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# CCS and the Many Challenges to Commercial Demonstration for Power Plants in Non-Oil/Gas Recovery Locations

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American Public Power Association

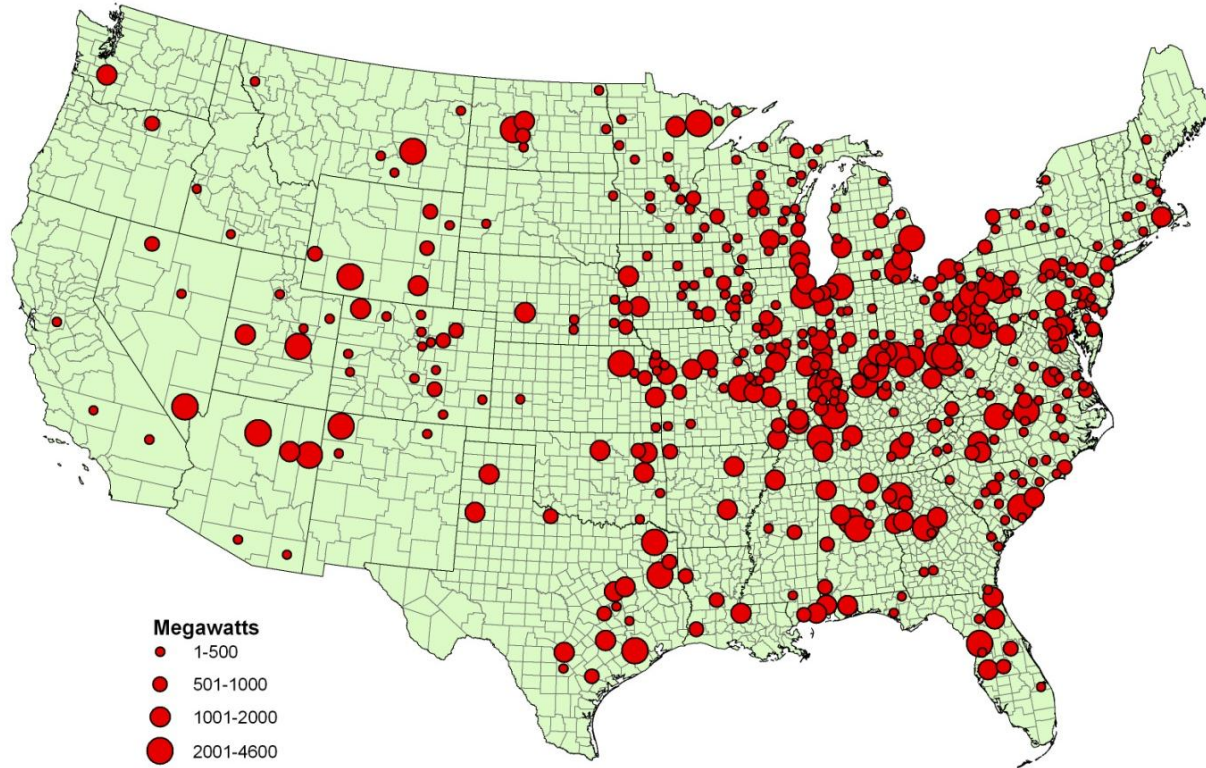
**August 29, 2013**

**APPA Academy**  
Where Power and Knowledge Meet

# Commercial Demonstrations of CCS Requires Massive Infrastructure



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# For Non-Oil & Gas this Leaves Deep Saline Aquifer Locations



