REINHOLD ENVIRONMENTAL Ltd.

2017 APC & Wastewater Round Table & Expo Presentation

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Carbonxt®

ADVANCED CARBON PRODUCTS

APC Roundtable | July 2017

Mercury Capture in the Wet Scrubber—Minimizing Plant Balance Effects

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Challenges Confronting Utilities

Must cope with:

- Environmental regulations
- Regulatory uncertainty
- Implementation costs that reduce profit

Carbonxt Approach:

- Solve the problem
- Serve as continued team member
- Develop cost saving solutions

How Well Are You Adapting?

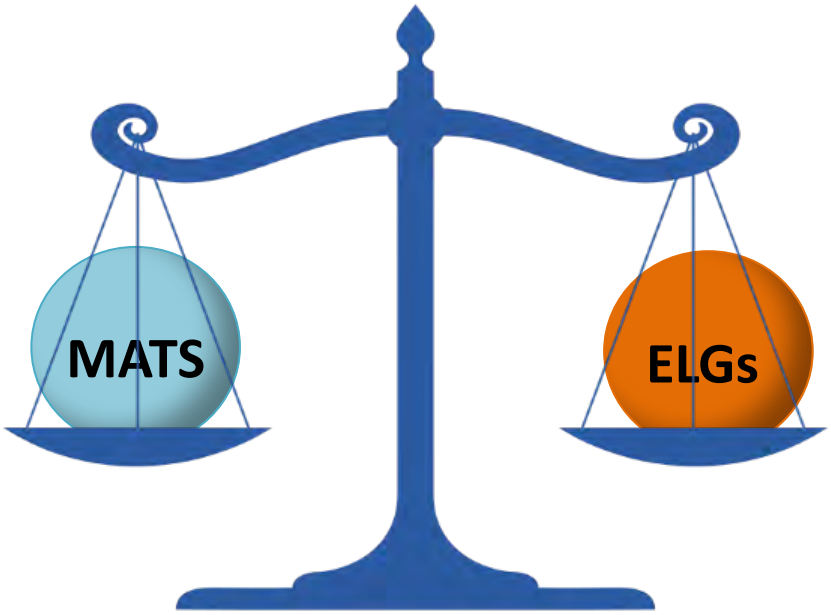
MATS-Phase I (2014-2016)

- PAC considered a commodity to meet MATS
- Utilities working independently to meet regulations
- Halogenated products leading to corrosion

Paradigm Shift

- Refined MATS compliance strategies that lead to:
  - Improved efficiencies
  - Lower operating costs and higher profits
- Collaboration between utilities and solution providers
- Lower or no use of halogens

The Balancing Act



Mercury and Air Toxics Standards (MATS)	Effluent Limitation Guidelines (ELGs)
Air Phase	Water Phase
Mercury, Particulate Matter, HCl/SO_2, HF	Mercury, Arsenic, Selenium, Nitrate/Nitrite

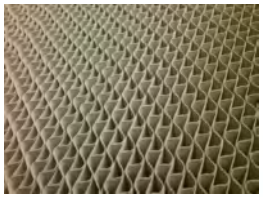
What's Your MATS Compliance Strategy?

Sorbent Injection

- Powdered activated carbon (PAC) or other sorbents
- Oxidizing carbons often chosen to achieve Hg oxidation
- Hg and PAC captured with fly ash

Coal Additives

- Used for Hg oxidation
- Hg capture occurs via various mechanisms:
  - Fly ash with high LOI
  - Injection of sorbents
  - Capture in the WFGD



Optimizing Existing Controls

- Targeted SCR catalysts for oxidation and capture in the WFGD

Oxidation Additives in the WFGD

Throw off plant balance

- Brominated salts are water soluble and accumulate in the scrubber slurry.
- Discharged water will affect municipal water plants downstream.
- Halogens + Organic Mater = Trihalomethanes (THMs)
  - Limit for Total THMs = 0.08 mg/L
- Many power plants that discharge wastewater are completely eliminating the use of brominated products.

Proven Alternate MATS Compliance Strategy: WetJect™

Why?

