

Water Vulnerabilities for Existing Coal-fired Power Plants

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Existing Plants Program



Presentation Outline

- Introduction
- Objective
- Approach
- Findings
- Recommendations

Introduction

- Increasing water consumption by power plants; decreasing freshwater supplies
- Coal-fired power plants will compete with other users for freshwater
- Plant-specific concerns vary with local water demand and supply conditions
- Understanding the characteristics of vulnerable plants can help focus R&D efforts



Water demand and supply concerns for existing coal-fired power plants are serious

- Projected increase in water consumption by 2030:
 - Total (all users): ~7%
 - Existing coal-fired power plants: ~ 20%; some regions 100% or more
- Freshwater supplies decreasing in many areas
- Demand/supply conflicts at certain power plants can:
 - Cause power disruptions
 - Increase costs to consumers

Research and development (R&D) can help reduce freshwater consumption

- Existing research areas:
 - Advanced cooling technologies
 - Water reuse and recovery
 - Nontraditional sources of water
- Complementary research areas:
 - Focused on needs of vulnerable plants
 - Plant-specific vulnerabilities (and needs) relate to
 - Local- and region-specific demand and supply characteristics
 - Plant-specific design and operational characteristics

Objective: To identify complementary R&D efforts by collecting and using information on specific plants

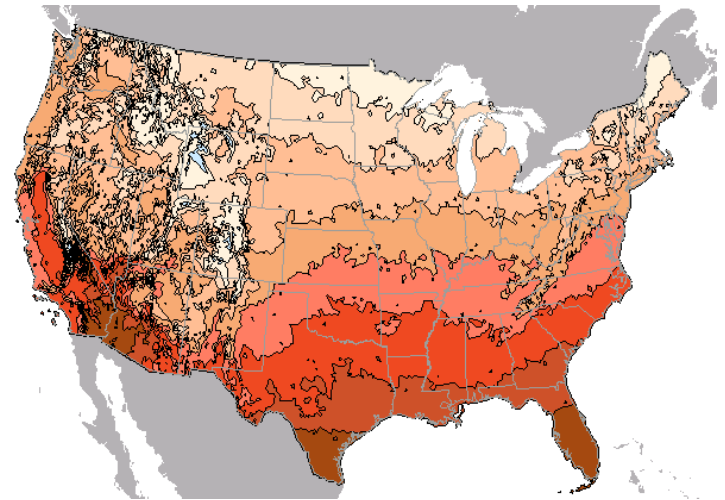
- Identify existing coal-fired plants that are most vulnerable to water demand and supply concerns
- Identify characteristics that are common to these plants
- Use this information to suggest R&D that will complement existing research to reduce freshwater consumption

Approach: Use a geographical information system (GIS) to analyze plant-specific data simultaneously with indicators of water demand and supply

1. Collect and review plant-specific data.
2. Develop indicators of water demand and supply.
3. Assess the vulnerability of each plant to each indicator.
4. Identify vulnerable plants.
5. Review characteristics of vulnerable plants to identify commonalities.
6. Assess proximity of vulnerable plants to nontraditional water sources.
7. Use results to suggest areas for R&D.

2. Develop indicators of water demand and supply

- Demand Indicators
 - Area demand indicators, e.g., areas with high
 - Water withdrawal rates
 - Projected population increases
 - Plant-specific demand indicators, e.g., high
 - Annual water consumption, withdrawal
- Supply indicators, e.g., areas with
 - Low precipitation
 - High temperatures
 - Increasing drought trends
- GIS format
 - Allow for visualization and analysis of any combination of plant and indicator data