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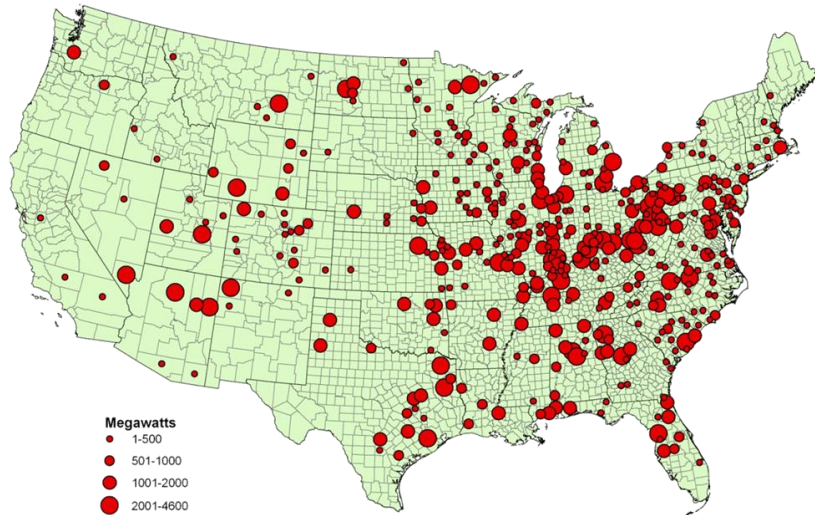


Source: NETL Sequestration Atlas of the U.S. and Canada

# Proximity of Fossil Plants to Deep Saline Aquifers Doesn't Always Match



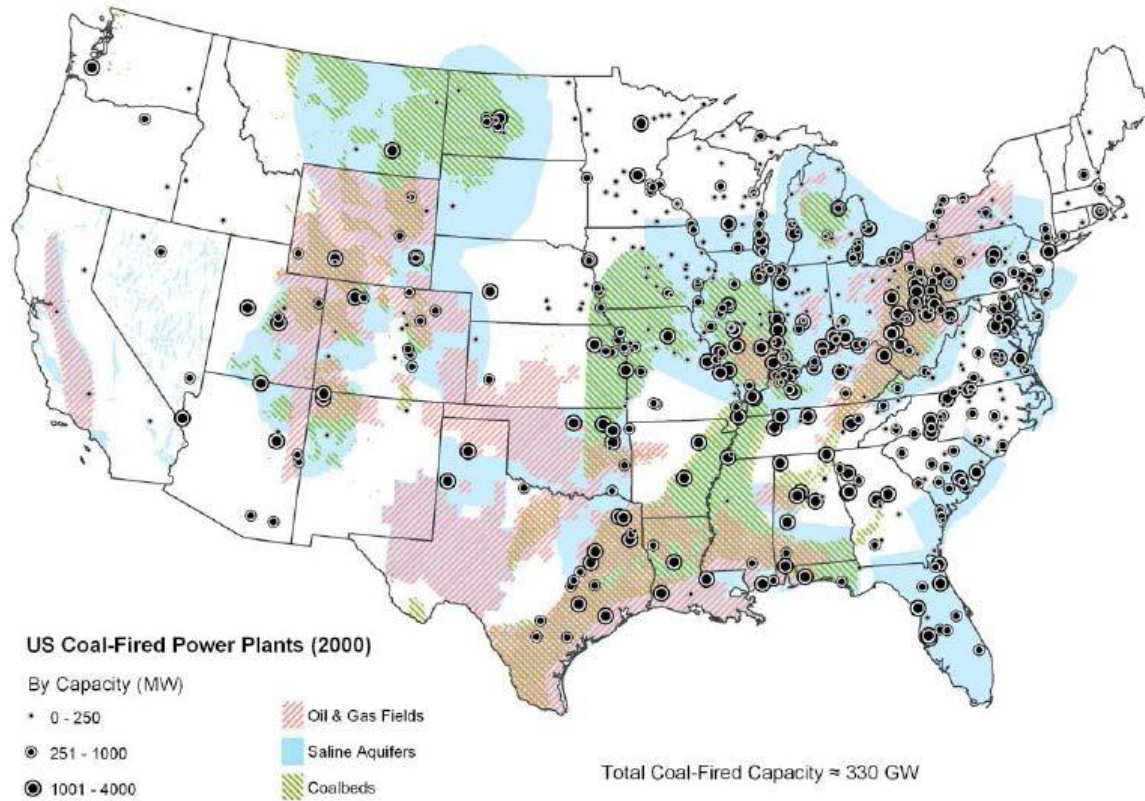
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# Newer Map of U.S. Coal Plants and Storage Sites



