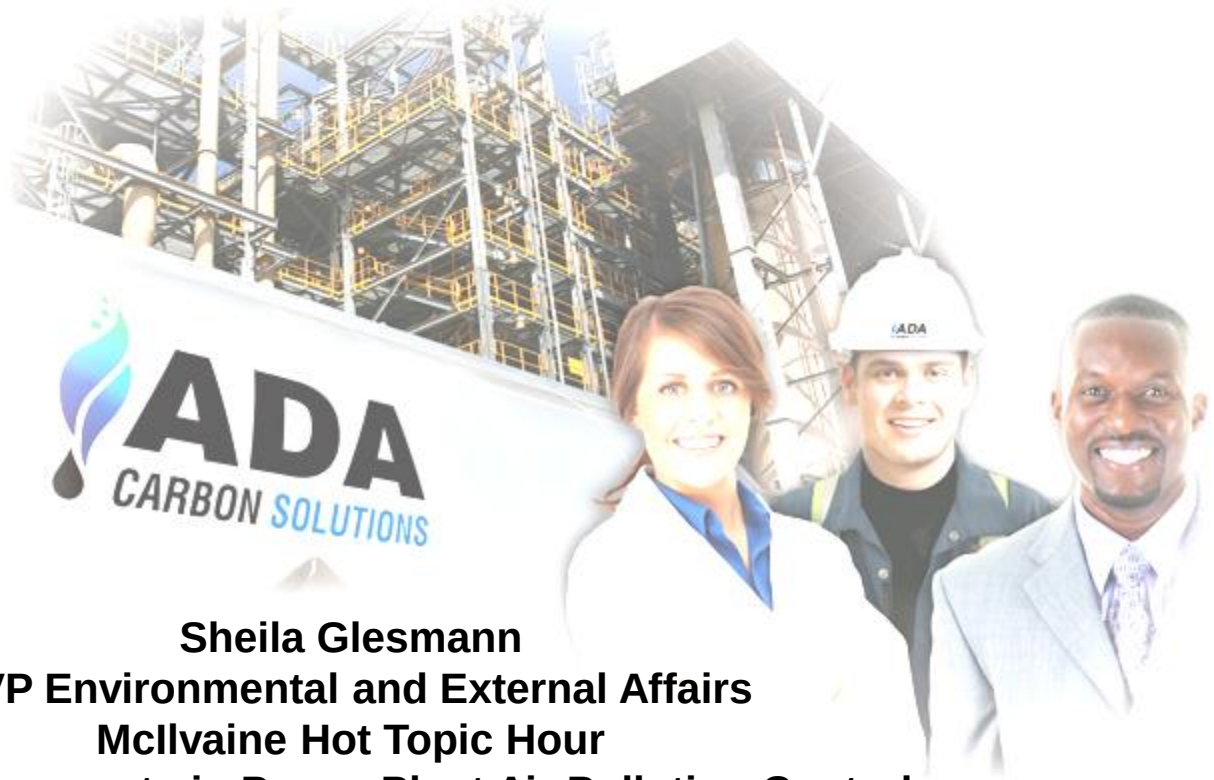
Advancements in Activated Carbons



Sheila Glesmann
SVP Environmental and External Affairs
McIlvaine Hot Topic Hour
New Developments in Power Plant Air Pollution Control
July 11, 2013

Expertise. Reliability. Compliance.

Genesis of Activated Carbon Injection for Mercury Capture

1990s

- Multiple-pollutant control laboratory and pilot-scale studies to start evaluating co-benefits and sorbent injection
- Technology transfer of Activated Carbon Injection (ACI) from Municipal Sewer Waste over to Coal Firing, but mercury concentrations much lower from coal
- Major issues with measurement of Hg at these low levels in actual flue gas matrix

Early 2000s

- Significant field studies and demonstrations of same PACs used for water treatment and MSW plants
- Introduction of halogen-treated activated carbons
- Measurement improvements and options expand
- Issues such as ash disposal identified, studied

