Advancing Cleaner Energy

Trends in Treating WFGD Effluent

Sharon Sjostrom 3-7-13

New Regulations → Updated Technologies

- Federal Effluent Guidelines
  - Last modified in 1982 (before many plants had installed advanced controls)
  - Revised guidelines expected on April 19, 2013
    - The proposed rule was formally received by the White House Office of Management and Budget (OMB) Jan. 15.
    - OMB reviews are supposed to take no more than 90 days (*by executive order*).
- National Pollutant Discharge Elimination System (NPDES) permit program through the Clean Water Act (CWA) amended in 1987

What Are the New Effluent Targets?

- FGD wastewater
  - Chemical precipitation,
  - Chemical precipitation with biological treatment
  - Chemical precip + biological + evaporation (ZLD)
- Fly ash and bottom ash transport water
  - Zero Discharge
- Leachate from ponds and landfills containing coal combustion residues
  - Chemical precipitation, or
  - Chemical precipitation with biological treatment

EPA Steam Electric Power Generating Effluent Guidelines Rulemaking, Feb 24, 2012

Guideline: Merrimack Station NPDES Permit

- BAT effluent limitations . . . "which . . . shall require application of *the best available technology economically achievable . . ., which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants*"

http://www.epa.gov/region1/npdes/merrimackstation/

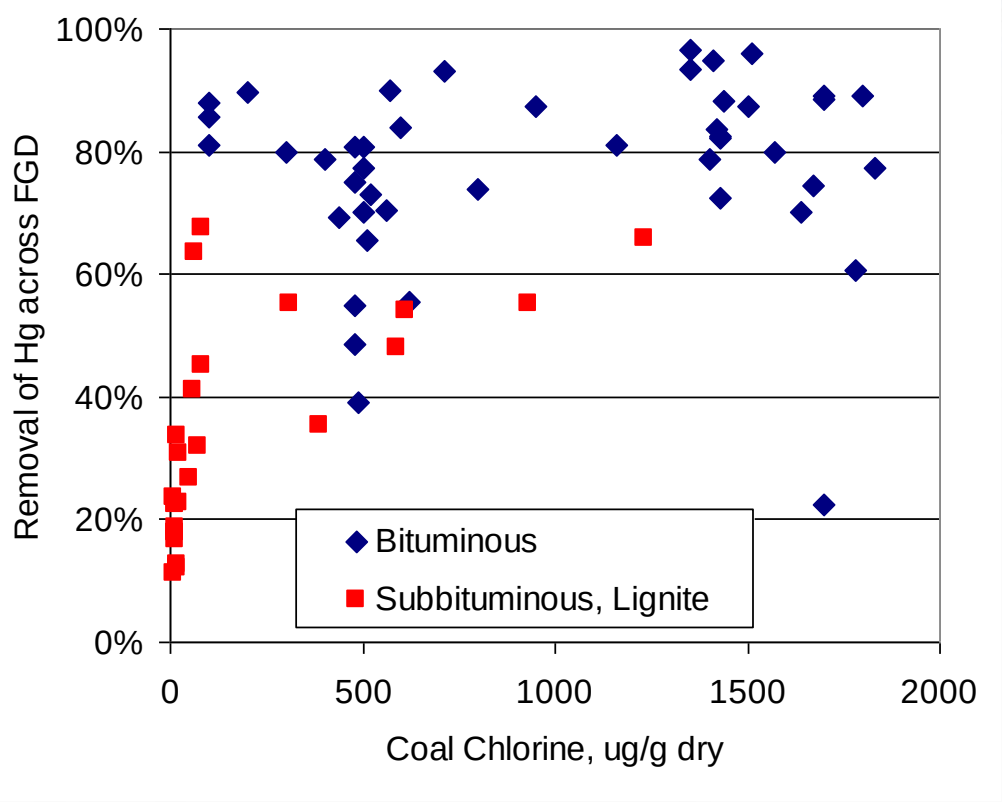
Proposed Merrimack FGD Wastewater Limits

	Daily Max	Monthly Average
Arsenic (µg/L)	15	8
Boron (µg/L)	Report	Report
Cadmium (µg/L)	50	Report
Chlorides (mg/L)	18,000	Report
Chromium (µg/L)	10	Report
Mercury (µg/L)	0.014	Report
Selenium (µg/L)	19	10

http://www.epa.gov/region1/npdes/merrimackstation/

Mercury in WFGD

- Many plants rely on WFGD for mercury capture
- High ORP → less Hg associated with solids
- Halogens often added to coal to increase mercury capture in WFGD
- Bromine coal additives increase selenium in WFGD (decrease ash Se)



