Electric Utilities' Perspective on GHG Standards for New & Existing Power Plants

Presentation to NAESO

Theresa Pugh
Director of Environmental Services
American Public Power Association

With Technical Materials Provided By
J. Edward Cichanowicz and Michael C. Hein
Consultants to APPA

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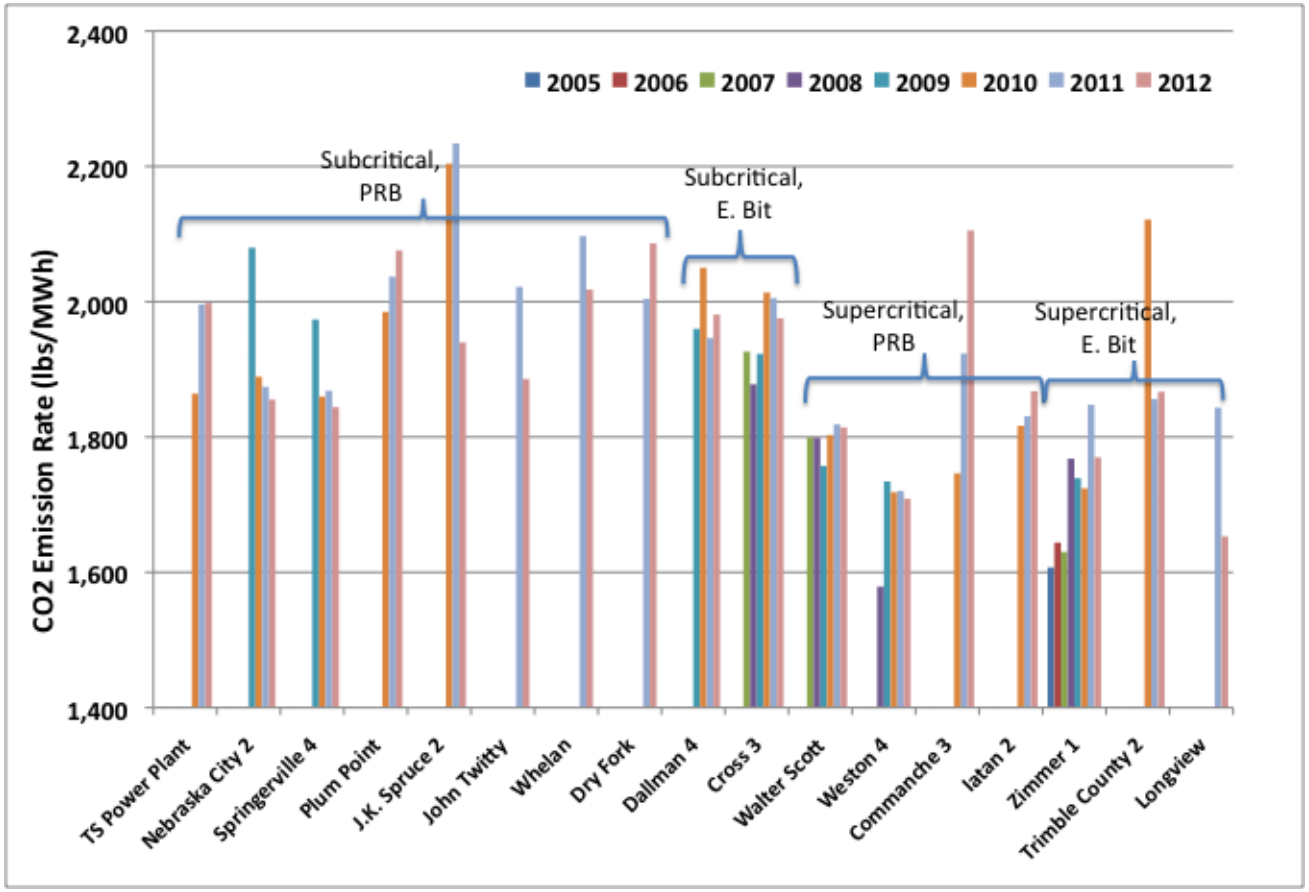
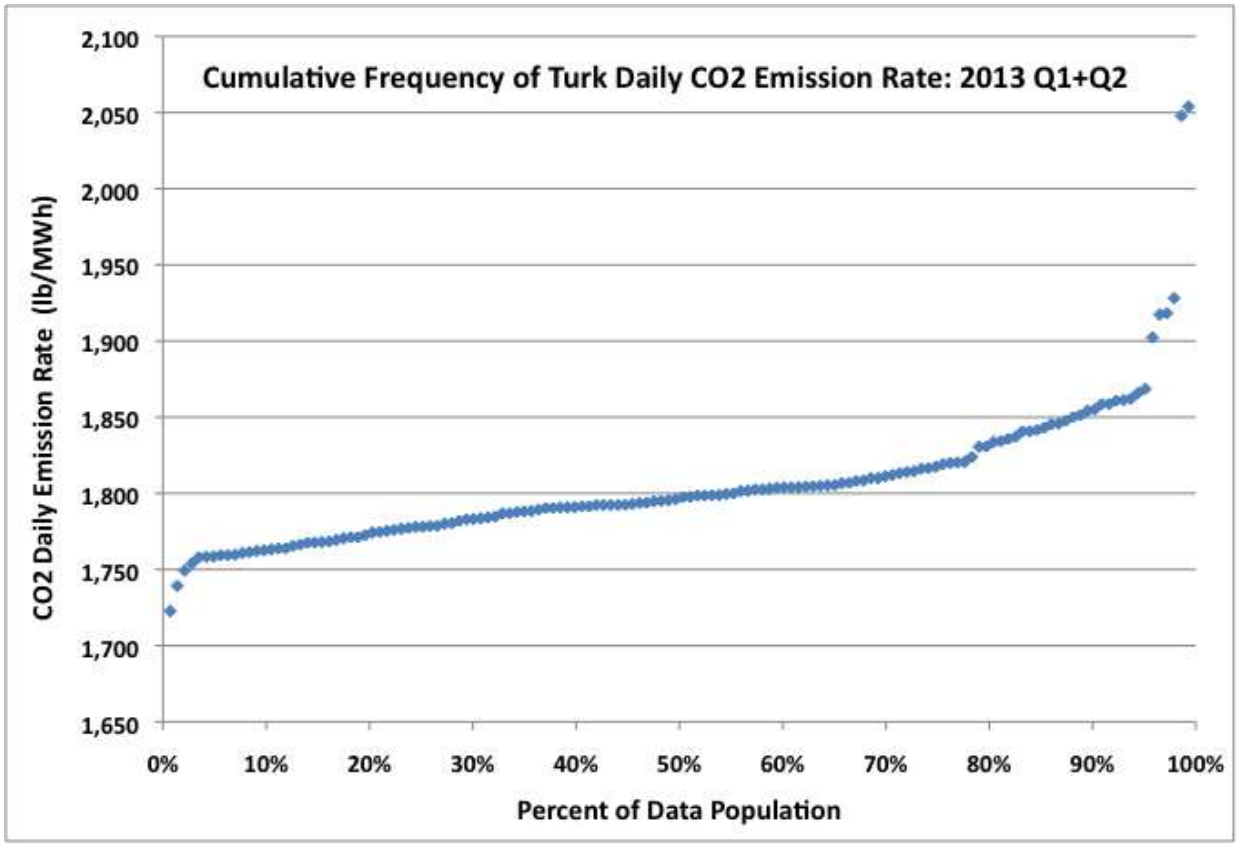
APPA's Key Issues and Concerns