Mean annual temperature
Source: USGS 2005

3. Assess vulnerability of each plant with respect to each demand and supply indicator

Selected Demand and Supply Indicator Criteria

Indicator	Measure	Criteria	
		Major	Moderate
Area Demand Indicators			
High withdrawals	State withdrawals (gal/mi ²)	>220,000	150,000–220,000
Population	Projected change/mi ² (2005–2030)	101–228	51–100
Potential conflicts	Potential crisis area by 2025	highly likely	substantial
Plant-Specific Demand Indicators			
Power generation	Net annual generation (MWh)	>10,000,000	5,000,000–10,000,000
Cooling water	Average annual consumption	>10 mgd	5–10 mgd
Supply Indicators			
Precipitation	Mean annual precipitation	<5 in	5–12 in
Temperature	Mean annual temperature	>70°F	65–70°F

4. Identify vulnerable plants

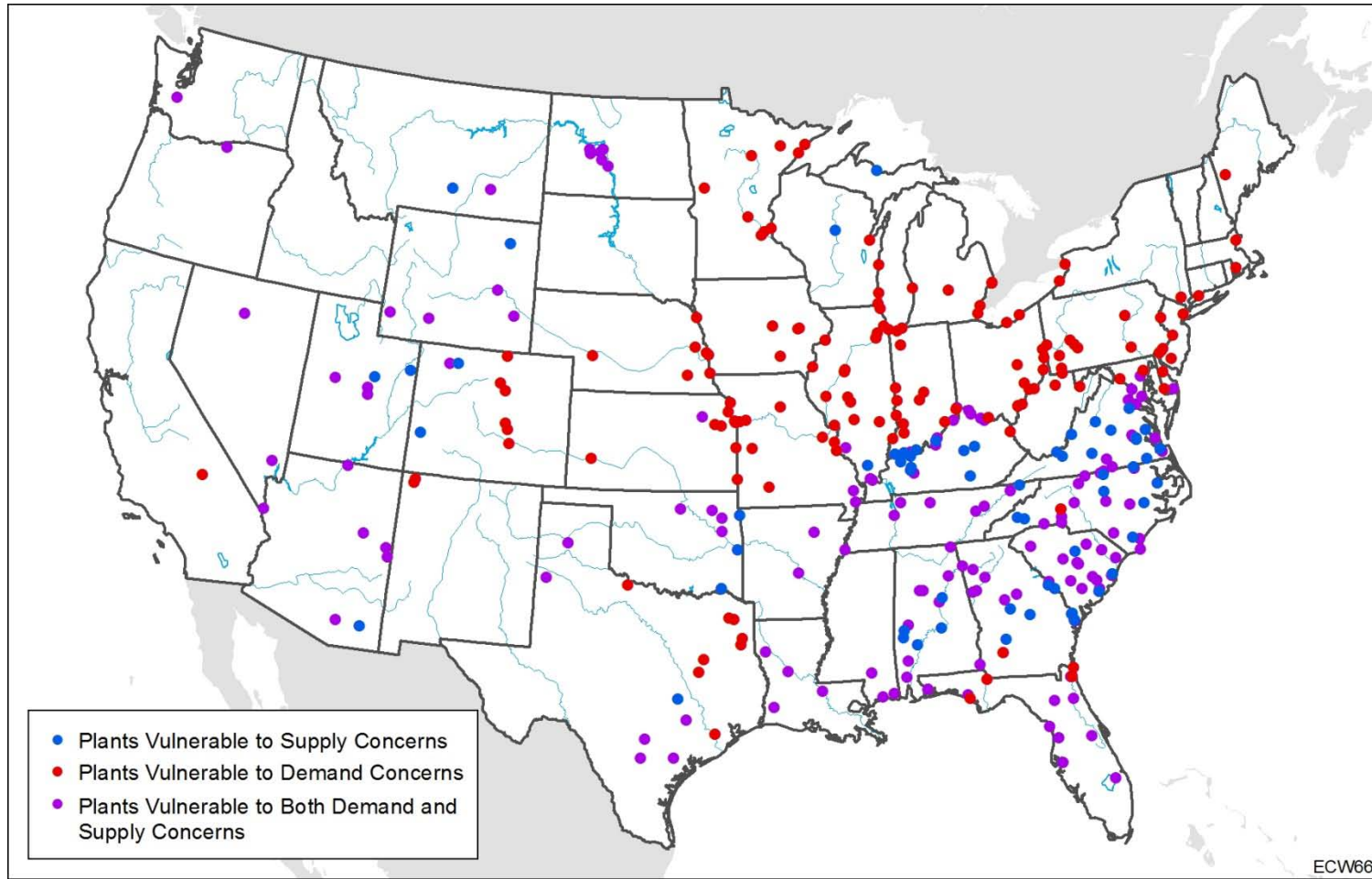
Summary Statistics for Vulnerable Plants