- Capable of removing elemental and oxidized Hg
- Reduce/eliminate air phase injection of PAC
  - Lower CAPx
  - Lower OPx
  - Minimize impact on balance of plant

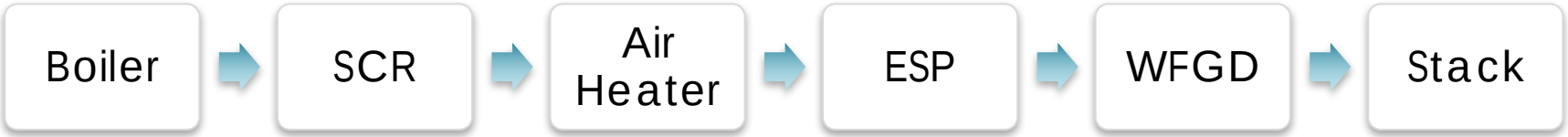
How?

- Lab scale optimization prior to full scale application
  - Determine optimal chemistry to enhance elemental and oxidized Hg capture
- Addition of WetJect Catalytic Sorbent

WetJect Case Study 1

Unit: 650MW

- Low sulfur eastern bituminous coal
- SCR with “exhausted” catalyst and ammonia injection
- Coal Hg concentration (0.12 - 0.45 ppm)



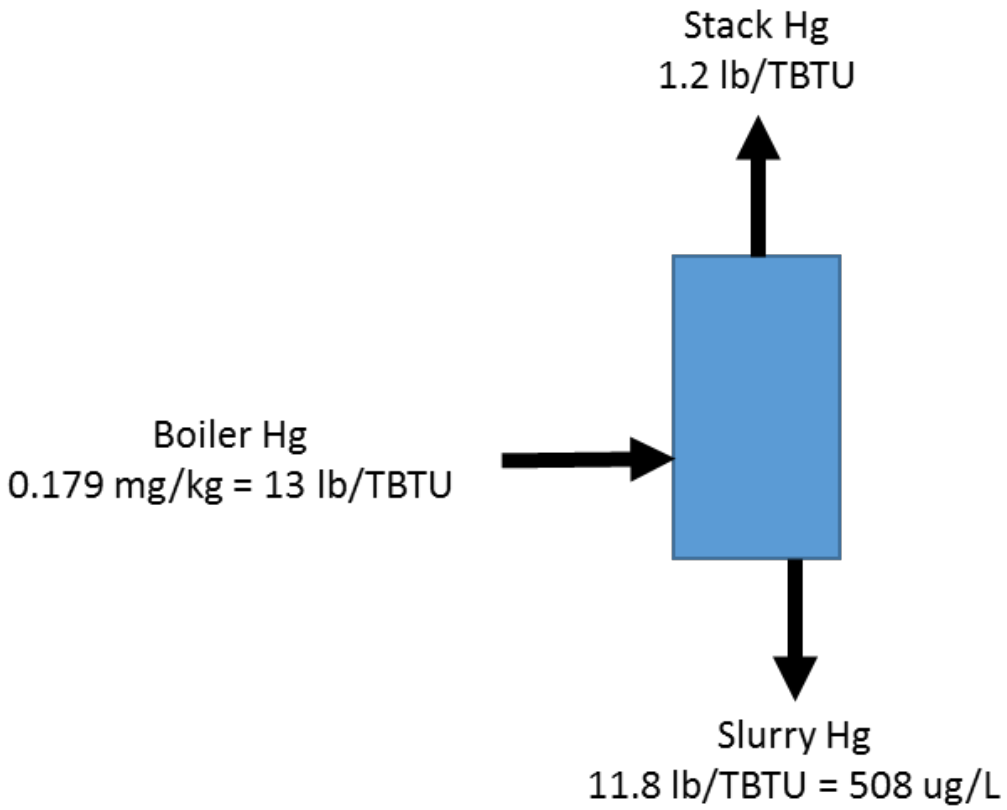
- Months of data acquisition to understand the problem
- Devised customized test plans to meet utility specifications
- Onsite for technical advice during demonstration
- Engineered WetJect for utility’s application

