

# Implications of the Toxic Releases Inventory for Electric Utilities

**Edward S. Rubin**

**Michael B. Berkenpas**

Carnegie Mellon University

Pittsburgh, PA 15213

# The Toxics Release Inventory

- Public database for community access to toxic release information
- Established by the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986
- Strengthened by Pollution Prevention Act of 1990
- Lists approximately 650 chemicals and chemical categories
- No explicit consideration of risks or effects

# Application to Power Plants

---

- Electric utilities added to TRI as of 1998 (along with six other industry groups)
- Includes all coal-fired and oil-fired plants with more than ten employees (approximately 1000 facilities)
- First reports were due by July 1, 1999 for releases in calendar year 1998

# What Gets Reported?

- “Coincidentally manufactured” chemicals, if more than 25,000 lbs/yr
- “Processed” chemicals, if more than 25,000 lbs/yr
- “Otherwise used” chemicals, if more than 10,000 lbs/yr
- *De minimus* exemption for byproducts distributed in commerce

# TRI Chemicals Potentially Relevant to the Electric Utility Industry

## Metals

Antimony  
Arsenic  
Barium  
Beryllium  
Cadmium  
Chromium  
Cobalt  
Copper  
Lead  
Manganese  
Mercury  
Molybdenum  
Nickel  
Selenium  
Silver  
Thallium  
Zinc

## Organics

Benzene  
Dichloromethane  
Ethylbenzene  
Ethylene Glycol  
Formaldehyde  
Formic Acid  
Methanol  
Naphthalene  
PCBs  
Polycyclic aromatics  
Propylene  
Toluene  
Xylene

## Other

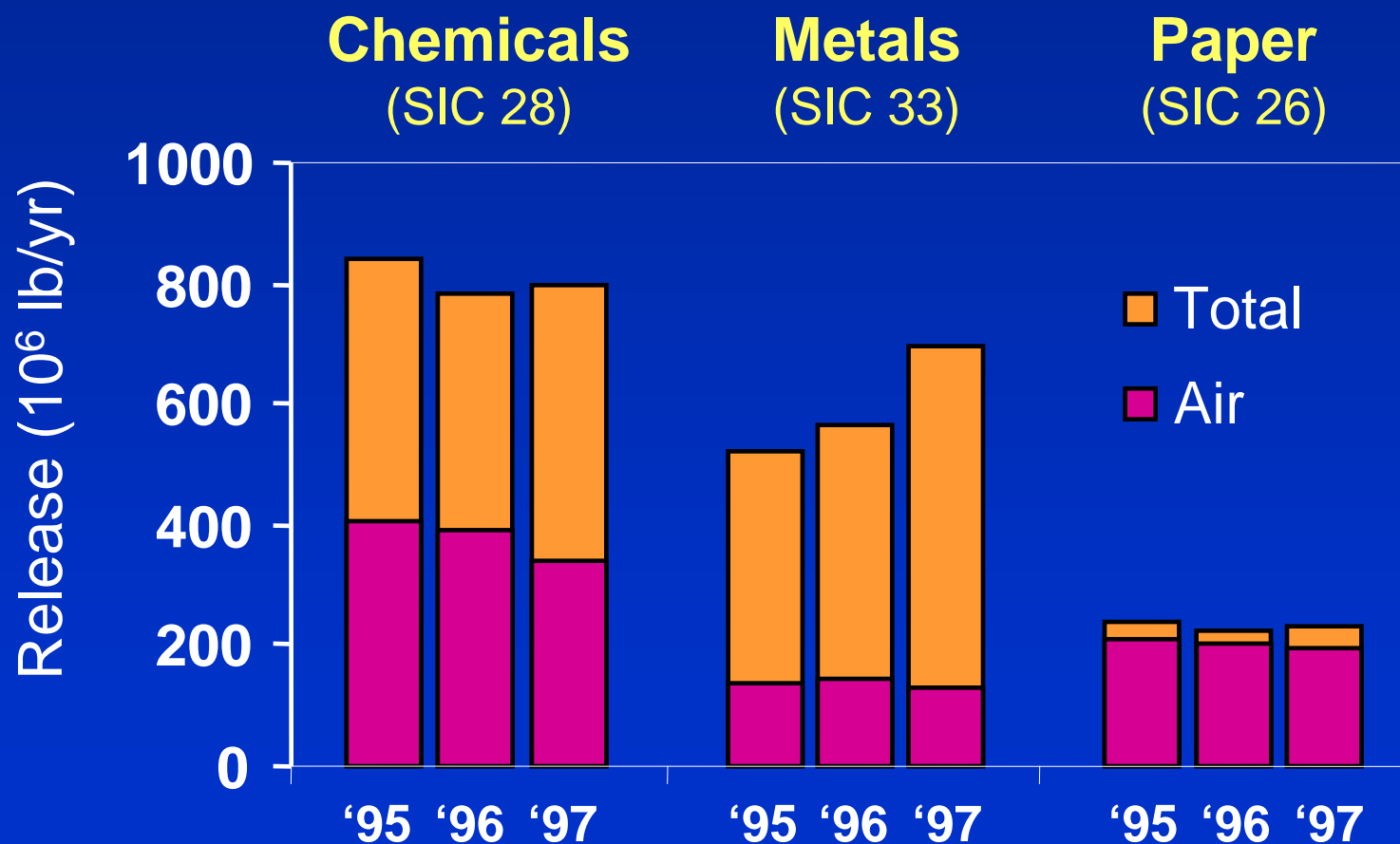
Ammonia  
Asbestos (friable)  
Bromine  
Chlorine  
Chlorine Dioxide  
Hydrazine  
Hydrogen Fluoride  
Hydrochloric Acid  
Nitric Acid  
Ozone  
Sulfuric Acid  
Thiourea