Vulnerability	Criteria (No. of vulnerabilities)		Number of Plants
	Major	Moderate	
Demand	≥ 2	≥ 4	144
Supply	≥ 1	≥ 2	64
Both supply & demand			139
Total			347

5. Review characteristics of the vulnerable plants to identify commonalities

- Location
- Type of cooling system
- Age of cooling system
- Source of cooling water
- Size of plant (capacity)

Forty-three states contain at least one vulnerable plant; about 1/3 are located in the southeast



Roughly half of the vulnerable plants use once-through and half use recirculating cooling systems

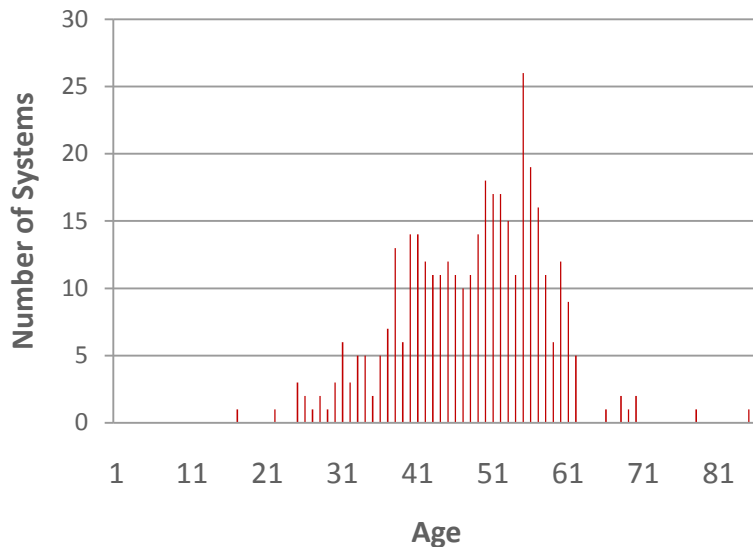
Primary Cooling System	Vulnerable Plants	
	Number	Percent
Once through		
Cooling ponds/canals	17	6
Freshwater	130	42
Saline water	17	6
Total once through	164	53
Recirculating		
Cooling pond/canals	25	8
Forced draft	49	16
Induced draft	45	15
Natural draft	24	8
Total recirculating	143	47
Plants providing water data*	307	100

*Plants with generating capacities <100 MW are not required to report water data

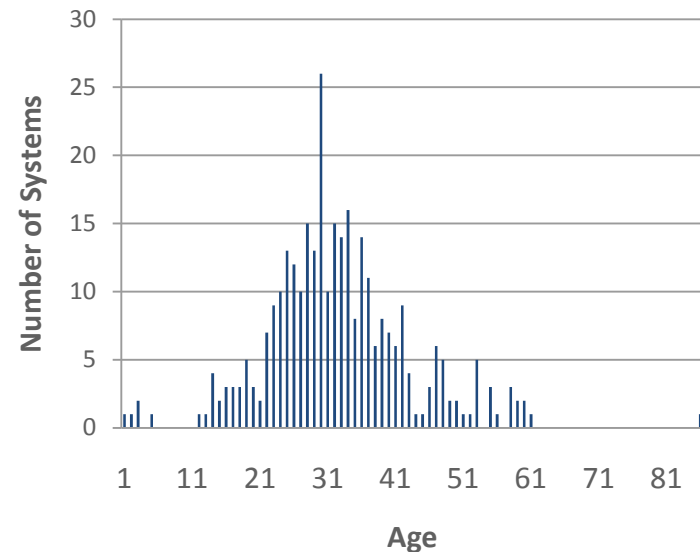


Most once-through systems are roughly 40-60 years old; most recirculating systems are roughly 20-40 years old