Today

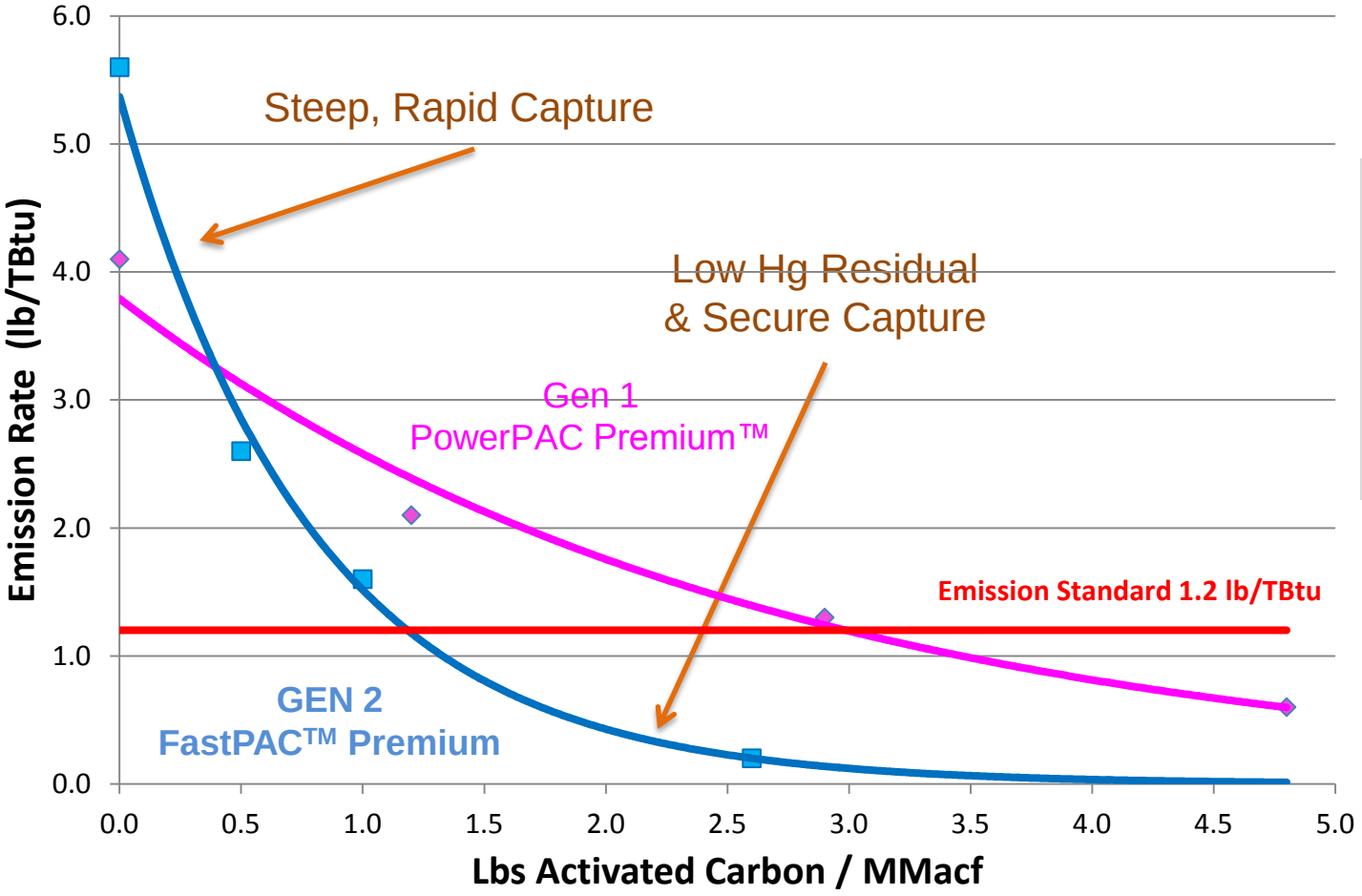
- ADA Carbon Solutions as first, fully focused PAC manufacturer for mercury removal introduces new products tailored to this application
- Identification of critical aspects of carbon that drive performance in mercury capture
- Focused product development in specific application challenges
- Measurements still challenging and high-maintenance

Ongoing Development

- Meaningful quality criteria that correlate with mercury capture performance
- Rapid innovation targeting specific application challenges
  - High Acid Gases
  - Concrete Compatibility
  - Faster Kinetics
- Solutions tailored for specific circumstances to achieve the optimal compliance solutions