# Objectives of this Study

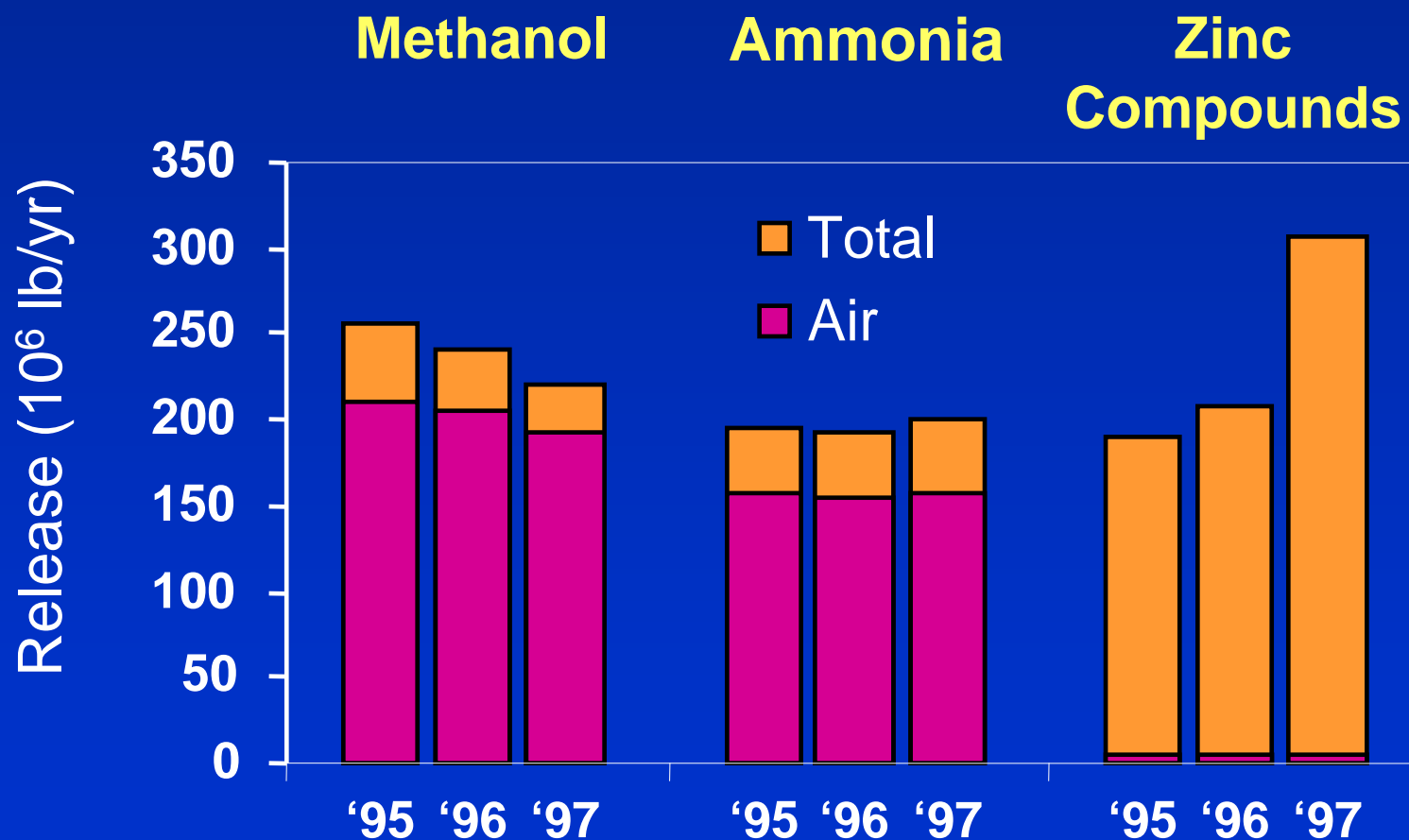
---

- How do electric utility releases compare to other industries now reporting to the TRI?
- What are the implications for electric utility companies?
- How can releases be reduced?