Station Concerns

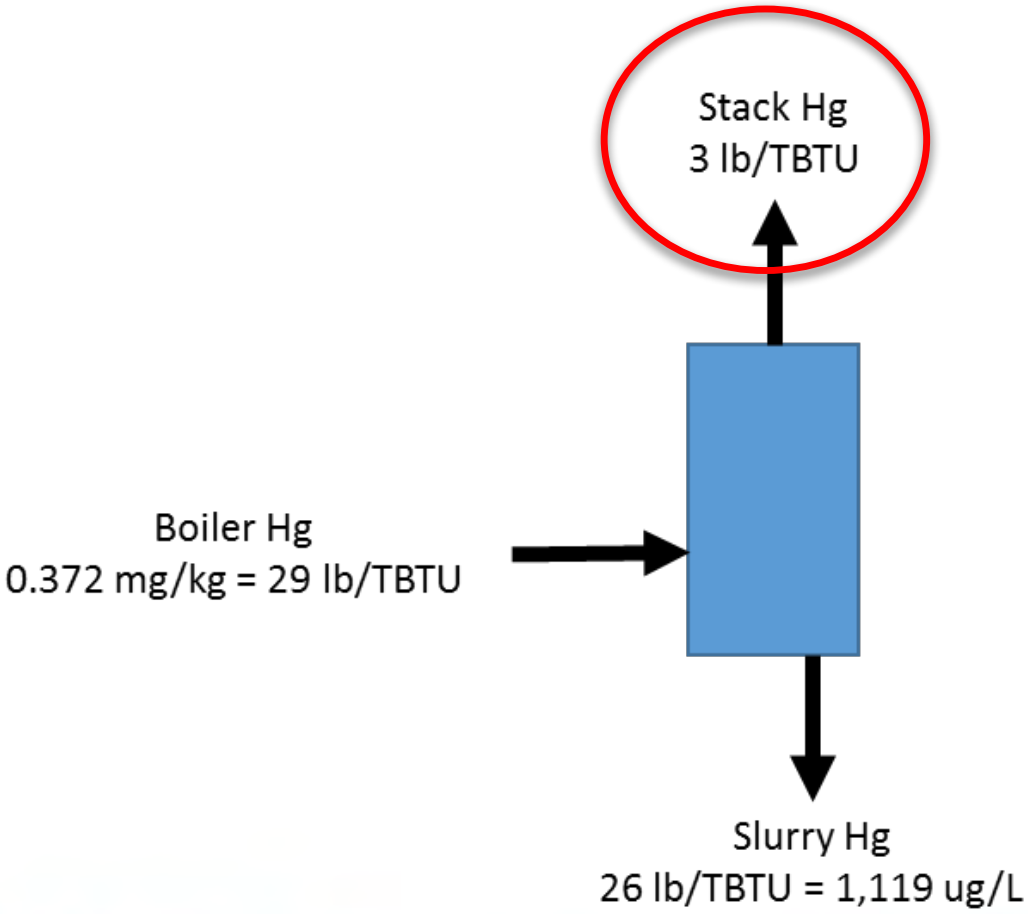
- Variable Hg content coal
- Unable to meet Hg removal targets with scrubber additive.
- Considered ACI but with high SO_3 this would necessitate high sorbent usage (>500 lb/hr) and/or dry sorbent injection.

Typical Scrubber Chemistry

Parameter	Value	Units
Density	1,123	g/L
ORP	130	mV
pH	6.5	s.u.
TOC	149	mg/L
DOC	110	mg/L
Total Hg of Slurry	527	µg/L
Hg of Slurry Solids	512	µg/L
Dissolved Se	68	µg/L
Total Se	2150	µg/L
Dissolved As	1.87	µg/L
Total As	1790	µg/L



Higher Hg Inputs



- Struggled to meet MATS on a 30-day average
- Unable to adjust inputs with sorbent traps on a 7-day lag.
- Financial burden to purchase low Hg content coal

Mercury in the System

Coal Hg Content

Day	Moisture (%)	Ash (%)	Sulfur (%)	Heating value (BTU/lb)	Mercury Content mg/kg-dry
Day 1	8.50	8.98	1.99	12,392	0.163
Day 2	9.09	8.94	2.08	12,334	0.176
Day 3	8.23	9.01	2.10	12,463	0.162
Day 4	8.46	8.66	2.18	12,464	0.148
Day 5	6.23	9.65	2.54	12,731	0.163
Day 6	6.67	7.72	2.41	12,904	0.121