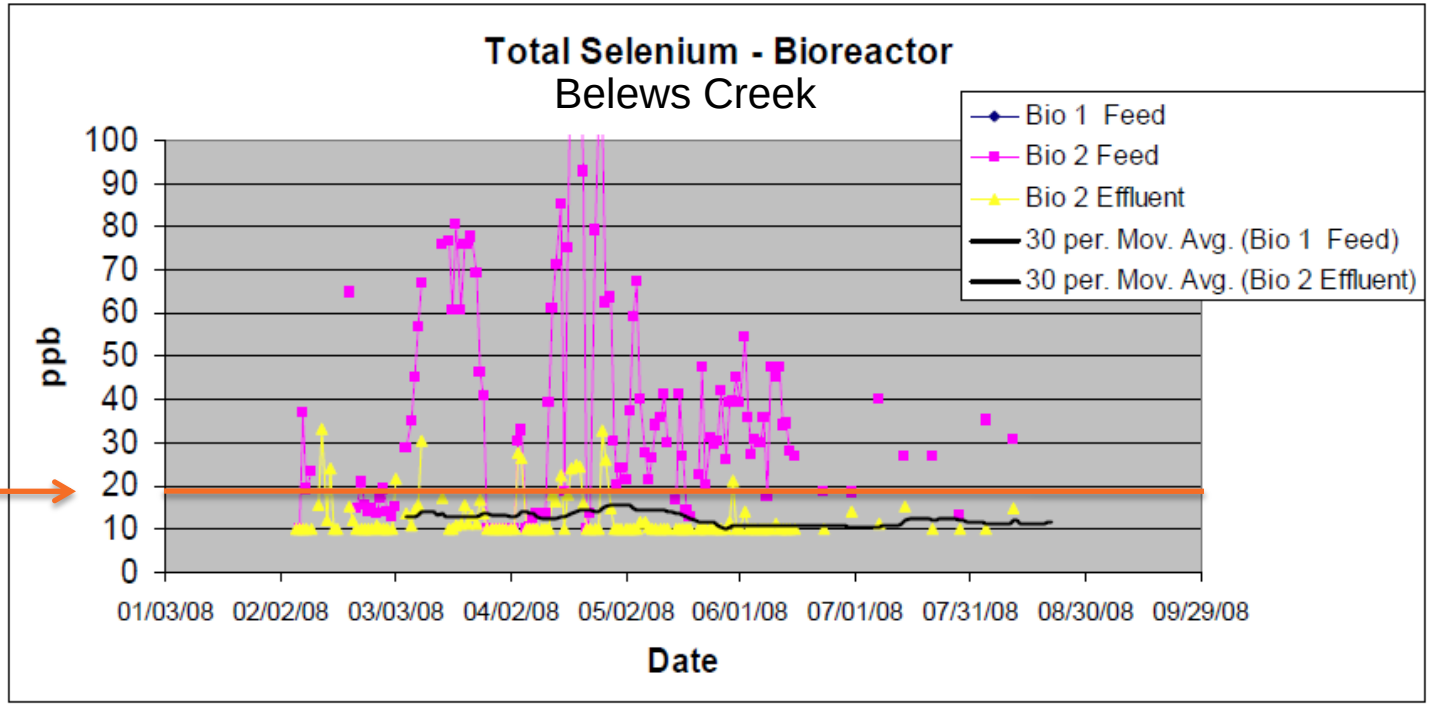
Selenium

- Selenium speciation is important
  - Selenite (Se[IV], Se^{+4}) more toxic
  - Selenate (Se[VI], Se^{+6}) more difficult to remove
- Se^{+4} can be removed through iron coprecipitation, Se^{+6} needs some bugs .. or more
- Forced oxidation WFGD may increase fraction of Se^{+6}
- Upstream controls (DSI) may reduce Se load to WFGD