# Largest Total Releases by Industry



# Largest Total Releases by Chemical





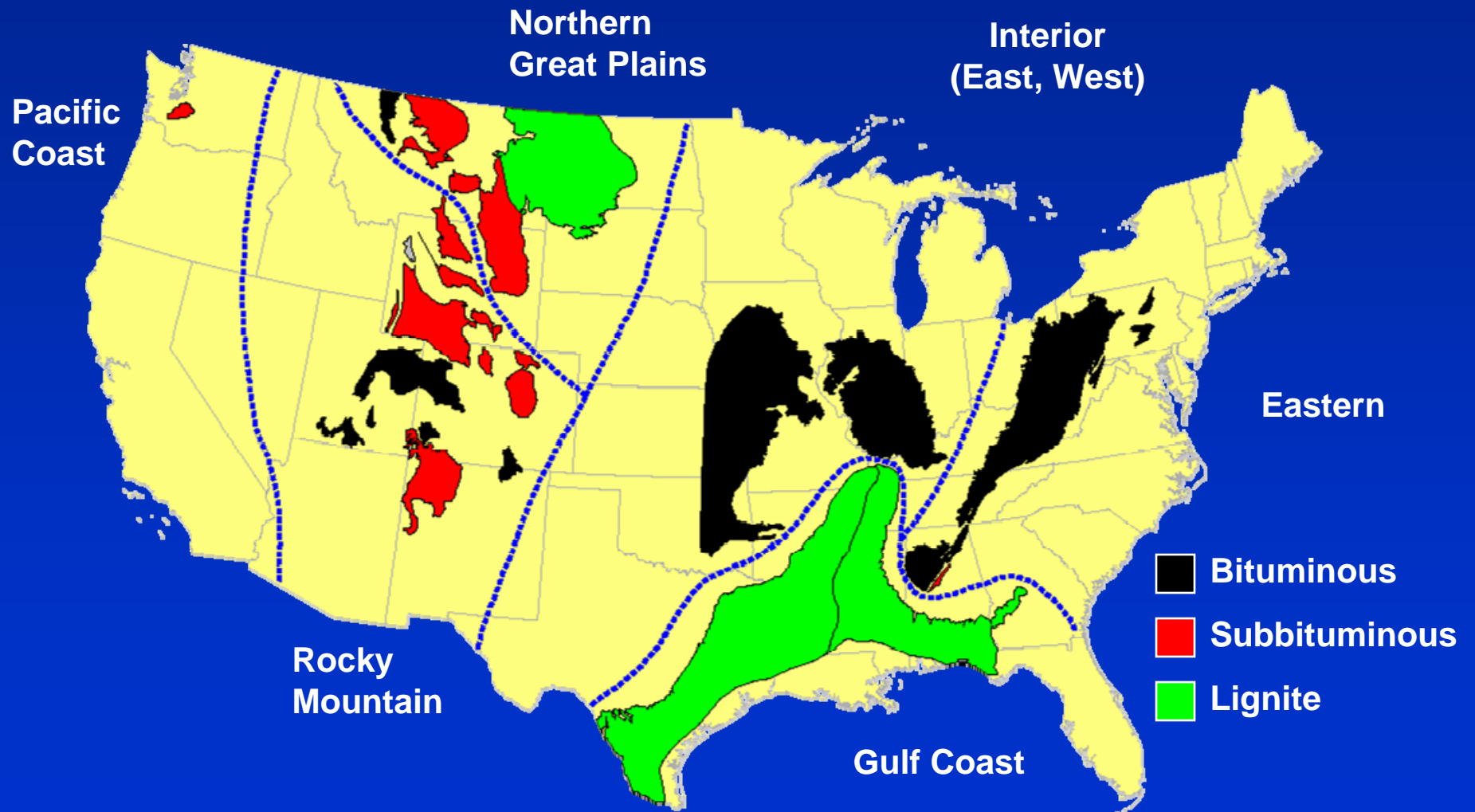
# Study Approach

- Use FERC Form 423 data to quantify annual coal consumption at each U.S. power plant
- Use PISCES Model to estimate trace element composition by region, and air/land partitioning by plant type
- Apply TRI thresholds and byproduct exemptions to calculate reportable releases