Flyash Hg Content

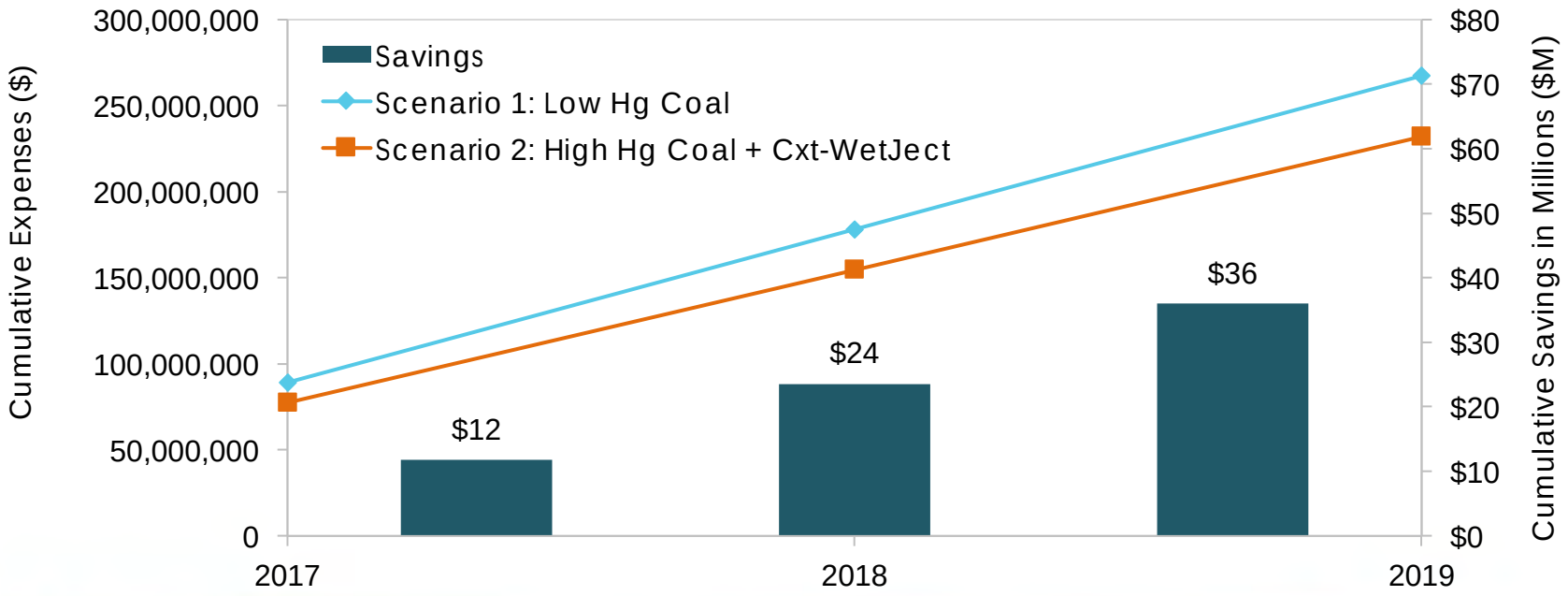
LOI (%)	Mercury Concentration (ppm)
7.73	0.169
9.73	0.163
8.06	0.140
5.57	0.167
5.37	0.076
8.94	0.194

Stack Mercury with WetJect™

Day	Load MW	Hg Sorbent Trap ug/m^3
Day 1	611	0.364
Day 2	692	0.472
Day 3	641	0.468
Day 4	697	0.462
Day 5	620	0.388
Day 6	650	0.405

Maintaining Balance-of-Plant and Increased Savings

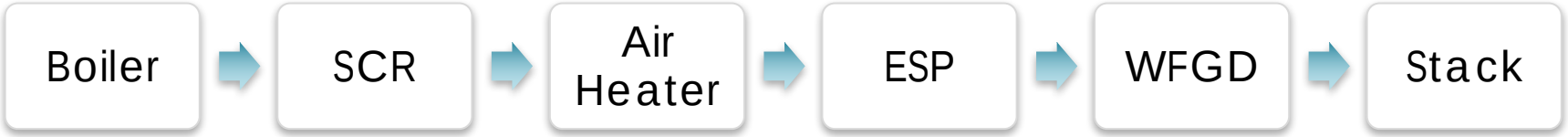
- Monitored water chemistry, water quality, gypsum with no impact
- Solution justified by low capital requirement



WetJect Case Study 2

Unit: 500 MW

- High Hg variation in coal– from 0.1 – 0.5 ppm
- Brominated coal additive & WFGD additive for compliance
- Slow response time for additive put plant at risk