- Coal-fired mercury control has been studied by EPRI, EPA, DOE and others since 1990
- Activated Carbon Injection (ACI) has been commercial in coal fired power plants since 2007
- As of mid-2012, there were 63 GW of ACI bookings (ICAC)

Advances in High Hg Capture Efficiency - Gen 2 - FastPAC™ Premium EGU Test



- > 200 MW EGU
- PRB coal fired
- Cold-side ESP
- Hg CEMS

Our patent-pending FastPAC™ Premium Reduced PAC usage by 50% and Improved Hg Removal to >95%

Innovation Focused on Mercury Capture

Water Products Re-Purposed for Mercury Capture

Gen 1
- Power PAC™
- Power PAC Premium™

First Generation of Design-for-Purpose Mercury Capture PAC Products

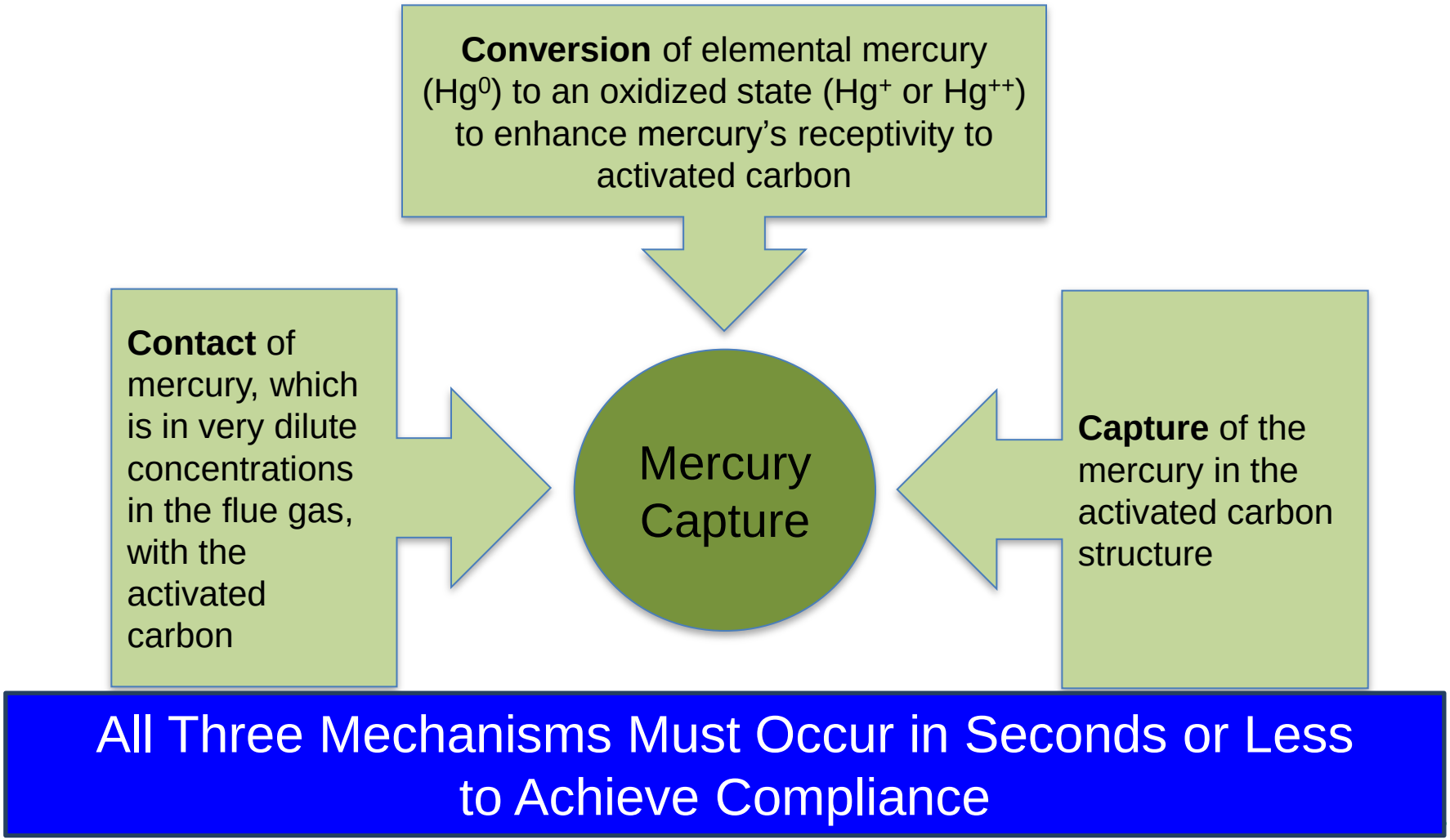
Generation 2
- Power PAC Premium Plus™
- FastPAC™ Platform