# Summary of Power Plant Coal Consumption (million tons/yr)

<u>FERC 423 Database</u>		<u>DOE/EIA Utility Data</u>			
<b>Coal Rank</b>	<b>1995 Totals</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>
Bituminous	419				
Subbituminous	330				
Lignite	75				
<b>Total Coal</b>	<b>823</b>	<b>829</b>	<b>875</b>	<b>899</b>	<b>911</b>
Power Gen (BkWh)		1653	1738	1789	1807

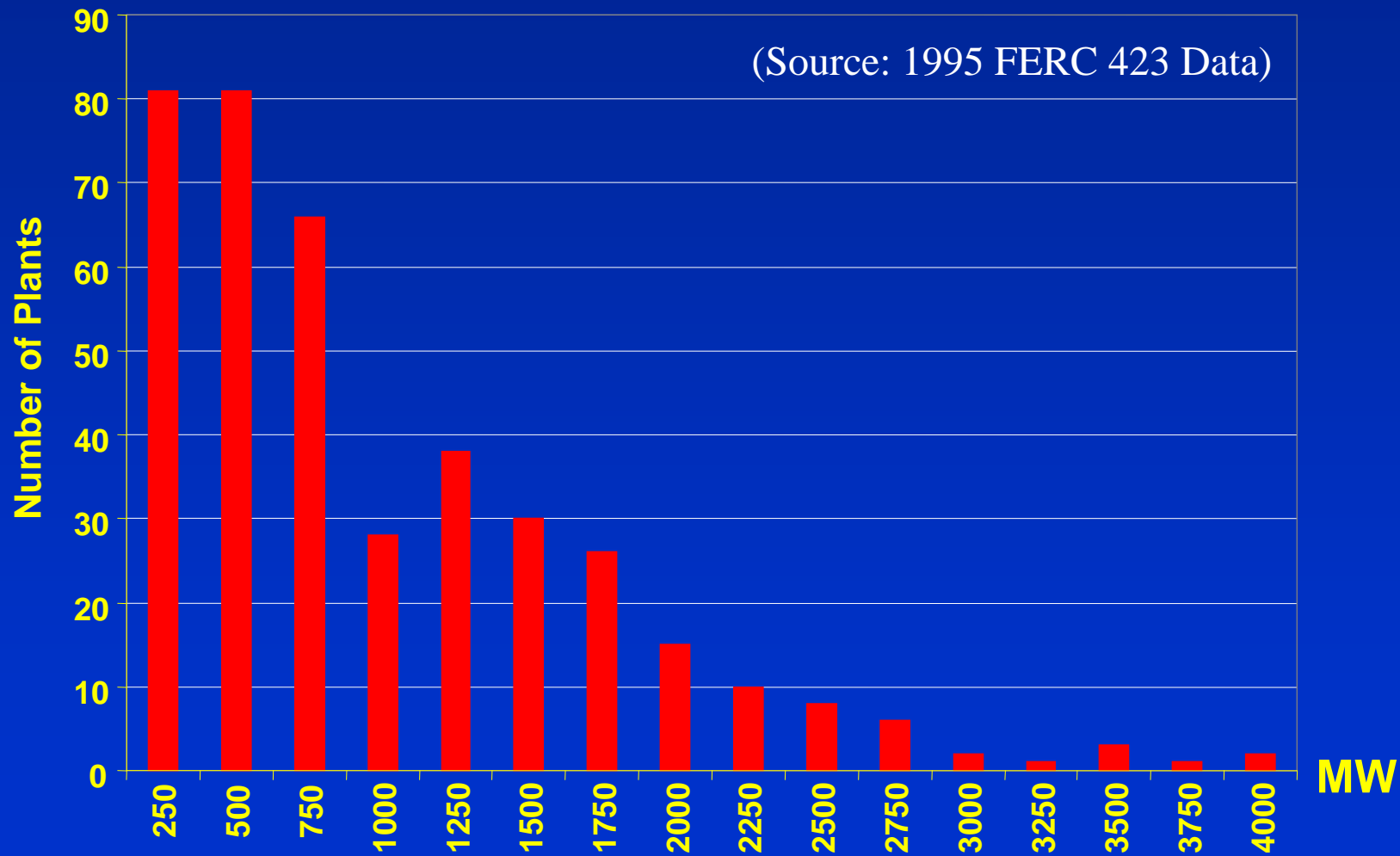
# Coal Supply Regions for PISCES Model and Database