- Both proposed rules should be differentiated by fuel type.
- Do not set emissions standards for coal at 1,200 lbs/MWh with CCS because it is unrealistic. No commercial coal plant can meet and sustain 1,100 lbs/MWh. CCS is highly unlikely to be commercially available within the 8-year NSPS review.
- Set the new coal standard at a range between 1,900 and 1950 lbs/MWh (achievable by the most advanced current technology). Revisit the commercial availability of CCS at the next 8 year review. (The New Plant rule requires CCS for coal)
- Set the gas standard at 1,100 lbs/MWh and provide flexibility for actual operating conditions. Life of unit(s) must consider many factors such as ramping, cycling. and altitude. EPA should call for comments on these practical operating issues.
- Gas infrastructure readiness is doubtful (storage and pipes); EPA should examine and consider this carefully and call for comments.
- RTO market design, especially in those with mandatory capacity markets, inhibit necessary infrastructure additions.

17 “New PC” Units Firing PRB, E. BIT



Turk Ultra-Supercritical Boiler: CO_2 Emissions Rate Variability



Cichanowicz, Hein

Set the CO_2 Emission Rate for New Natural Gas/ Combined Cycle at 1,100 lbs/MWh

- Achievable for New Generating Units
- Heat Rate/CO_2 Emission Rate Degrades with:
  - Time (component wear)
  - Non-steady operation (ramping)
- Will "Back-Up" Role for Wind Elevate CO_2 Rate?
  - *Dynamics of operation suggest "yes"*
  - NREL: *Heat rates may be higher during ramping* [1]
  - *Wind CO_2 offset 75% of predicted* [2]

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[1] *Power Plant Cycling Costs*, prepared by Intertek APTECH for NREL, Report AES 12047831-2-1, April 2012

[2] *Air emissions due to wind and solar power*, Environmental Science and Technology, 2009, Jan 15, 43(2):253-8

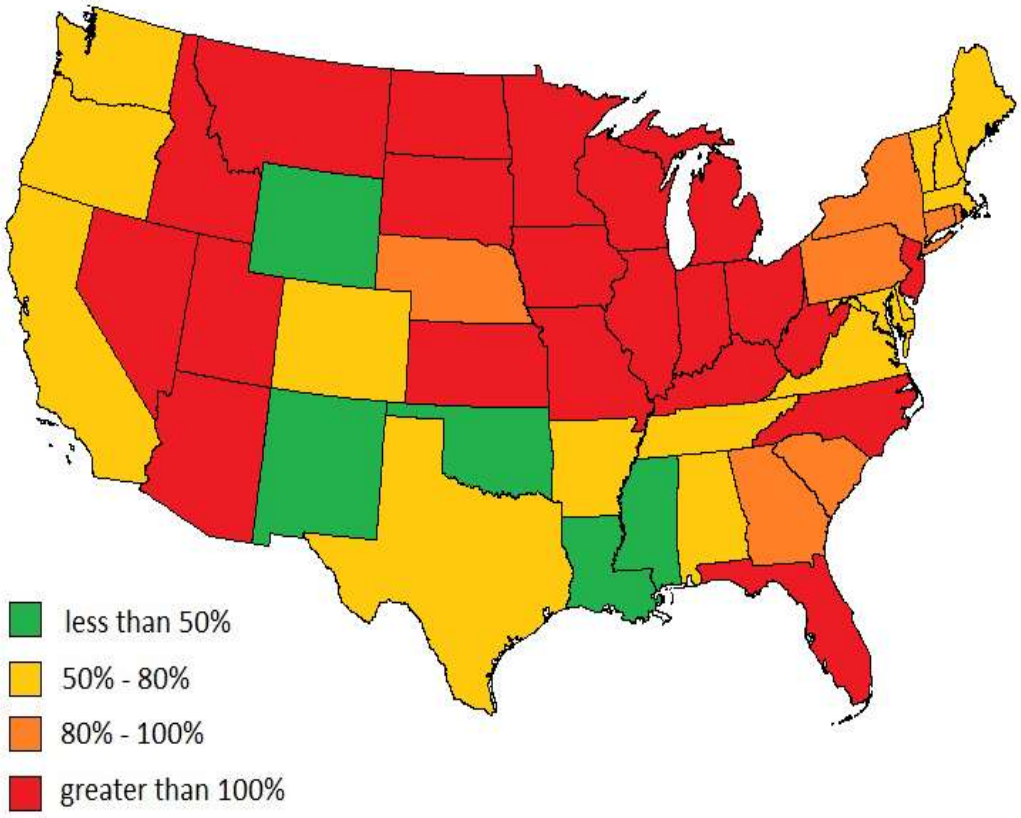
Question for EPA

- What do we know about actual CO_2 emissions from maturing NGCC over time as renewables are added and natural gas ramps to follow?
- Carnegie-Mellon Study:
  - CO_2 emission reductions from a wind or solar photovoltaic (PV) system coupled with a natural gas system are likely to provide 75% to 80% less CO_2 reduction than previously assumed.
  - Even the best system they analyzed, NOx reductions with 20% wind or solar PV penetration were 30% to 50% below what was expected.
- From Power Article
  - Researchers at the National Renewable Energy Laboratory (NREL) acknowledged in 2012 that many efforts to assess the emissions benefits of wind have failed to account for ancillary emissions from generating units that cycle or ramp to compensate for the renewable resources' intermittent generation.

Infrastructure for Natural Gas Is Essential for NGCC

- Infrastructure readiness for fuel switching to natural gas?
- Is CCS really commercially demonstrated for coal or gas?