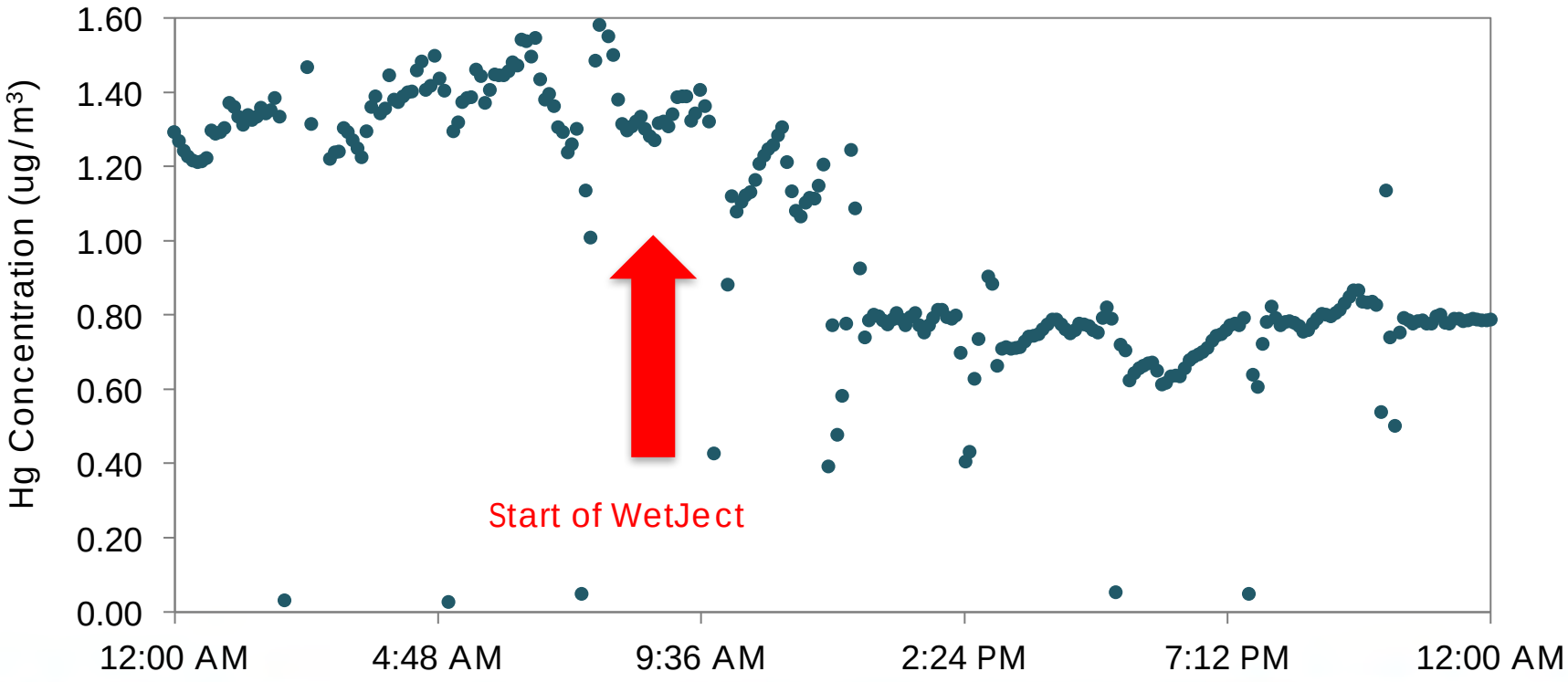


Testing Results:

- Confirmed ability to mitigate coal Hg variations
- Demonstrated quick response solution to high Hg levels
- Low cost, low maintenance, easy integration
- No adverse effects to plant balance

Successful Hg Removal Results

1. Station burning high Hg content coal (0.40 ppm)
2. Scrubber additive injection rate was maxed out (10 gal/hr)
3. 60% decrease in elemental Hg at the stack with WetJect