# Mass Concentration of Trace Chemicals in Coal (ppmw, dry basis)

Chemical	Bit	Sub	Lig
Antimony	1.0	0.57	0.74
Arsenic	10.0	5.9	8.5
Barium	94.5	196.	220.
Beryllium	1.3	0.5	1.9
Cadmium	0.53	0.83	0.1
Chloride	750.	195.	140.
Chromium	18.6	5.0	9.3
Cobalt	6.4	2.0	3.7
Copper	21.	9.3	10.5
Fluoride	69.	44.	79.
Lead	8.1	7.8	6.2
Manganese	22.4	35.5	74.
Mercury	0.12	0.10	0.22
Molybdenum	2.1	1.7	3.0
Nickel	16.1	9.5	5.9
Selenium	3.2	0.9	1.3
Silver	0.2	0.16	0.1
Thallium	1.6	2.0	0.5
Zinc	22.0	8.7	7.8

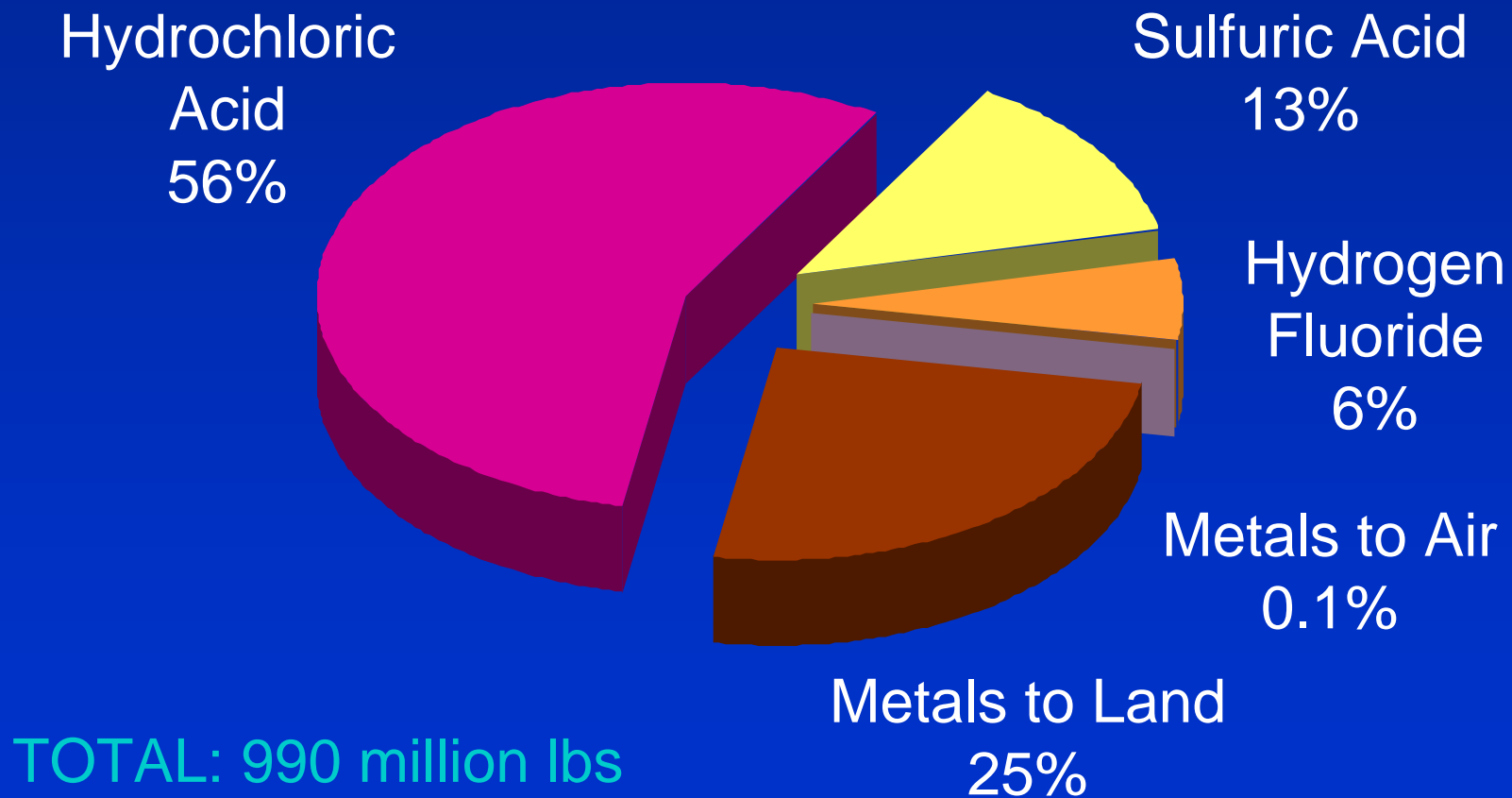
# Size Distribution of Coal-Fired Power Plants Modeled in this Study