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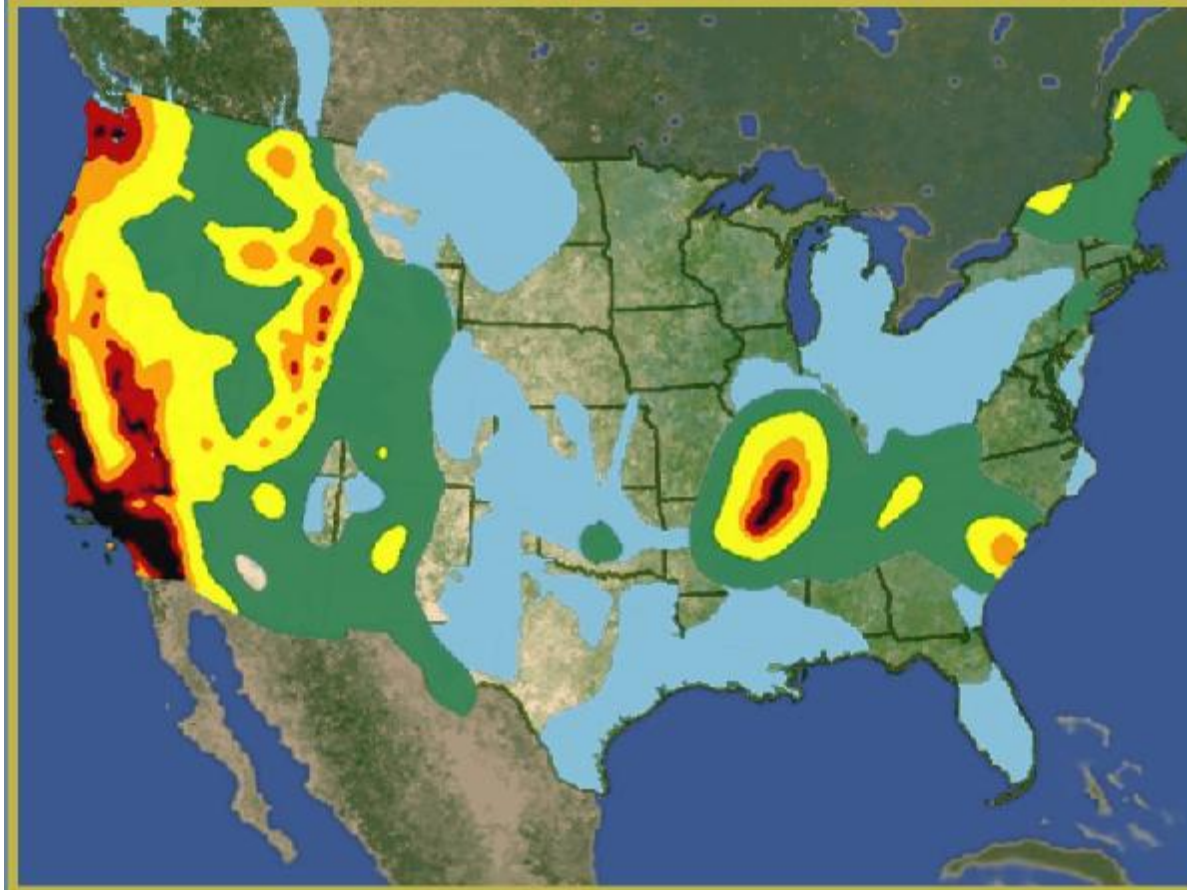
Source: Current State and Future Direction of Coal-Fired Power in the Eastern Interconnection, EISPC, June 2013