Positive Scrubber Response

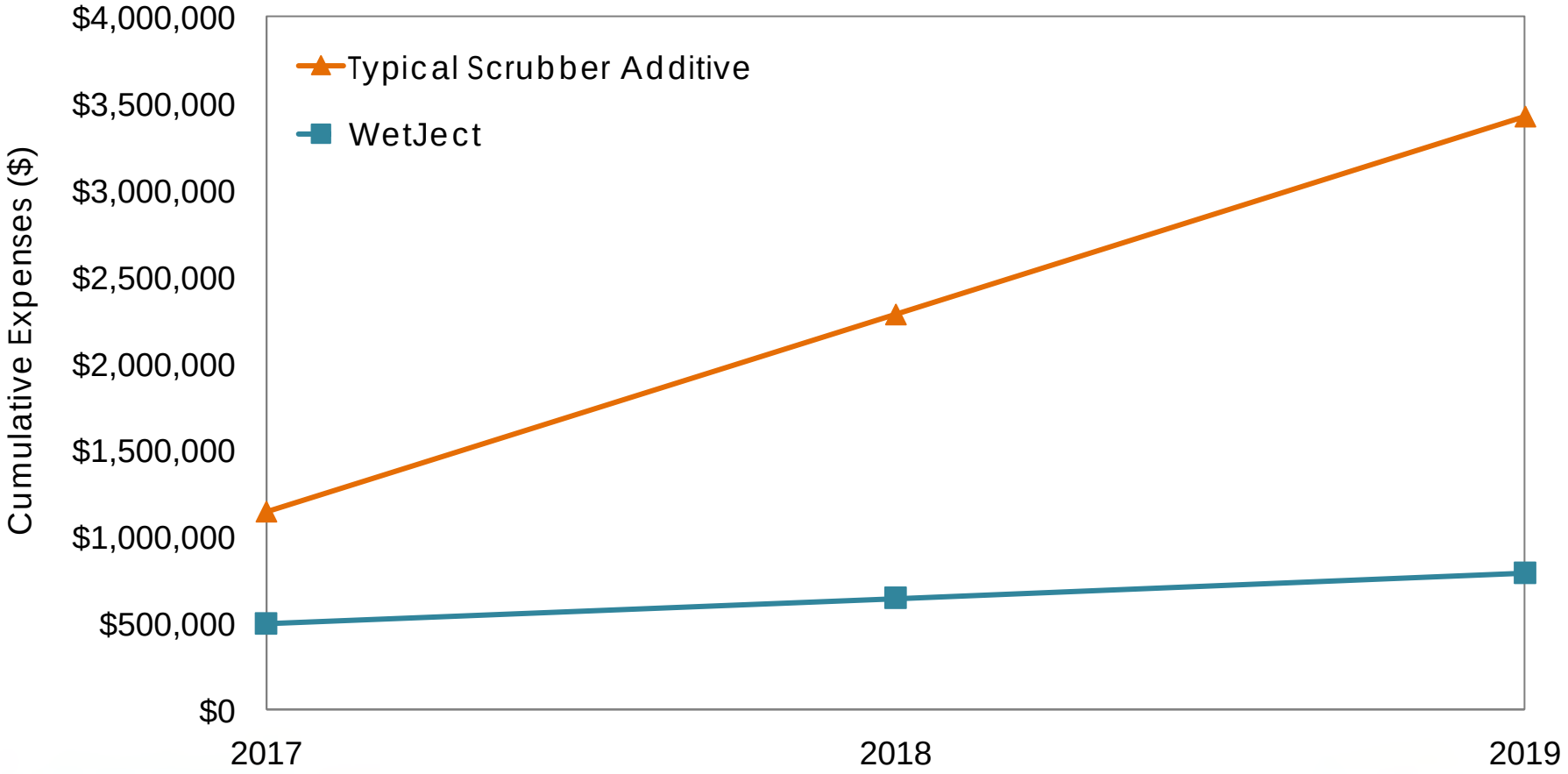
WFGD Slurry Analysis

COLLECTION POINT	PARAMETER	DAY 1 BASELINE	DAY 3 WETJECT
COAL	Hg Coal Content (ppb)	84	132
SLURRY BLEED	Dissolved Hg (µg/L)	0.49	0.01
	ORP (mV)	224	192
	pH	6.14	6.25

- Lower dissolved Hg concentration in the scrubber slurry below ELG limits, even with an increase in Hg coal content.
- No significant changes in pH or ORP – maintained scrubber operation
- No impact to balance of plant