Interstate Pipeline Capacity Utilization if an Individual State Switched Its Coal-Fired Generation to Natural Gas



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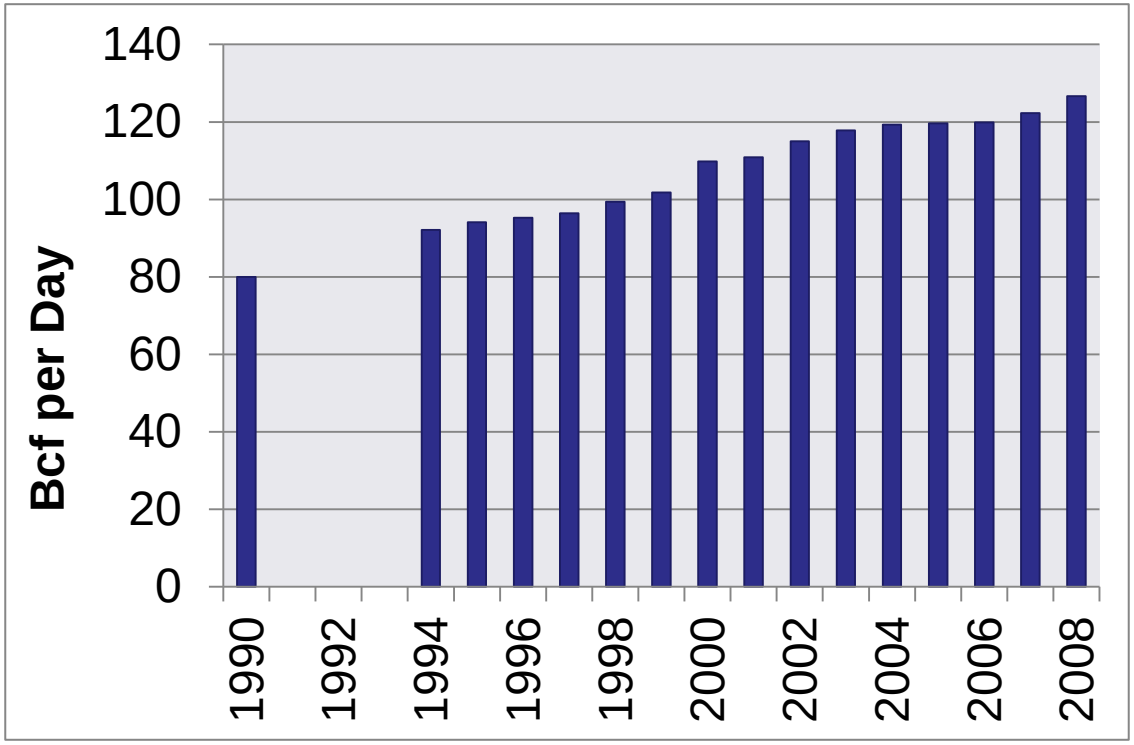
Source: APPA's 2010 Natural Gas Study

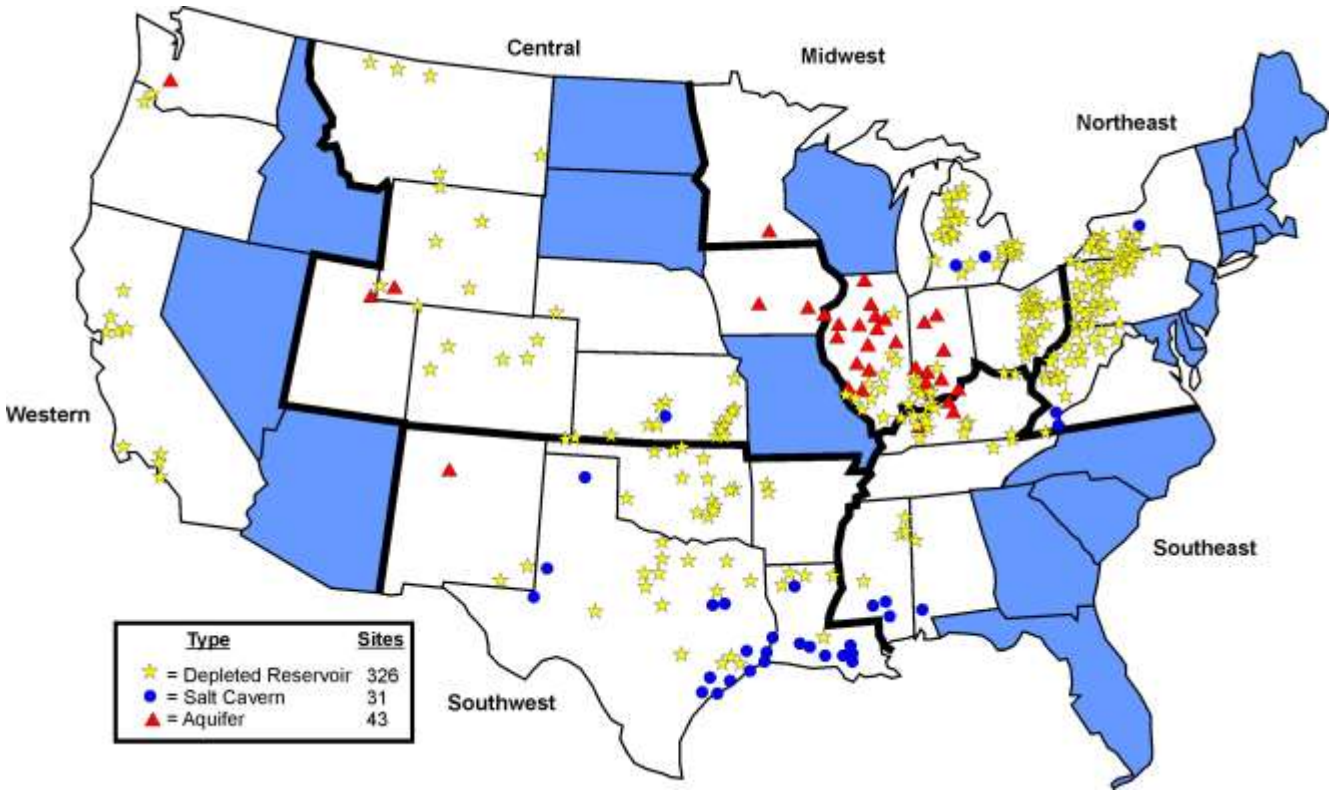
Note: Reflects a presumption that over time older coal plants may be retired and replaced with natural gas. The increased percentage of natural gas in each state does not include natural gas used to back up wind or solar, do these 2010 estimates include any natural gas usage for new manufacturing or LNG exports

Total Interregional Pipeline Capacity 1990 to 2008



Source: Aspen Analysis of EIA data (1991 to 1993 missing from the EIA source data)