Once-through Cooling Systems

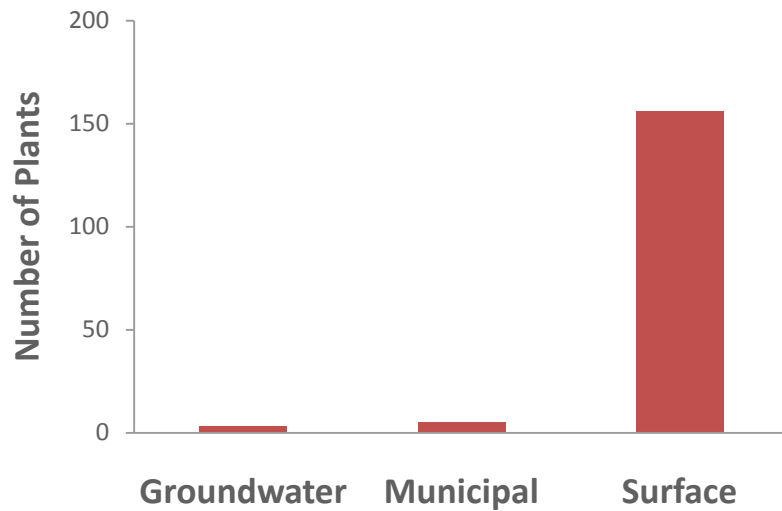


Recirculating Cooling Systems

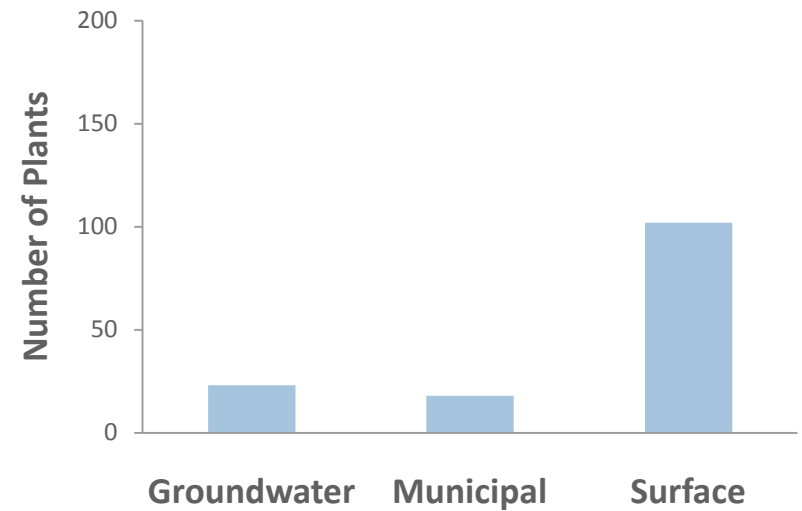


Almost one-fifth of the plants with recirculating systems use groundwater

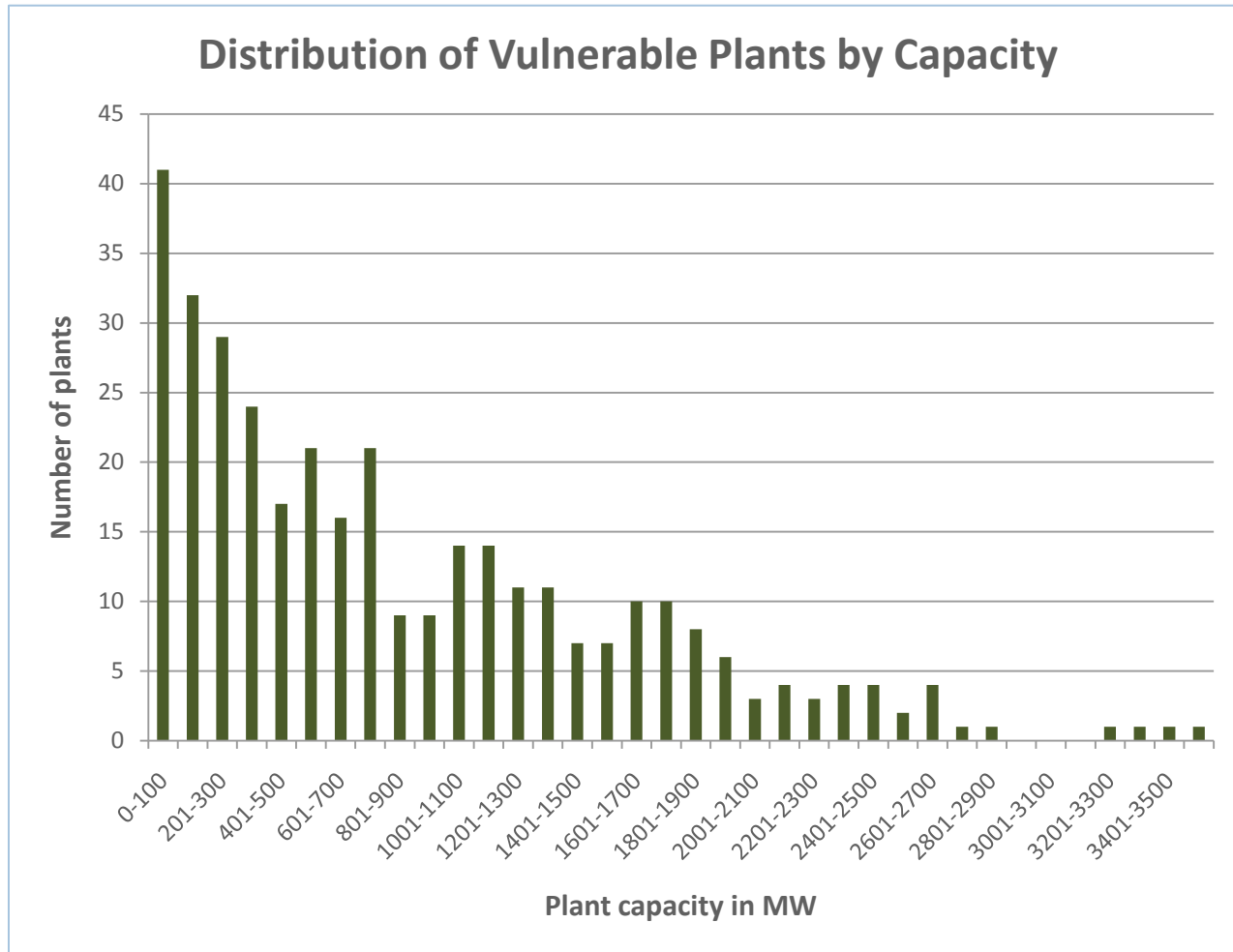
Once-through Cooling Systems



Recirculating Cooling Systems