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

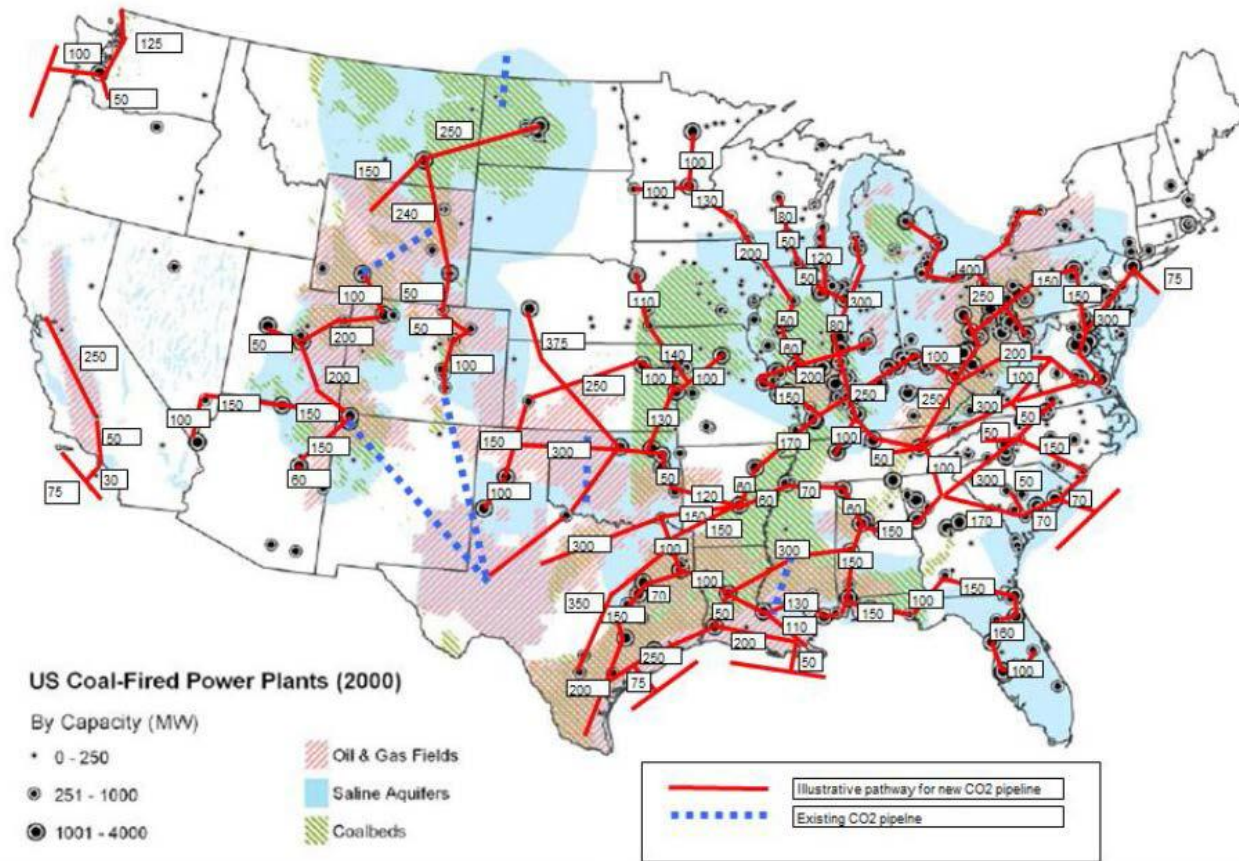
# Deep Saline Aquifer Locations and Lenient Seismic