Geographic Distribution of Underground Gas Storage Facilities for Electric Utilities
Storage Is Key Because Gas Must Be within 10, 15, or 20 Minutes for Reliability



Source: APPA's 2010 Natural Gas Study
Note: reflecting no new storage permitted/built since 2010

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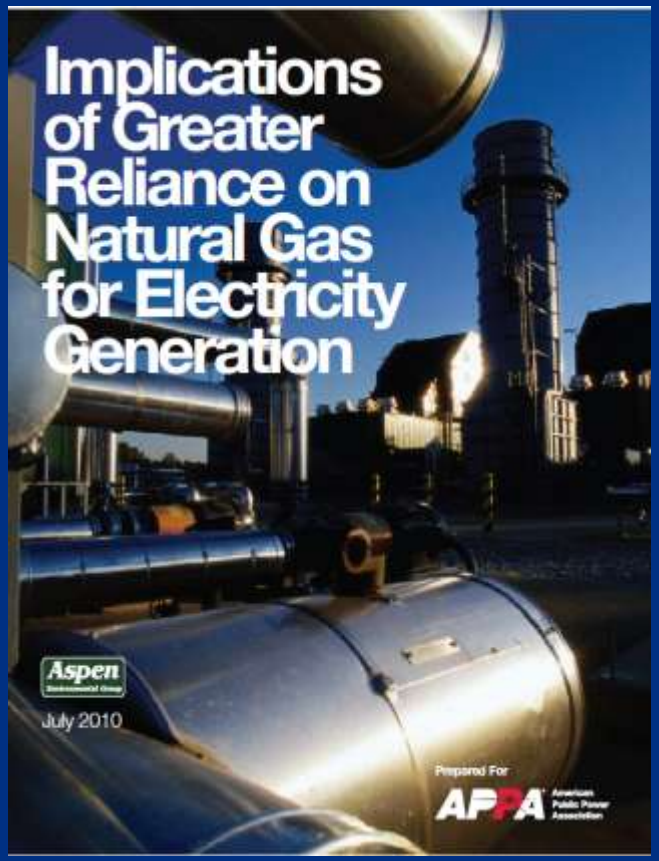
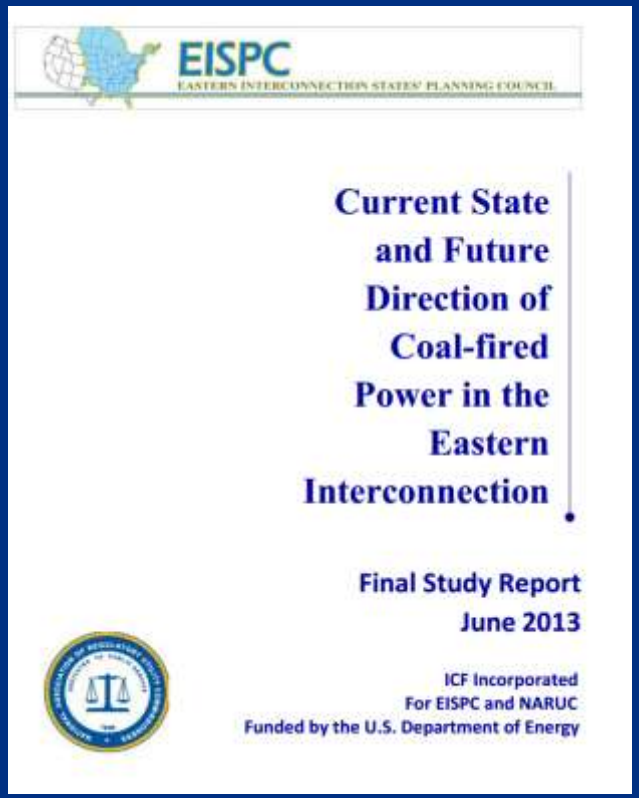
APPA Natural Gas Study



Available at:

http://www.publicpower.org/files/PDFs/ImplicationsOfGreaterRelianceOnNGforElectricityGeneration.pdf

Recommended Reading



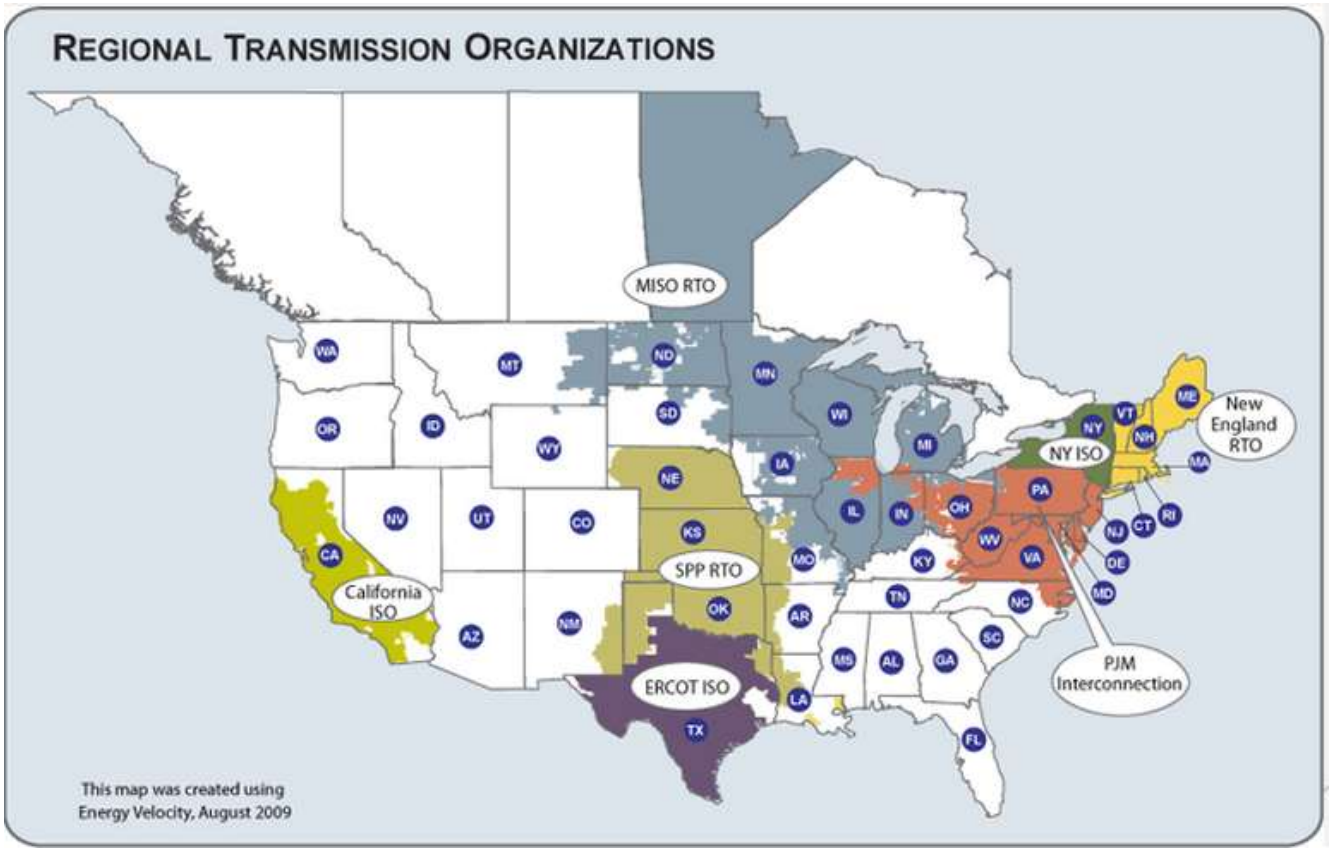
Available at:

http://naruc.org/Grants/Documents/Final-ICF-Project-Report071213.pdf

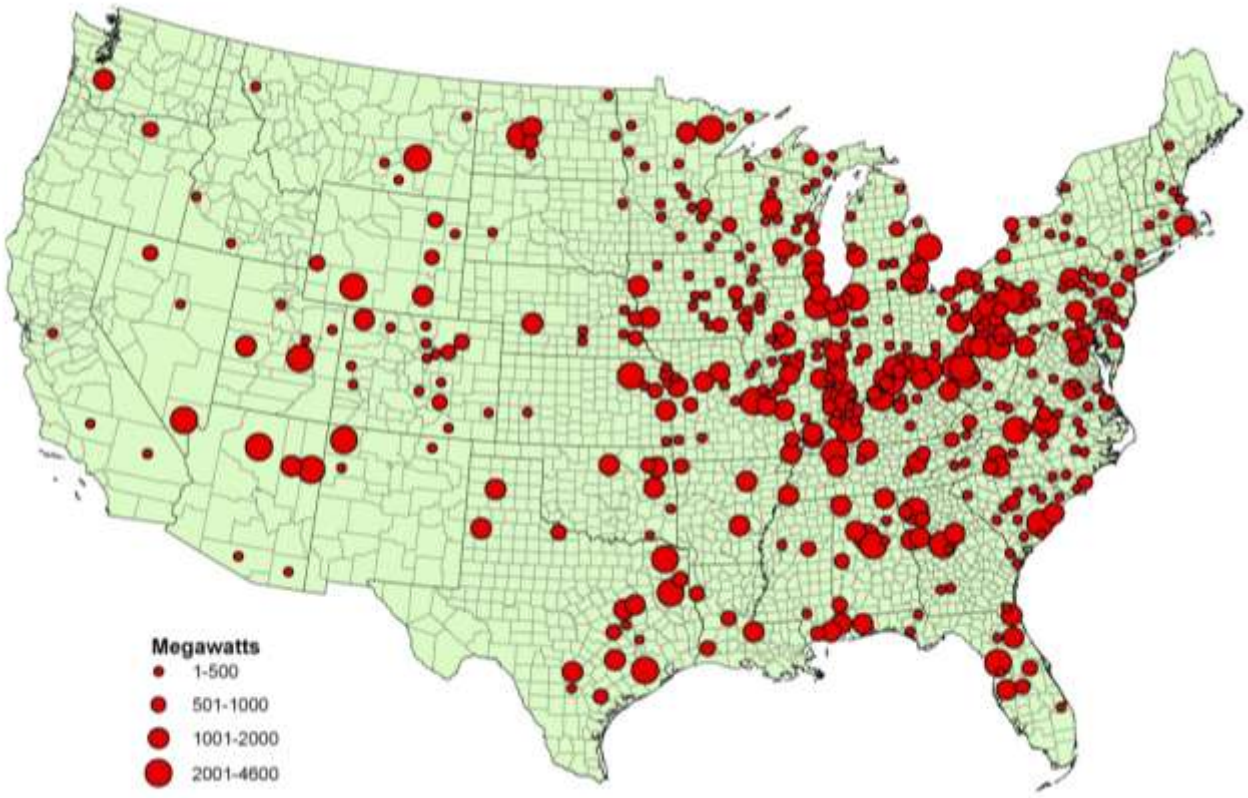
Some Wholesale Electricity Market Structures Inhibit Construction of New Infrastructure

- RTO/ISOs in New England, New York, PJM (Mid-Atlantic) with mandatory forward capacity markets
- Not real markets; administrative constructs with complex and changing rules
- Subject of numerous contested proceedings and litigation
- Short-term focus does not support long-term investments
- EPA/OMB should examine this issue closely

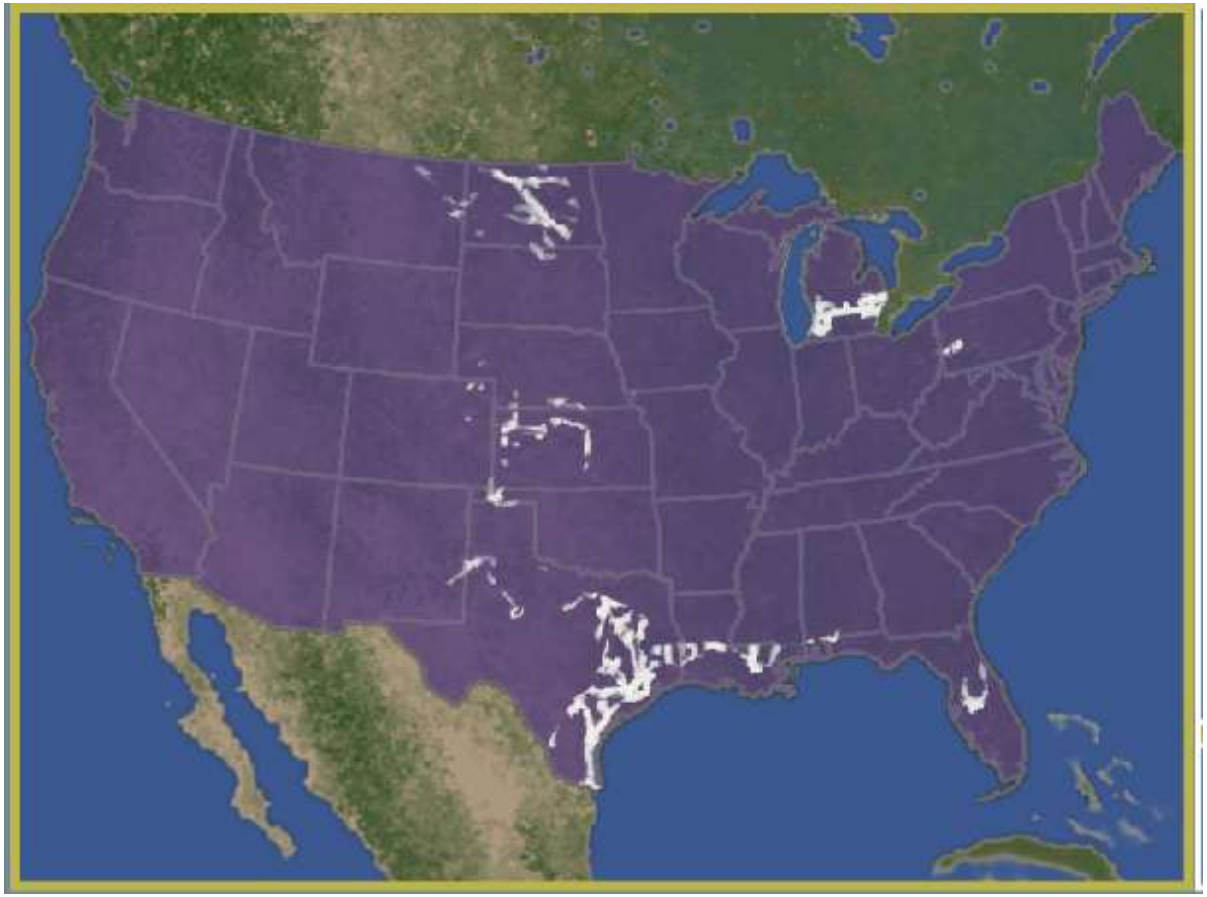
Regional Transmission Organizations/Independent System Operators