# Base Case Estimates of Total Power Plant Releases for 1995 (millions of pounds)

<b>TRI Chemical</b>	<b>Air</b>	<b>Total</b>
Hydrochloric acid aerosol	553.5	553.5
Barium compounds	< 0.4	142.3
Sulfuric acid aerosol	129.6	129.6
Hydrogen fluoride	55.4	55.4
Manganese compounds	0.2	29.3
Zinc compounds	0.2	19.2
Copper compounds	0.1	12.2
Nickel compounds	0.1	11.7
Chromium compounds	< 0.1	9.9
Lead compounds	< 0.1	6.8
Arsenic compounds	< 0.2	6.0
Molybdenum trioxide	< 0.1	4.7
Cobalt compounds	< 0.1	3.6
Antimony compounds	< 0.1	1.5
Selenium compounds	0.3	0.7
Thallium compounds	< 0.1	0.4
Beryllium compounds	< 0.1	0.3
<b>Total</b>	<b>740.</b>	<b>987.</b>

# Estimated 1995 Toxic Releases from Electric Power Plants (Base Case)

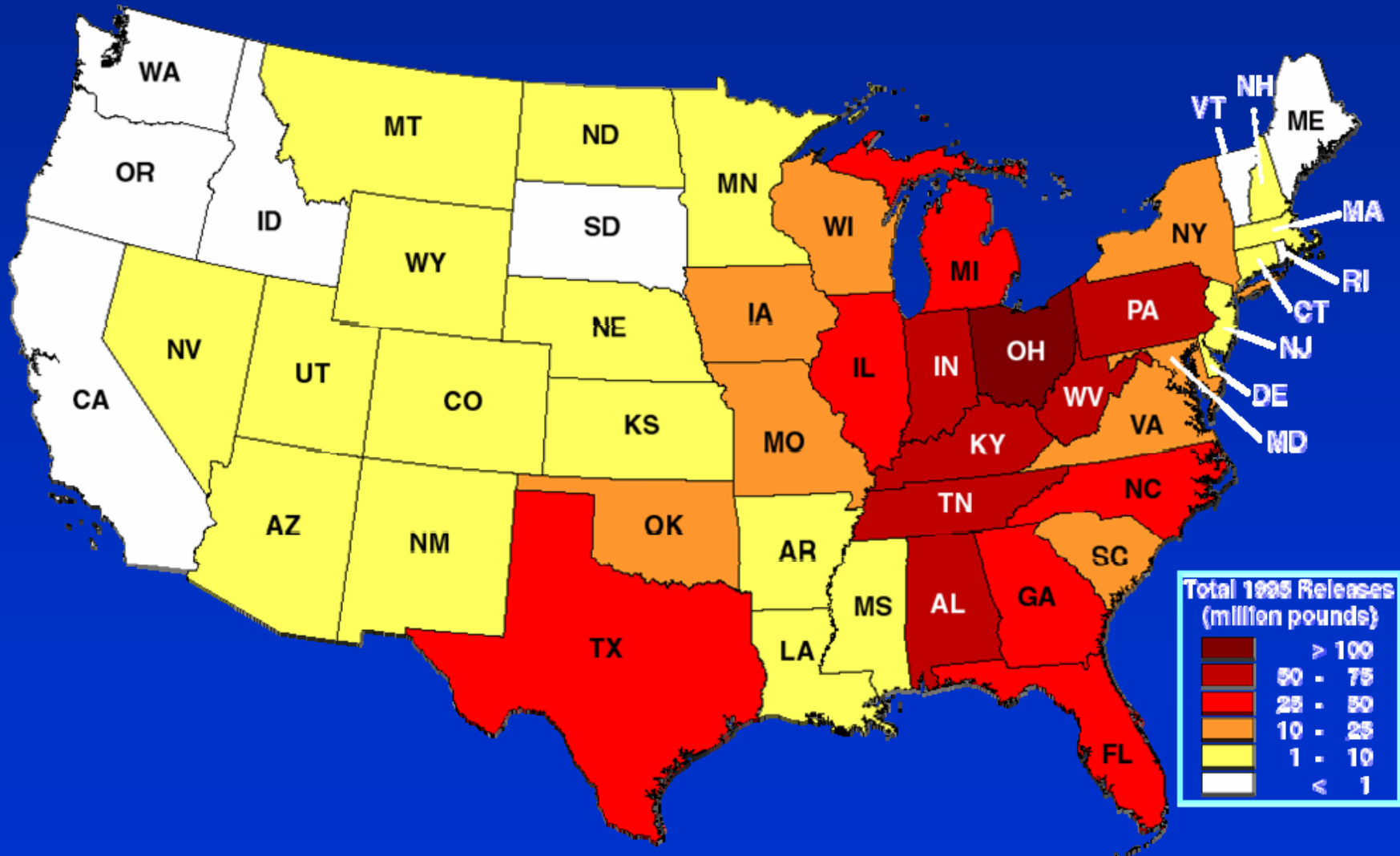


# Uncertainty Estimates for 1995 Releases from Coal-Fired Power Plants (millions of pounds)

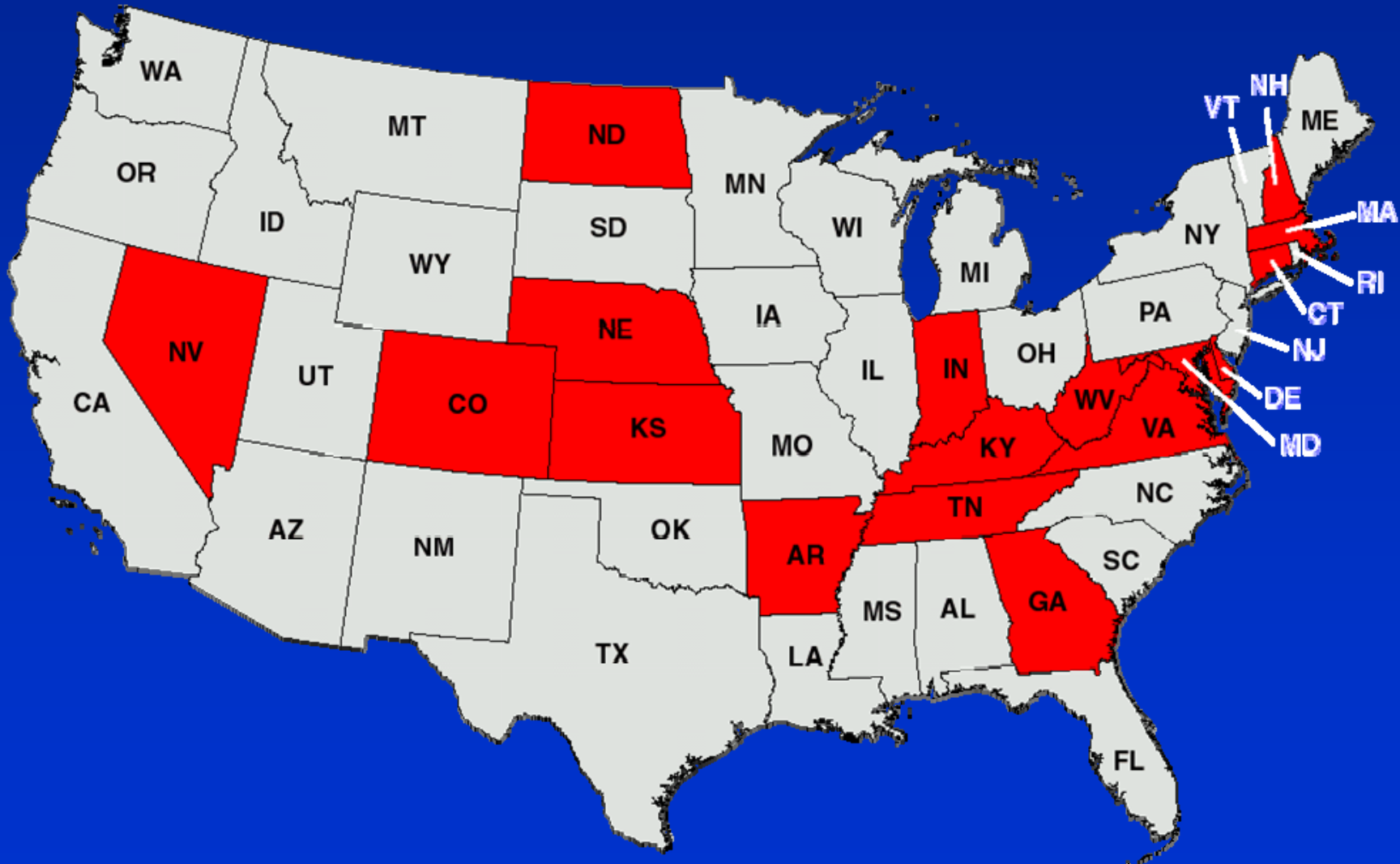
<b>Substance</b>	<b>Air Releases</b>		<b>Total Releases</b>	
	<b>Base</b>	<b>Bound</b>	<b>Base</b>	<b>Bound</b>
HCl aerosol	553	1,147	553	1,147
H <sub>2</sub> SO <sub>4</sub> aerosol	130	287	130	287
Hydrogen fluoride	55	135	55	135
Metal compounds	< 2	2	249	311
<b>Total</b>	<b>740</b>	<b>1,541</b>	<b>987</b>	<b>1,880</b>