Generation 3
- SO_3 Tolerant
- Concrete Compatible
- Others

2000 - 2010 | 2011 | 2012 - Future

A Scientific Approach to PAC Design Guided by Focused Applications Expertise

Three Critical Mechanisms for Efficient Mercury Capture



Fate of Mercury – What does it take to capture mercury?

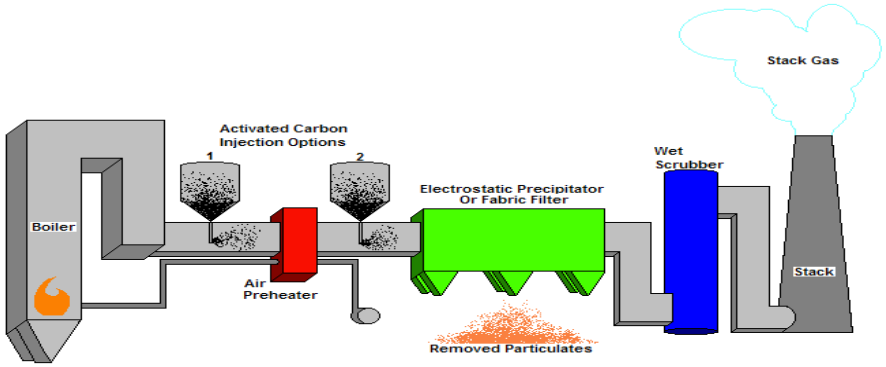
		Predominant Mercury Capture Mechanisms		
		Oxidize Mercury	Contact with Capture Media	Secure Mercury Capture & Removal
Emission Treatment	Coal Pretreatment	Effective	Effective	Effective?
	Pre- & Post Combustion Oxidation	Effective		
	Fly Ash / LOI		Effective	Effective?
	Selective Catalytic Reduction	Effective		
	Activated Carbon Injection	Effective	Effective	Effective
	Non-carbon Sorbents	Effective	Effective	Effective?
	Wet Scrubber		Effective	Effective?

Technologies that do not fulfill all three mechanisms require supplemental process steps that could add capital and/or operating costs

Technology Philosophy

- Engineered controls are required.
- Complementary systems are beneficial.

- Reduce Hg emissions into the downstream wet scrubber to reduce potential of Hg re-emissions.