The median capacity of the vulnerable plants is about 650 MW

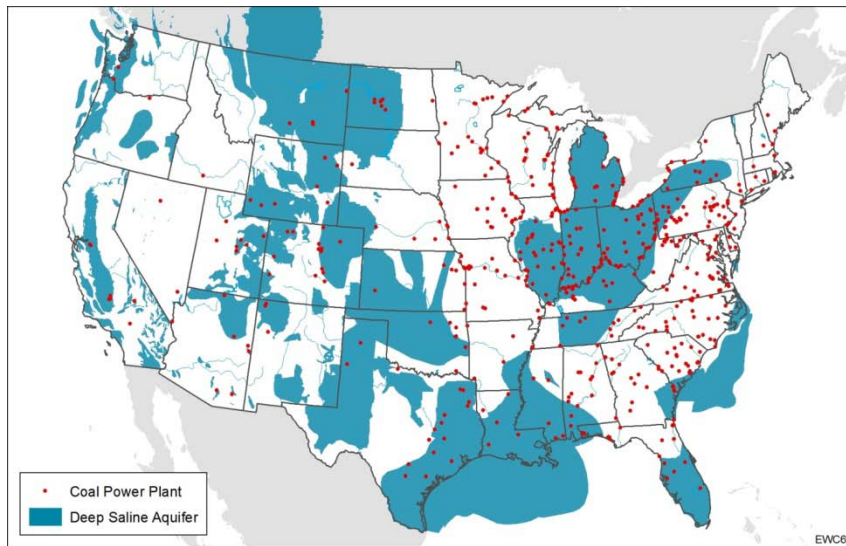


6. Assess proximity of vulnerable plants to nontraditional water sources

Nontraditional Source	Area Mapped
Waters from saline formations associated with CO ₂ storage	Deep saline aquifers