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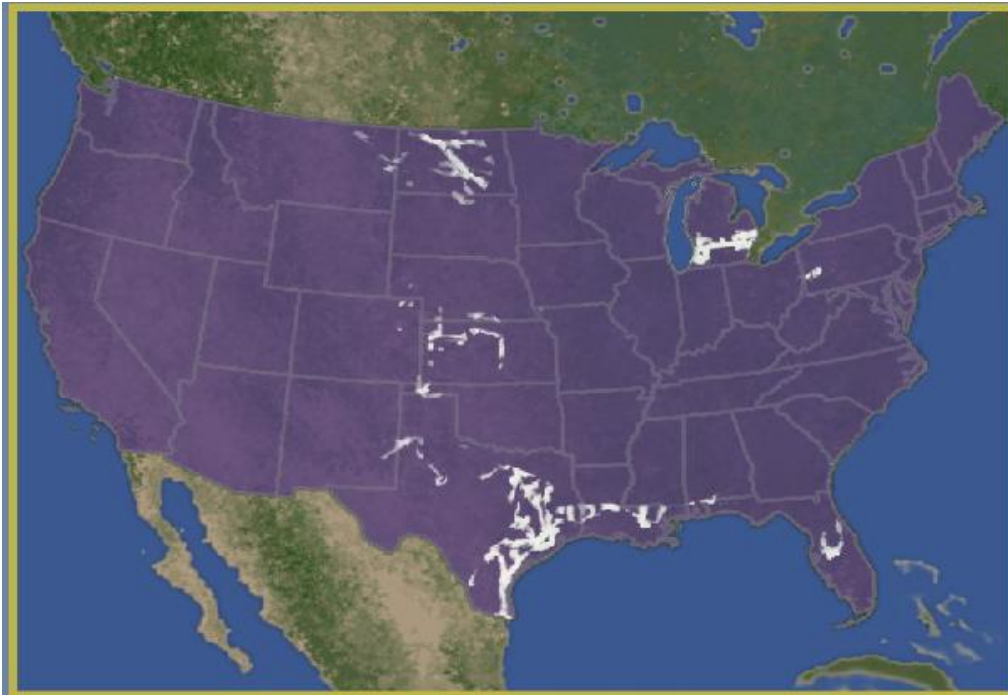
# Map of Possible CO<sub>2</sub> Pipeline Corridors for High CCS Case with Greater Use of EOR



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>

**It has taken us 6 years to increase CO<sub>2</sub> pipeline from 3,000 miles to 6,000 miles. How to get to 66,000 by 2030?**



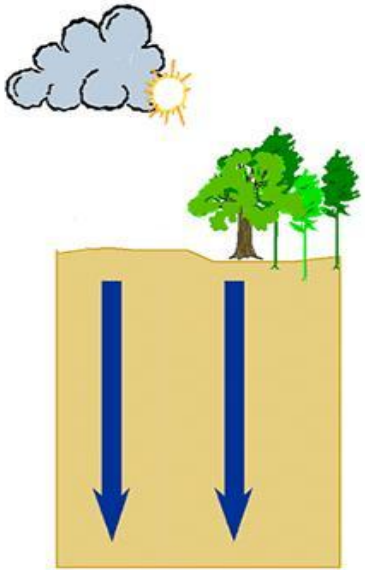


# Virtually no 3D Seismic Done in Non-Oil & Gas Locations for Volumetric Estimates Yet



Subsurface space required for only 40% of the Carbon Dioxide from a 300 MW power plant for one year:

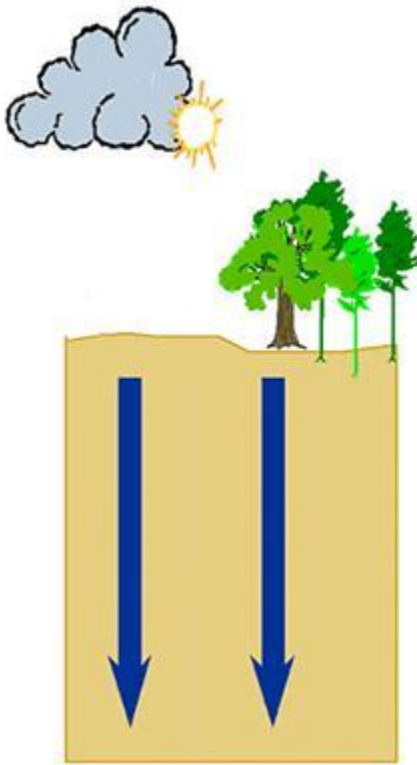
2,750 Acres



Source: J. Gledhill, Policy Navigation for APPA

# 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



Source: J. Gledhill, Policy Navigation for APPA

# North America CO<sub>2</sub> Geologic Potential by State



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	ICF CO <sub>2</sub> EOR	ICF Depleted Oil	ICF Coal Beds	ICF Saline	ICF Lower-48		Lower-48
	Mid	Mid	Mid	Mid	Mid		Mid
	Volume	Volume	Volume	Volume	Volume		NATCARB
State or Area	Gtonne	Gtonne	Gtonne	Gtonne	Gtonne		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