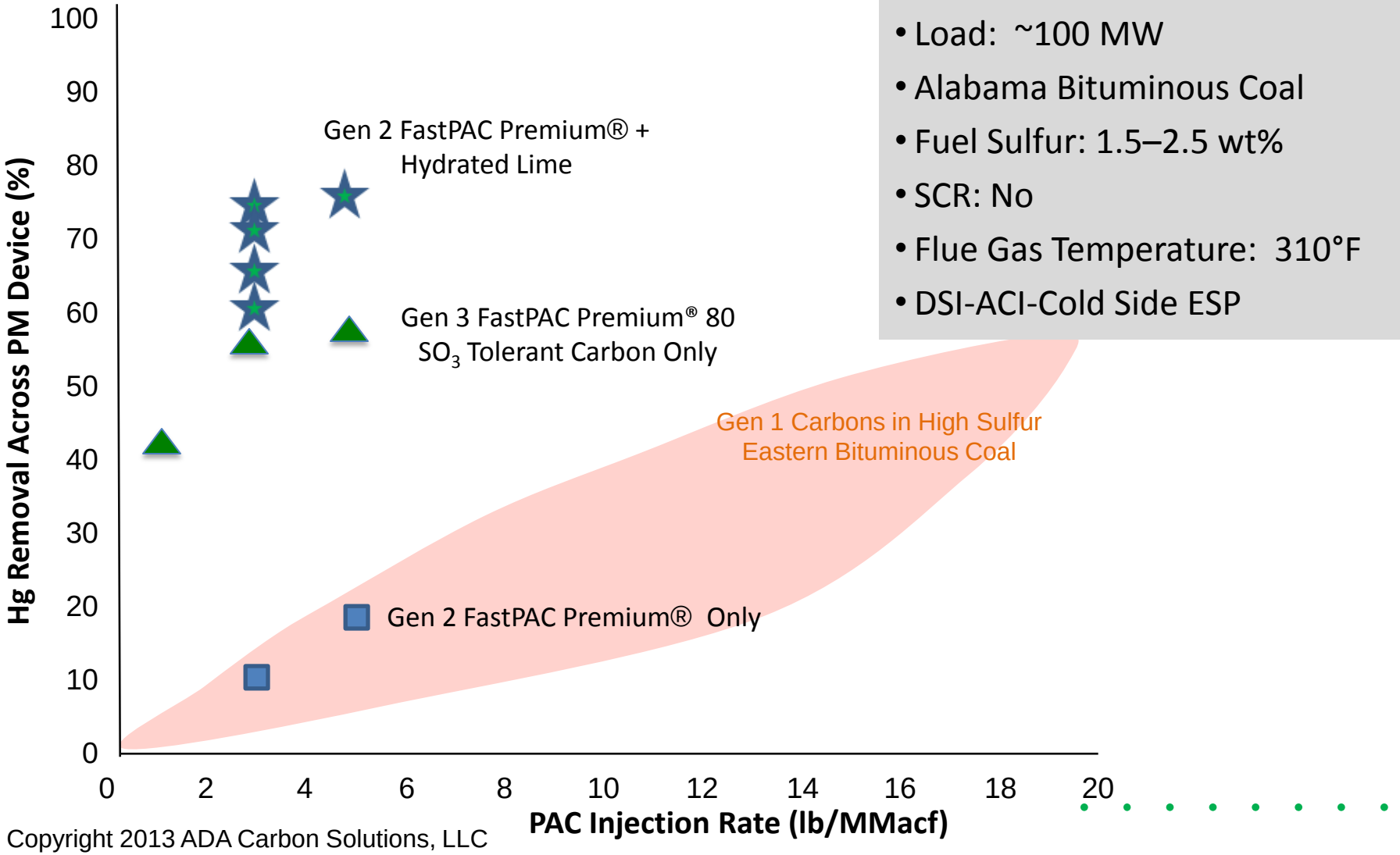
Plant	Basis	Period	N	Frac > Limit	Mean	99th Percentile
Unit A	TBtu	30-d	402	0.25	0.82	1.87
Unit B	TBtu	30-d	773	0.24	0.83	1.59
Unit C	TBtu	30-d	926	0.26	0.92	1.90
Unit D	TBtu	30-d	917	0.33	0.97	1.62
Unit E	TBtu	30-d	1003	0.18	0.89	1.87
Unit F	TBtu	30-d	788	0.05	0.71	1.30
Unit G	TBtu	30-d	695	0.14	0.97	1.35

Increasing Hg concentration challenge & increasing complexity of chemistry and consistent process control.

The combination of SCR and wet FGD does not guarantee compliance with MATS.