Expected Trends

- If Merrimack is an indicator, low discharge limits may drive ZLD systems

Merrimack Proposed Daily Limit



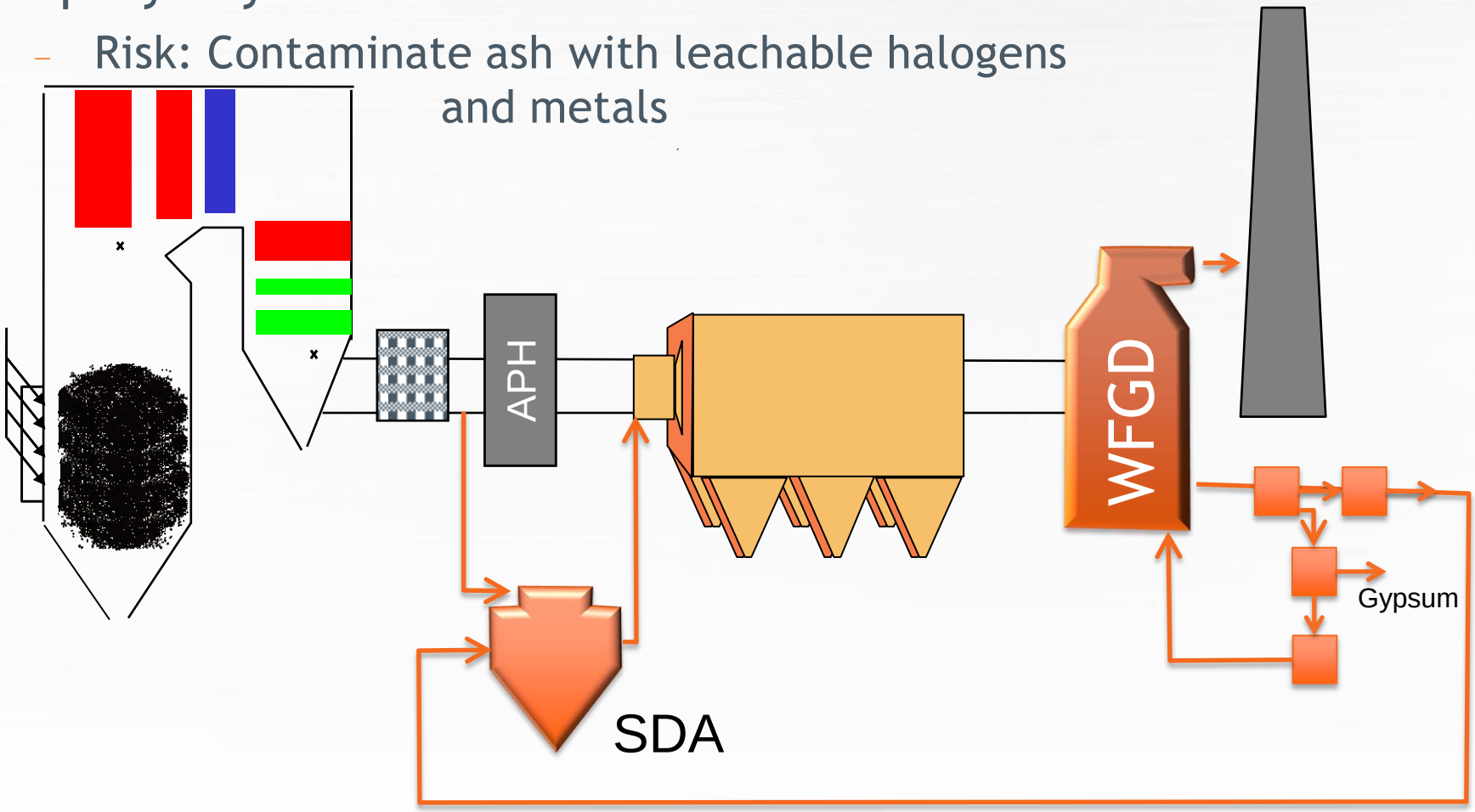
Robert Wylie, Duke Energy, 2008

EPA Recommended Treatment Technologies

- Chemical precipitation and filtration
  - Remove the heavy metals, particularly mercury and arsenic
  - $15 million for a 500 to 600 MW plant (EPRI: $25 to $50M)
- Chemical precipitation with **biological treatment**
  - Remove selenium, nitrates and sulfates
  - $24 million for a 500 to 600 MW plant
- Chemical precipitation followed by "**vapor-compression evaporation**"
  - Evaporation in brine concentrator
  - Crystallized salts and dispose in a landfill
  - Recycle or evaporate all liquid (zero discharge)
  - $50 million for a 500 to 600 MW plant (EPRI: > $100M)

ZLD Options

- Spray Dryer
  - Risk: Contaminate ash with leachable halogens and metals



ZLD Options

- Brine concentrator + crystallizer → landfill salts
  - Risk: salts are very soluble (leachable) and hydroscopic
  - High energy required to dry
- Stabilize Brines/Salts
  - Difficult due to mobility of metals
  - Mixing with other materials can increase mobility (including lime)
  - Options: Geopolymers with low leachability

Considerations for Discussion

- Regulations will drive technology choices
  - Effluent guidelines for pond leachate, strict NPDES permit trends, and unknown future CCR regulations may require new techniques to stabilize solids
- Removing and stabilizing selenium, halogens, and mercury may be challenging
  - Leaching protocols developed (LEAF) for more “realistic” evaluations
- New landfill management practices may be required
- Integrated APC management recommended to manage suite of compliance limits and operational impacts
  - Composite of technologies (air, water, and solids) may be required
  - No silver bullets
- Technology choices may limit fuel choices

Questions?