Commercial Demonstrations of CCS Require Massive Infrastructure

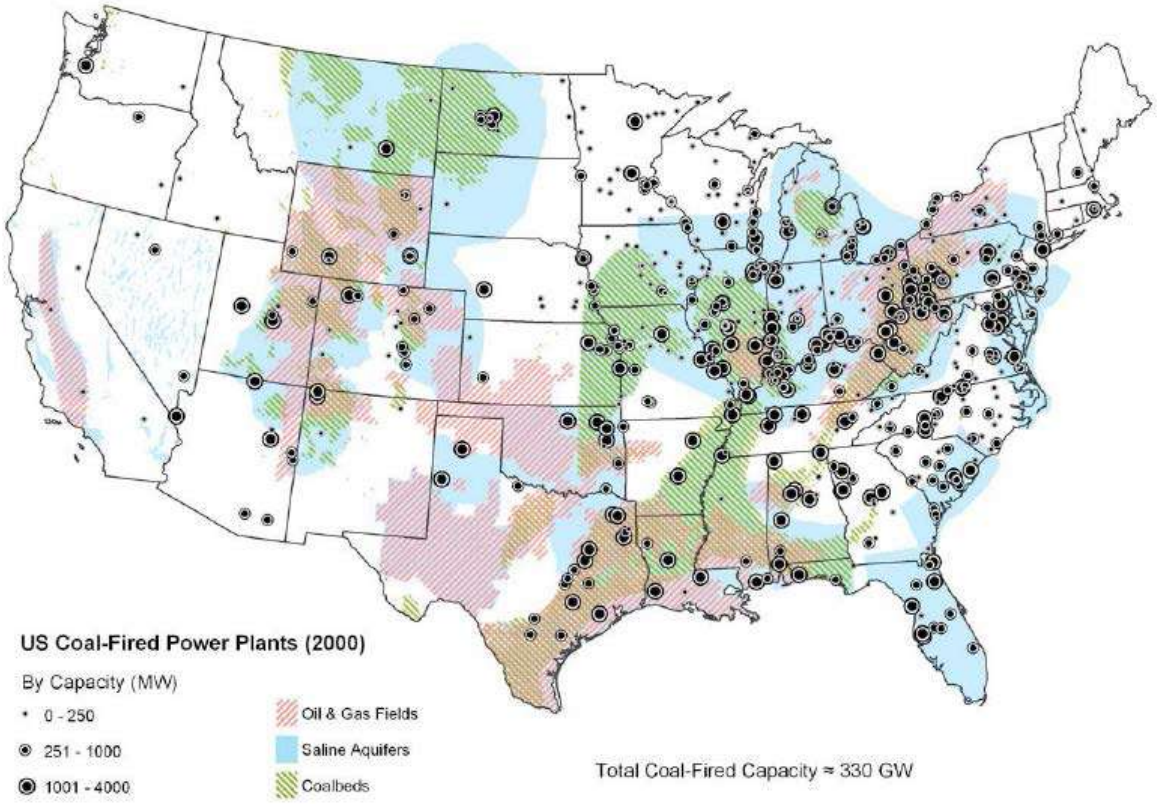


Optimal Sites – Not Requiring Proximity to Additional CO_2 Pipelines



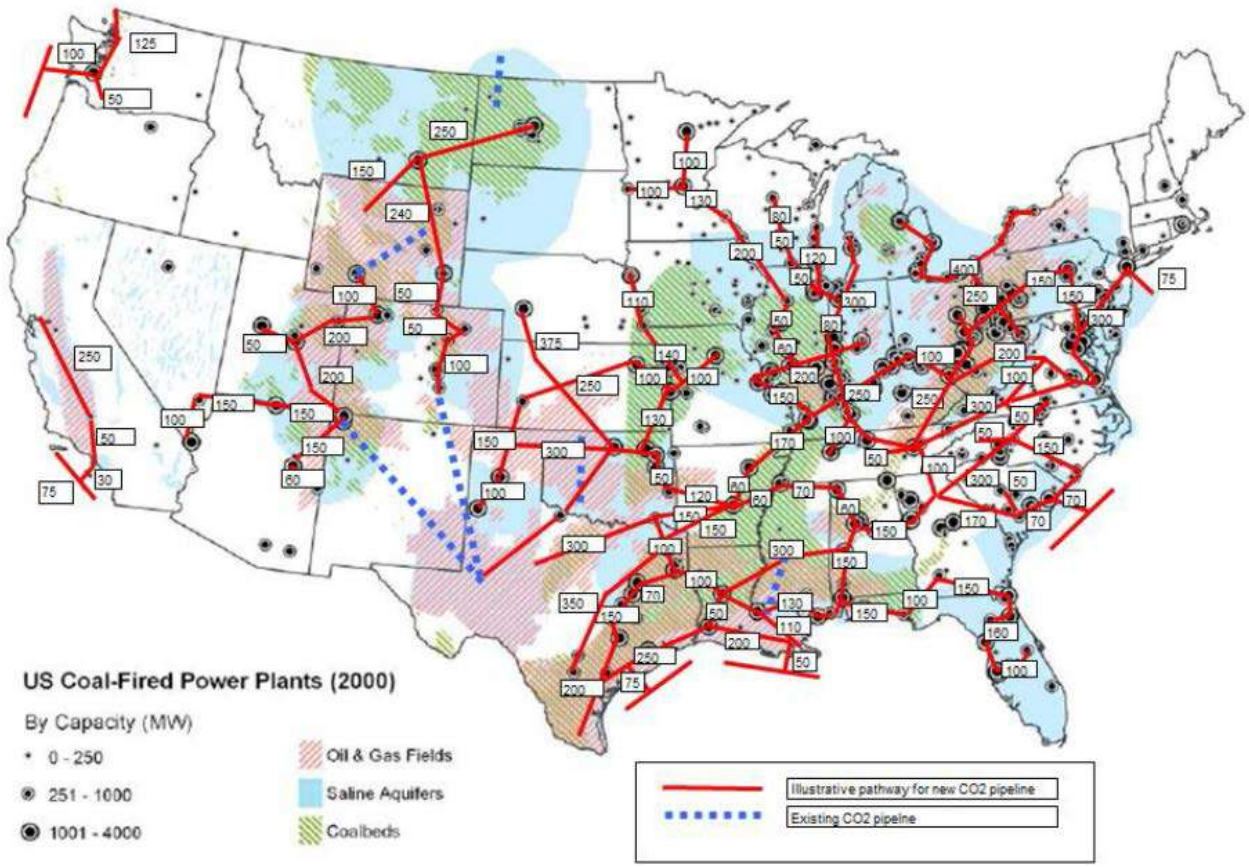
Deep Saline Aquifer Locations May Face Competing Storage Uses: CO_2 and Water

Map of US Coal Plants and Storage Sites



Source: Current State and Future Direction of Coal-Fired Power in the Eastern Interconnection, EISPC, June 2013
http://naruc.org/Grants/Documents/Final-ICF-Project-Report071213.pdf

Map of Possible CO_2 Pipeline Corridors for High CCS Case with Greater Use of EOR



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Source: Current State and Future Direction of Coal-Fired Power in the Eastern Interconnection, EISPC, June 2013
http://naruc.org/Grants/Documents/Final-ICF-Project-Report071213.pdf

North America CO_2 Geologic Potential by State

State or Area	ICF CO2 EOR Mid Volume Gtonne	ICF Depleted Oil Mid Volume Gtonne	ICF Coal Beds Mid Volume Gtonne	ICF Saline Mid Volume Gtonne	ICF Lower-48 Mid Volume Gtonne	Lower-48 Mid NATCARB Gtonne
ALABAMA	0.07	0.28	3.13	86.70	90.2	90.2
ARIZONA	0.00	0.01	0.00	0.85	0.9	0.9
ARKANSAS	0.08	0.18	2.58	31.87	34.7	34.7
ATLANTIC OFFSHORE	0.00	0.00	0.00	317.00	317.0	317.0
CA. ONSHORE	1.24	2.20	0.00	221.78	225.2	225.2
COLORADO	0.20	1.41	0.68	227.60	229.9	229.9
DELAWARE	0.00	0.00	0.00	0.05	0.1	0.1
FLORIDA	0.13	0.00	2.03	116.33	118.5	118.5
GEORGIA	0.00	0.00	0.05	11.85	11.9	11.9
IDAHO	0.00	0.00	0.00	0.39	0.4	0.4
ILLINOIS	0.10	0.00	2.16	61.91	64.2	64.2
INDIANA	0.02	0.00	0.14	49.91	50.1	50.1
IOWA	0.00	0.00	0.01	0.08	0.1	0.1
KANSAS	0.41	1.18	0.01	8.80	10.4	10.4
KENTUCKY	0.01	0.04	0.19	5.40	5.6	5.6
LA. OFFSHORE	1.46	9.61	0.00	2,133.07	2,144.1	2,144.1
LA ONSHORE	1.36	9.25	13.61	1,101.56	1,125.8	1,125.8
MARYLAND	0.00	0.00	0.00	2.96	3.0	3.0