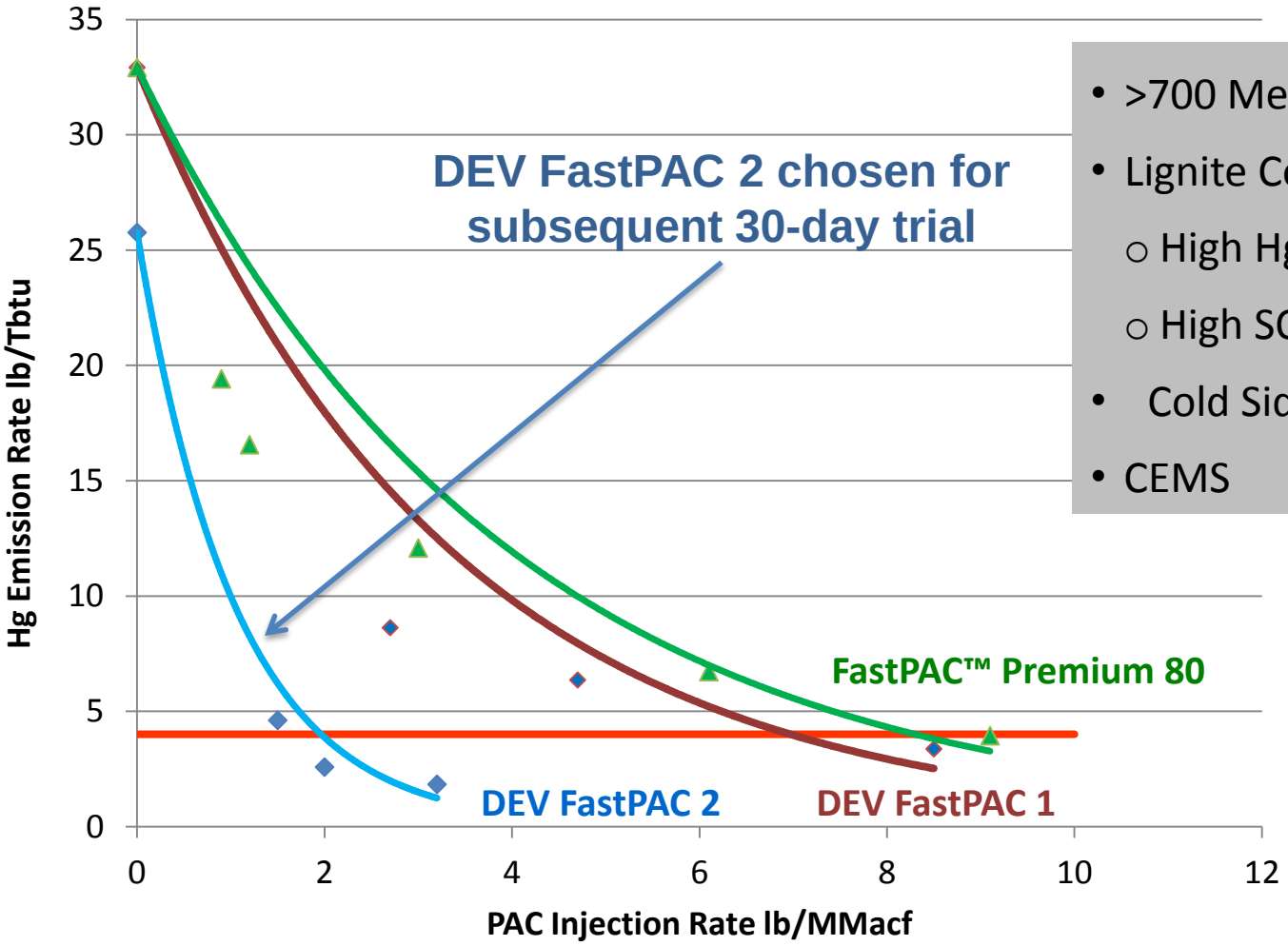
Southern Plant Gorgas: Gen-3 FastPAC Premium® 80 SO_3 Tolerant Carbon

- Load: ~100 MW
- Alabama Bituminous Coal
- Fuel Sulfur: 1.5–2.5 wt%
- SCR: No
- Flue Gas Temperature: 310°F
- DSI-ACI-Cold Side ESP



Expertise. Reliability. Compliance.

Full-Scale Utility Test: FastPAC™ Premium 80 & Developmental SO_3 Tolerant Carbons