	ICF	ICF	ICF	ICF	ICF	
	CO2 EOR	Depleted Oil	Coal Beds	Saline	Lower-48	Lower-48
	Mid	Mid	Mid	Mid	Mid	Mid
	Volume	Volume	Volume	Volume	Volume	NATCARB
State or Area	Gtonne	Gtonne	Gtonne	Gtonne	Gtonne	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

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>

# CCS must work on Natural Gas Combined Cycle in Order to Be “Commercially Demonstrated”--Not Just for Coal Plants

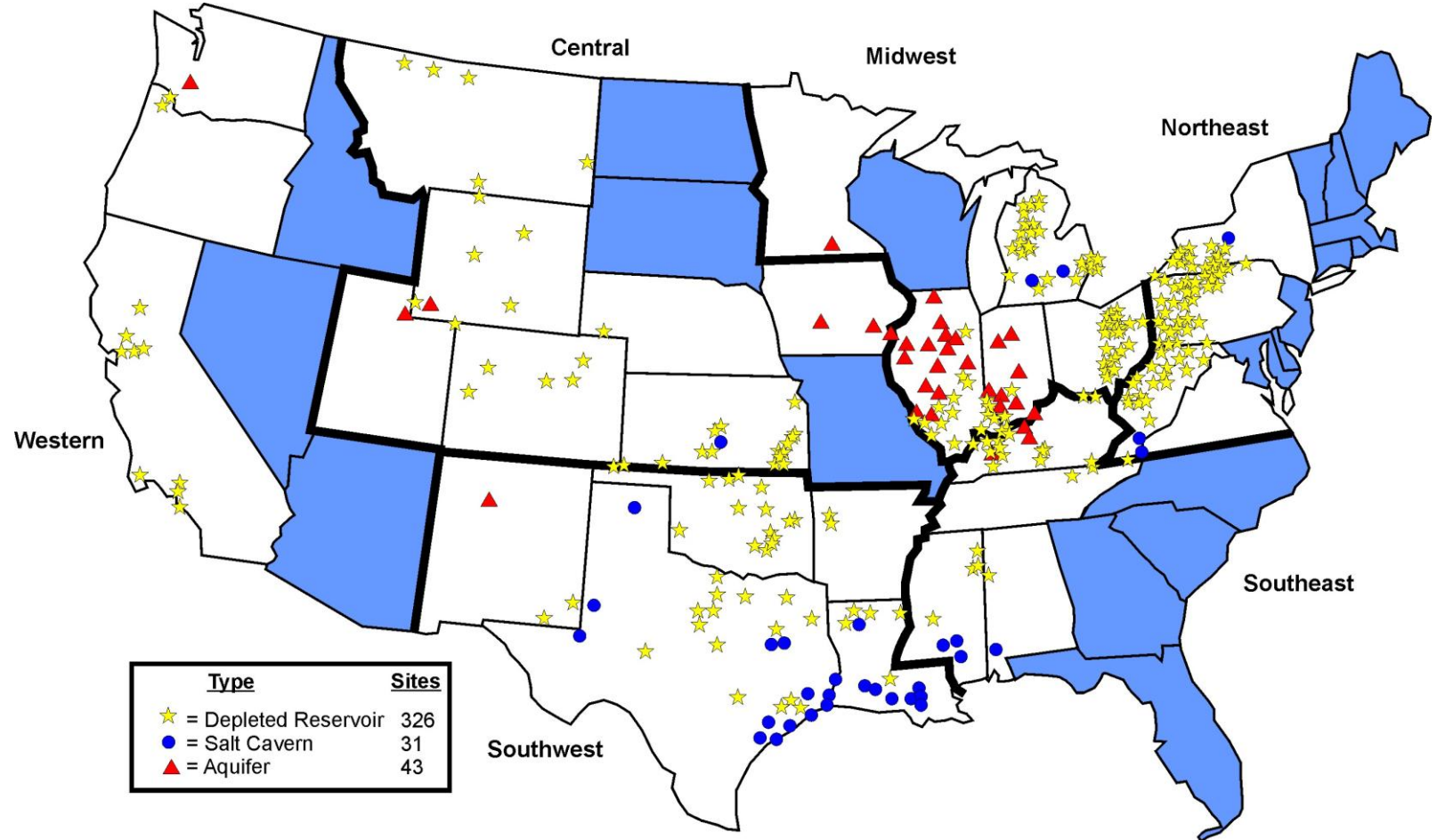
- CO<sub>2</sub> is all the more difficult to capture from NGCC plant than coal-fired power plant— so what is the Demonstrated Commercialization for NSPS for Natural Gas?