Mine pool waters	Coal mine locations, several eastern states
Produced water from enhanced coalbed methane	Coalbed methane fields
Produced water from oil and gas wells	100 top oil and gas fields

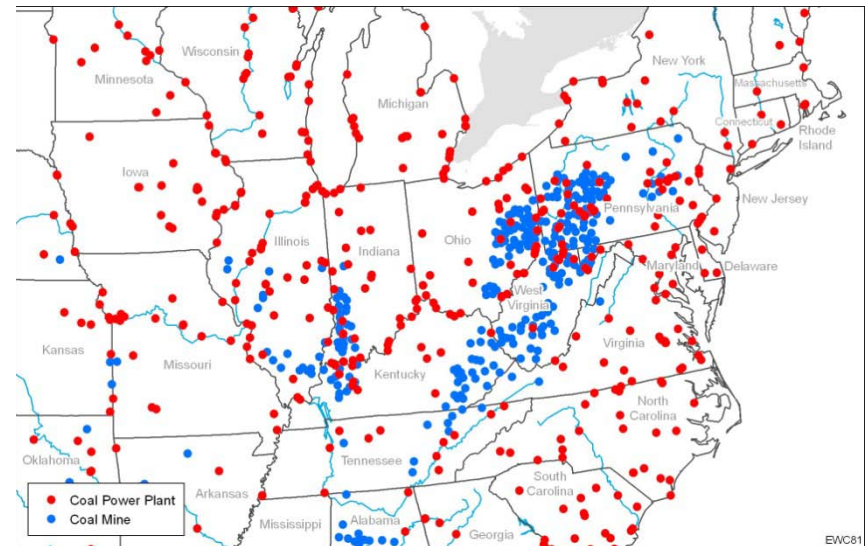
About 120 vulnerable plants are located over deep saline aquifers; about 50 are near coal mines