MICHIGAN	0.08	0.69	0.00	36.56	37.3	37.3
MINNESOTA	0.00	0.00	0.00	0.00	0.0	0.0
MISSISSIPPI	0.13	0.43	8.96	335.20	344.7	344.7
MISSOURI	0.00	0.00	0.01	0.17	0.2	0.2
MONTANA	0.25	2.35	0.32	887.22	890.1	890.1
N. DAKOTA	0.32	4.09	0.60	111.65	116.7	116.7

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Source: Current State and Future Direction of Coal-Fired Power in the Eastern Interconnection, EISPC, June 2013 http://naruc.org/Grants/Documents/Final-ICF-Project-Report071213.pdf

North America CO_2 Geologic Potential by State (Continued)

State or Area	ICF CO2 EOR Mid Volume Gtonne	ICF Depleted Oil Mid Volume Gtonne	ICF Coal Beds Mid Volume Gtonne	ICF Saline Mid Volume Gtonne	ICF Lower-48 Mid Volume Gtonne	Lower-48 Mid NATCARB Gtonne
NEW MEXICO	0.90	6.45	0.19	236.89	244.4	244.4
NEBRASKA	0.02	0.01	0.00	49.85	49.9	49.9
NEVADA	0.00	0.00	0.00	0.00	0.0	0.0
NEW ENGLAND STS	0.00	0.00	0.00	0.00	0.0	0.0
NEW JERSEY	0.00	0.00	0.00	0.00	0.0	0.0
NEW YORK	0.00	0.92	0.00	4.26	5.2	5.2
N. CAROLINA	0.00	0.00	0.00	9.75	9.7	9.7
OHIO	0.00	10.06	0.13	9.94	20.1	20.1
OKLAHOMA	1.41	6.71	0.01	0.00	8.1	8.1
OREGON	0.00	0.00	0.00	52.24	52.2	52.2
PACIFIC OFFSHORE	0.00	0.20	2.30	108.00	110.5	110.5
PENNSYLVANIA	0.00	2.97	0.28	17.26	20.5	20.5
S. DAKOTA	0.00	0.19	0.00	86.69	86.9	86.9
S. CAROLINA	0.00	0.00	0.00	4.93	4.9	4.9
TENNESSEE	0.00	0.00	0.00	3.57	3.6	3.6
TEXAS ONSHORE	7.55	38.65	22.82	2,458.83	2,527.8	2,527.8
TX. OFFSHORE	0.00	5.53	0.00	1,064.93	1,070.5	1,070.5
UTAH	0.28	0.88	0.08	154.84	156.1	156.1
VIRGINIA	0.00	0.06	0.49	0.24	0.8	0.8
WASHINGTON	0.00	0.00	0.00	220.75	220.8	220.8
WEST VIRGINIA	0.00	1.83	0.41	11.21	13.4	13.4
WISCONSIN	0.00	0.00	0.00	0.00	0.0	0.0
WYOMING	0.42	1.88	12.00	644.82	659.1	659.1
Lower 48 Total	16.45	108.05	73.13	10,887.8	11,087.0	11,085.4
Offshore L-48	1.46	15.34	2.30	3,623.0	3,643.0	3,642.1