Reemission Additive vs. WetJect

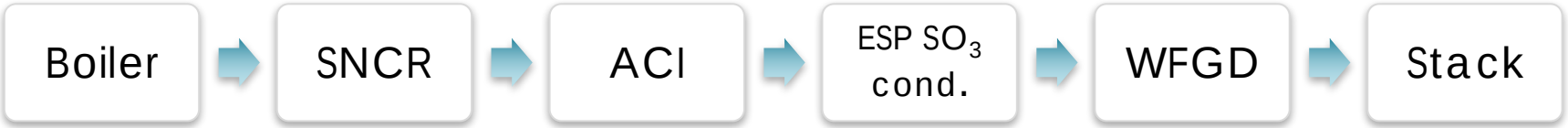
Cost Comparison



WFGD Demonstration 3

Unit: 500 MW

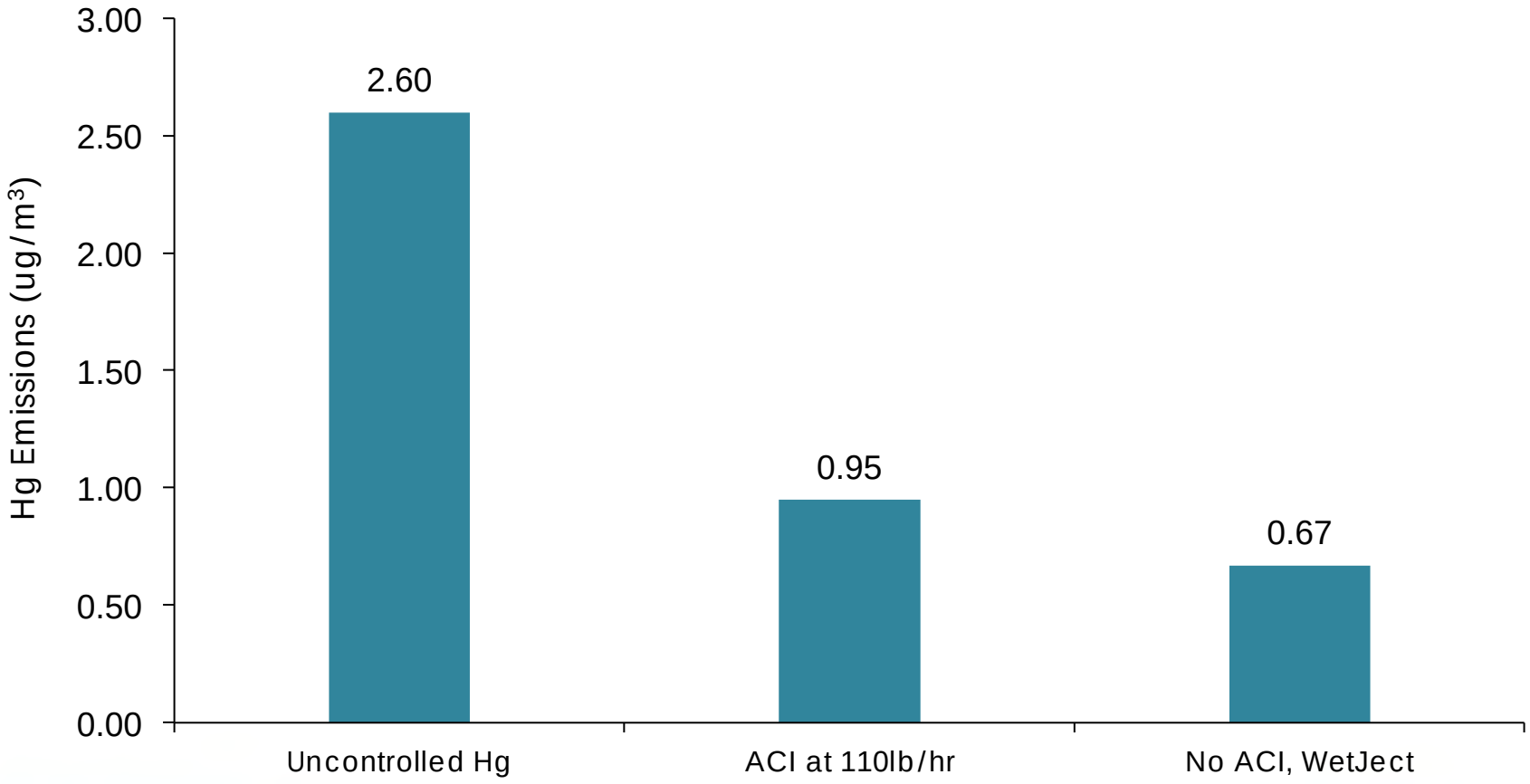
- Low sulfur bituminous coal with brominated additive
- SNCR, air phase ACI, ESP with SO_3 conditioning, WFGD
- Plant losing $1M per year in fly ash sales due to ACI



Goals:

- Demonstrate MATS compliance using full-scale system
- Preserve fly ash sales – shut off air phase ACI during testing
- Maintain existing gypsum sales