# Base Case Estimates of TRI Releases from Coal-Fired Power Plants for 1995



# States Where a Power Plant is the Largest TRI Source (1995)



# Projections for 1998

## Electric Utility Releases

Source	Million pounds	
	Coal	Oil
Carnegie Mellon (This study + 10% above 1995)	> 1100	Negligible
Edison Electric Institute (Actual utility data, extrapolated from 65% of coal-fired capacity and 40% of oil-fired capacity)	1100	

# Study Implications

- Electric utility industry is likely to dominate the 1998 Toxics Release Inventory (based on total mass of releases)
- Power plant HCl aerosol releases will exceed largest current releases
- In many states, a power plant will be named as the largest source of toxic releases

# Anticipated Utility Response

- Risk Communication Activities

Brochures, briefings, chemical profiles, toxicity weighting factors, screening studies, site-specific assessments

- Improved Data Acquisition

- Pollution Prevention Programs

- Emission Reduction Programs

# Reducing TRI Emissions

- **Improved Estimation Methods**
  - Site-specific modeling (e.g., PISCES Model) vs. EPA emission factors
  - Additional data collection (including ICRs)

# Reducing TRI Emissions

---

- Improved Estimation Methods
- **Decreased Plant Utilization**
  - Demand-side management
  - Environmental dispatch

# Reducing TRI Emissions

- Improved Estimation Methods
- Decreased Plant Utilization
- **Fuel Switching**
  - Low S, low Cl coals (e.g., subbituminous)
  - Natural gas



# Reducing TRI Emissions

- Improved Estimation Methods
- Decreased Plant Utilization
- Fuel Switching
- **Pollution Control Technology**
  - ESP upgrades
  - FGD systems

# Reducing TRI Emissions

- Improved Estimation Methods
- Decreased Plant Utilization
- Fuel Switching
- Pollution Control Technology
- **Plant Operating Practices**
  - Reduce or eliminate “otherwise used” chemicals (e.g., for water treatment and plant maintenance)

# Reducing TRI Emissions

- Improved Estimation Methods
- Decreased Plant Utilization
- Fuel Switching
- Pollution Control Technology
- Plant Operating Practices
- **Byproduct Utilization**
  - Bottom ash and Flyash
  - FGD solids

# Future Developments

- Lower reporting thresholds for persistent, bioaccumulating toxics beginning in 2000, e.g.,
  - Mercury threshold reduced to 10 lbs/yr
  - Some organics as low as 0.1 gram/yr (vs. 25,000 lbs/yr currently)