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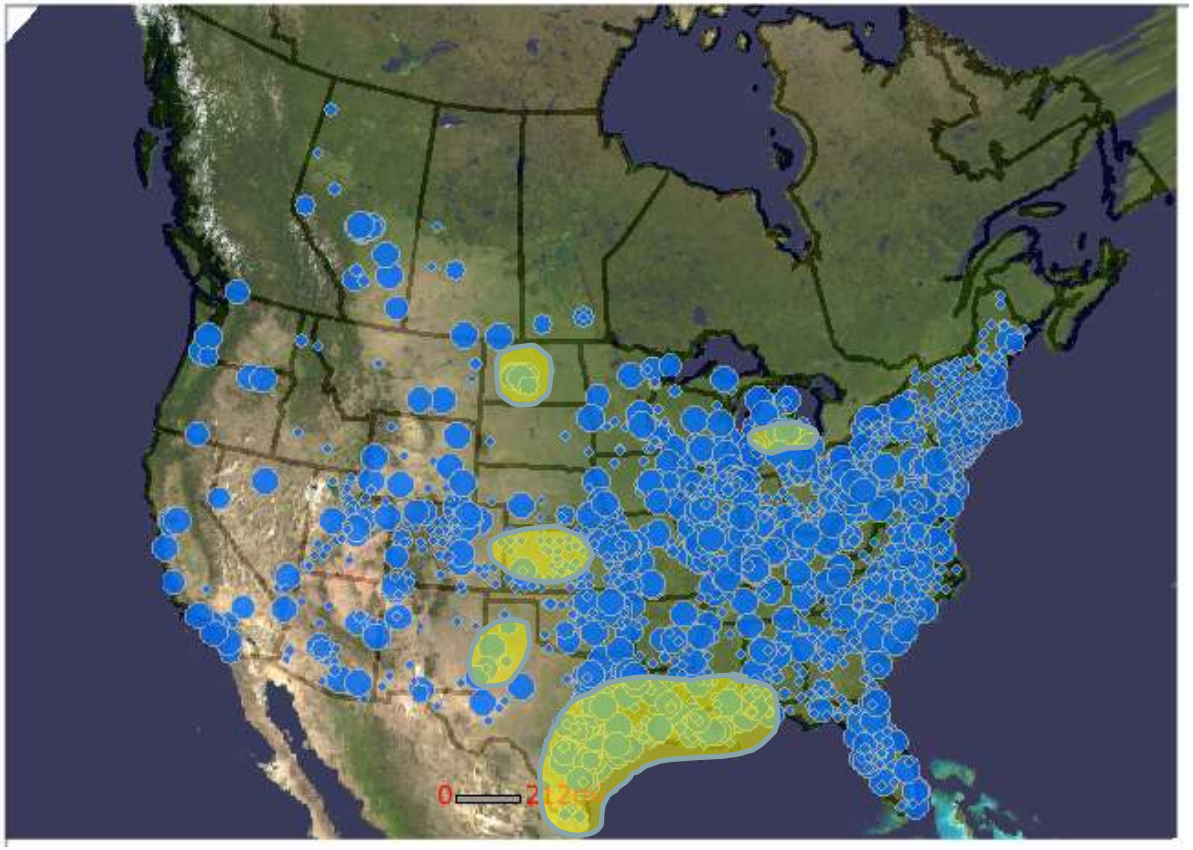
Source: Current State and Future Direction of Coal-Fired Power in the Eastern Interconnection, EISPC, June 2013 http://naruc.org/Grants/Documents/Final-ICF-Project-Report071213.pdf

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



Note: Optimal Locations are for new plants, not retrofit of existing power plants
Source of Map: NatCarb Atlas; Overlay: APPA Optimal Location Criteria Maps without CO_2 pipelines

Proposed Rule Should Address Legal & Commercial Obstacles to CO_2 injection

- Local laws banning or limiting fracking or similar drilling practices (Best Management Practices) for CO_2 injection
- Anti-fracking ordinances
- Safe Drinking Water Act and 22 state drinking water laws (*see Gablehouse paper)*
- Resources Conservation and Recovery Act (RCRA) "like kind waste" exemption for oil & gas does not apply to power sector for injecting acid gas
- Is CO_2 an acid gas subject to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) litigation?
- Who owns and pays for the CO_2 monitoring requirements 100 years after the power plant closes under Underground Injection Control (UIC) program?
- What is financial assurance or insurance posted under UIC program for CO_2 injected for 100 years after power plant closes? How does this affect bond ratings?

Proposed Rule Should Address Legal & Commercial Obstacles to CO_2 injection

- Not all states pool or unitize for oil/gas extraction or CO_2 injection
- Many states have no distinction between surface and subsurface space and surface owner decides
- What happens 10 years into CO_2 injection—can a new surface owner oppose and stop the project?
- Pore space may not be recognized in all states for CO_2 injection
- Not all state laws allow for the use of surface water for CO_2 injection/water lubrication (farmers/cattlemen)
- Not all banks/mortgage companies allow oil and gas leases beneath residential areas—why will CO_2 be more promising?

APPA CCS White Papers

- Retrofitting Carbon Capture Systems on Existing Coal-Fired Power Plants
- 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
- Carbon Capture and Storage From Coal-Based Power Plants
- Parasitic Power for Carbon Capture
- Geologic CO_2 Issue Spotting and Analysis
- Carbon Capture and Sequestration Legal and Environmental Challenges Ahead

Available online at: http://www.publicpower.org/files/HTM/ccs.html

Two Matters Must Be Resolved before Coal-Fired Plants with CCS Are Commercially Demonstrated or Finalized

1. Is CO_2 as an acid-gas a CERCLA (Superfund) pollutant?[1]
2. How long would monitoring be required after the power plant closes?

[1] EISPC Report, June 2013, Page 179

Contact Info

Theresa Pugh
Director of Environmental Services
tpugh@publicpower.org / 202-467/2943