Hg Compliance at the Stack



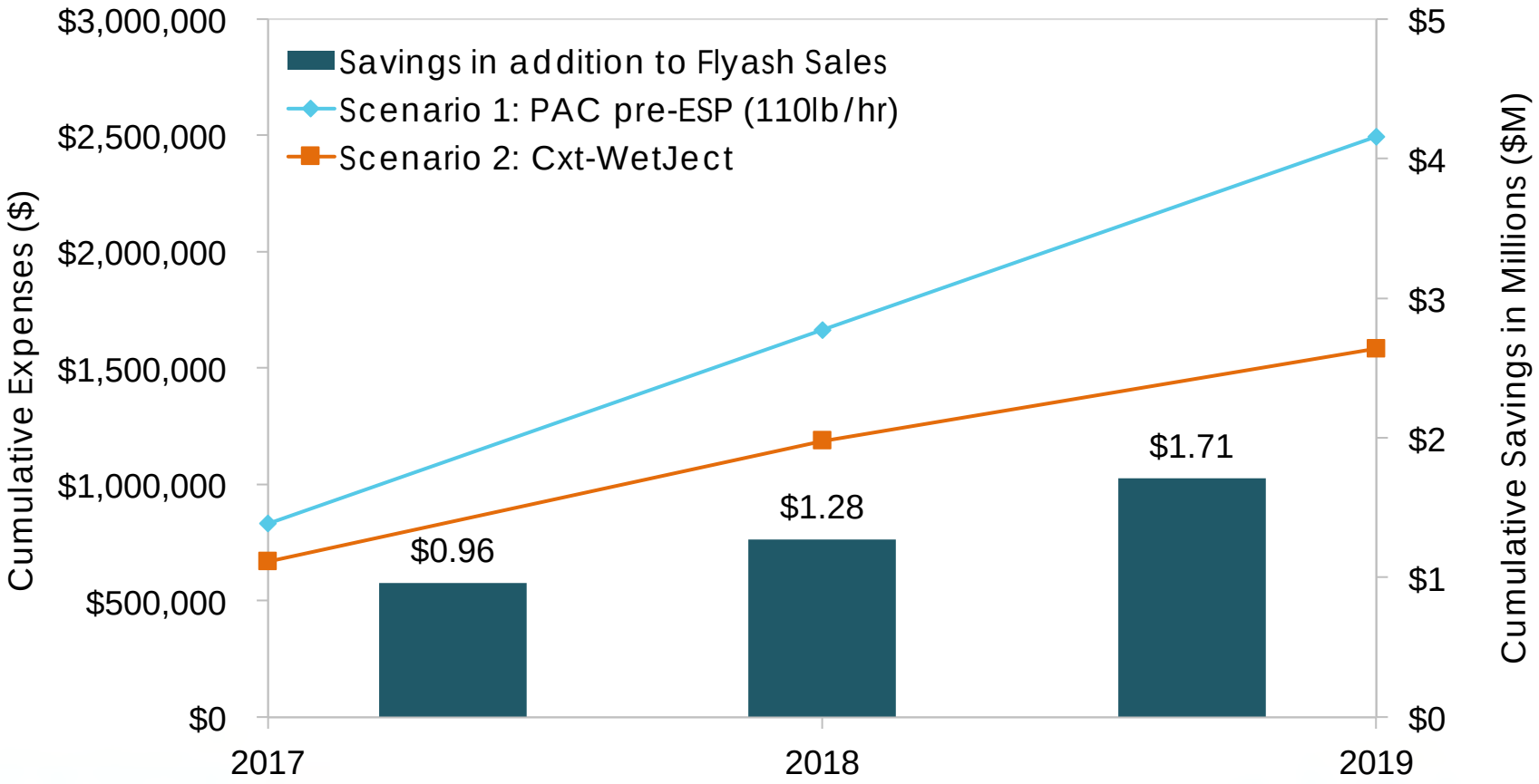
Providing Total Solution

WetJect system

Advantages:

- Low CAPx
- Little maintenance
- Compact
- Adjustable delivery rates

Cost Saving Solution



On the Cutting Edge of Environmental Control

- Holistic view of all components required to create a sound environmental control strategy
- Creating new developments to meet current and future needs
    - e.g., WetJect in the WFGD
- Working alongside and with your environmental team, providing technical insight

Find a solutions partner that tips the environmental balance in *your* favor.

Thank You!

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