# Geographic Distribution of Underground Gas Storage Facilities



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Type	Sites
★ = Depleted Reservoir	326
● = Salt Cavern	31
▲ = Aquifer	43

# Other Legal & Commercial Obstacles to CCS



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- Local laws restricting fracking or similar injection practices.
- Is CO<sub>2</sub> a hazardous waste for non-oil & gas uses under CERCLA/Superfund?
- Who owns the liability if parties go bankrupt?
- Who posts financial assurance for 100 or 1000 years?
- Not all states pool, unitize for CO<sub>2</sub> injection like oil & gas states.
- Will all states change laws to separate subsurface from surface so surface owners won't quash sequestration--NIMBY?
- What will banks & mortgage companies say about CO<sub>2</sub> sequestration under residential areas
- "Pore" space is a new concept for some state commercial laws



# APPA CCS White Papers



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- 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<sub>2</sub> Issue Spotting and Analysis
- **Carbon Capture and Sequestration Legal and Environmental Challenges Ahead** (best paper for pragmatic issues)

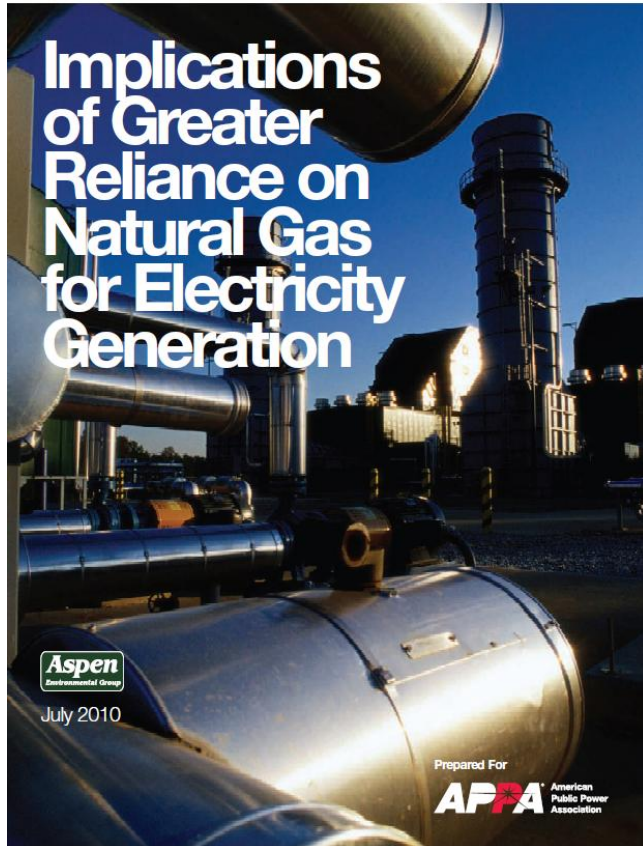
**Available online at:**

**<http://www.publicpower.org/files/HTM/ccs.html>**

# APPA Natural Gas Study (2010)



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

# Recommended Reading-hot off the press



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## Current State and Future Direction of Coal-fired Power in the Eastern Interconnection

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

Final Study Report  
June 2013

ICF Incorporated  
For EISPC and NARUC  
Funded by the U.S. Department of Energy



**APPA**Academy  
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# Questions?



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