Deep Saline Aquifers



Sources: NATCARB 2008 and NETL CPPDB 2007

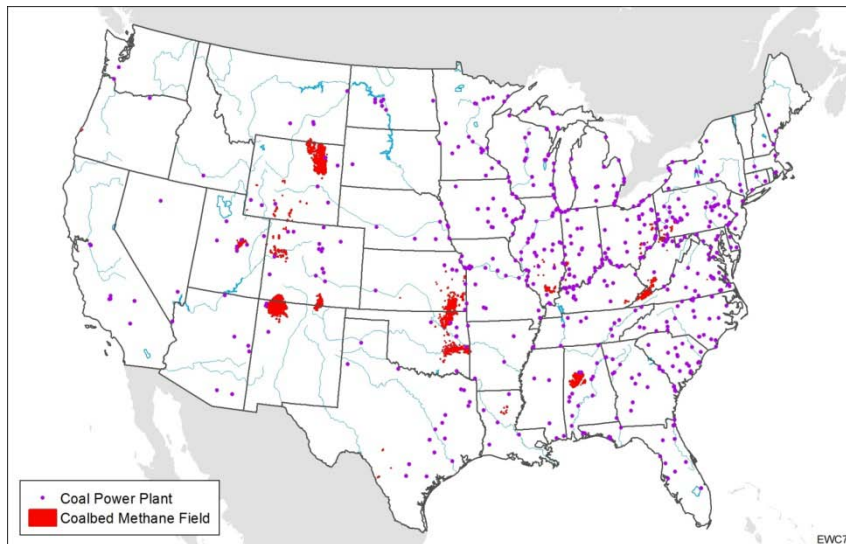
Coal Mine Locations, Eastern States



Sources: USGS 2010 and NETL CPPDB 2007

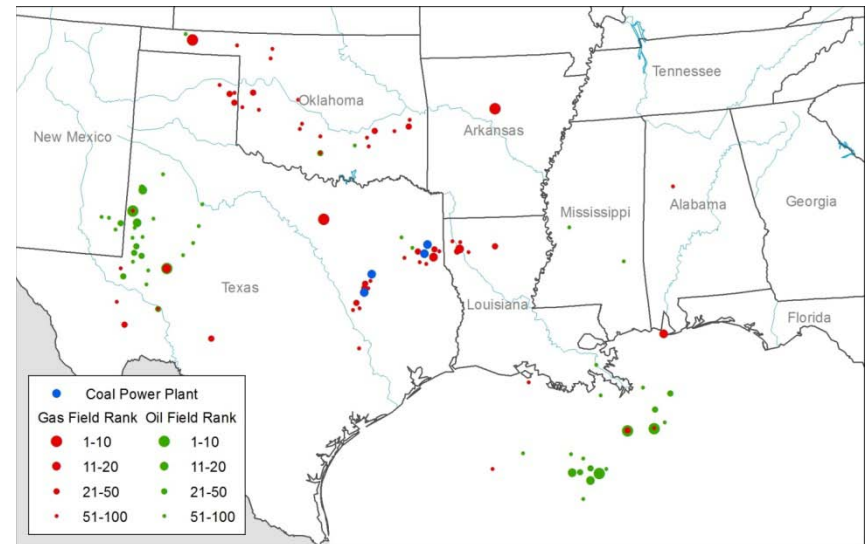
Thirteen vulnerable plants located near coalbed methane fields; 5 near major oil and gas fields

Coalbed Methane Fields



Sources: EIA 2009 and NETL CPPDB 2007

Top Oil and Gas Fields



Sources: EIA 2008 and NETL CPPDB 2007

7. Suggest complementary R&D directions

- Pursue R&D for both once-through and recirculating systems.
- Investigate the characteristics of once-through systems installed between 1952 and 1971 and recirculating systems installed between 1967 and 1988 that could affect water use.
- Consider conservation efforts for power plants that use groundwater.
- Target R&D efforts toward plants with capacities of 650 MW or less.
- When directing additional R&D toward nontraditional sources, consider using criteria that include proximity to power plants.
- Identify other impacts that could result from deploying successful R&D efforts to limit negative or unintended consequences.

Summary

- Used GIS to identify 347 coal-fired power plants in 43 states that are vulnerable to water demand concerns, water supply concerns, or both
- Reviewed:
 - Common characteristics of these plants
 - Locations relative to nontraditional water sources
- Developed complementary R&D recommendations to help ensure that coal-fired generation demands are met in a manner that supports sustainable water use.

Thank you for your attention

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Report is available at:

<http://www.evs.anl.gov/pub/doc/DOENETL-2010-1429%20WaterVulnerabilities.pdf>