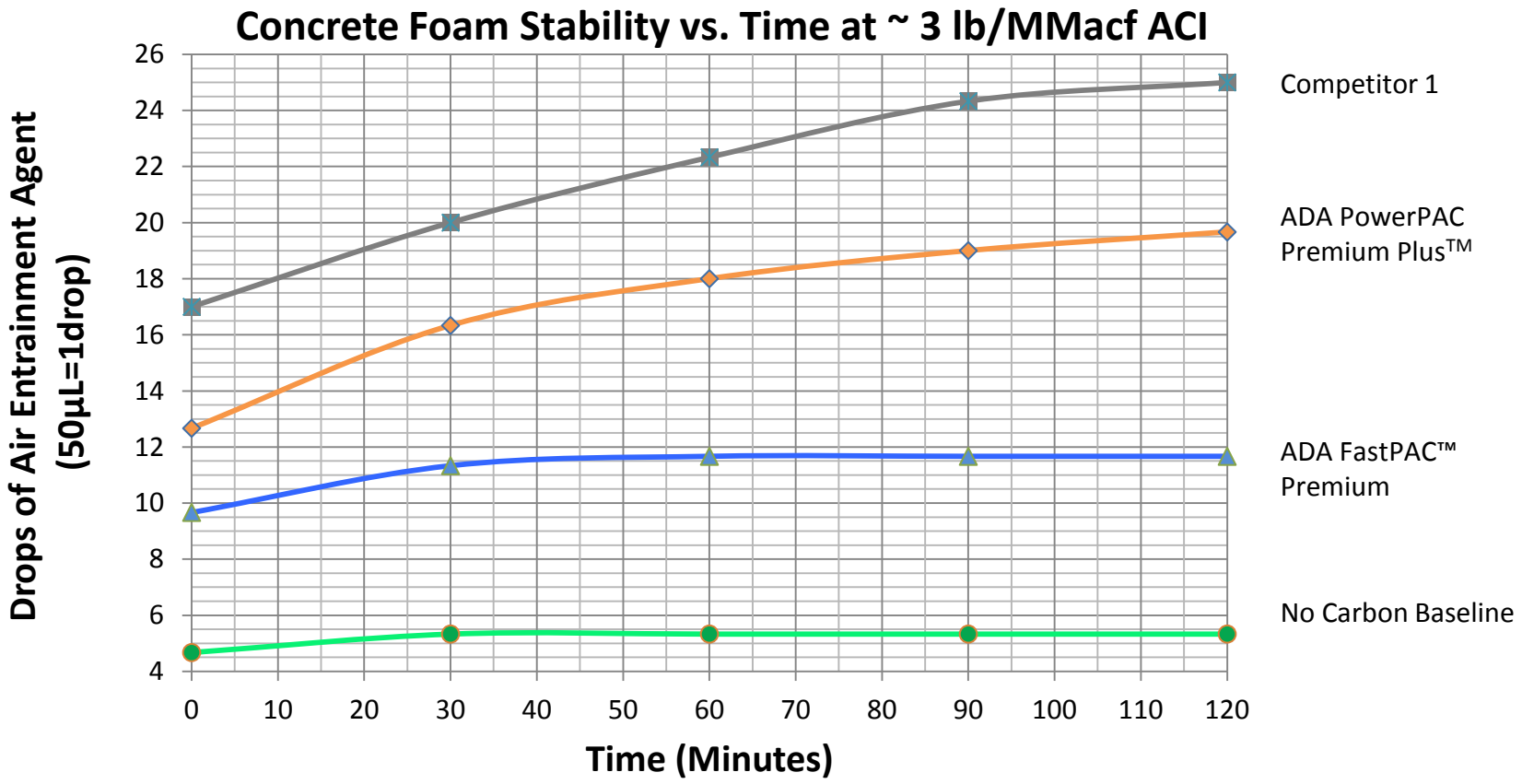
- >700 Megawatt Unit
- Lignite Coal
  - High Hg, 25-35 lb/Tbtu
  - High SO_3, 15+ppm
- Cold Side ESP
- CEMS

SO_3 Tolerant Carbons Highly Effective for High Mercury, High Sulfur Lignite Coal

Advances in SO_3 Tolerant Carbons – FastPAC Premium™ 80

- Over 18 full-scale utility tests of our FastPAC™ Premium 80 SO_3 tolerant PAC
- MATS compliance options for efficient Hg capture for high-sulfur coal demonstrated
  - Combination of DSI and ACI enhances mercury removal on high sulfur fuels and complements the performance of FGD co-benefit.
  - Combination of DSI and ACI provide sufficient mercury removal for MATS compliance on sub bituminous and select bituminous coal.
- New Generation-3 ADA Carbon Solutions SO_3 Tolerant carbons allow effective operational options with reduced PAC and DSI requirements

Advances in Concrete Compatibility From Our FastPAC™ Premium



Our patent-pending FastPAC™ Premium PAC conserves Air Entrainment Agent Usage and provides Rapid Foam Stability

Advances in Hg Capture Efficiency & Concrete Compatibility with Our Gen-2 FastPAC Premium™ Product Platform

- 53 Full plant utility tests completed in 2012 through the end of May 2013
- 30-60% lower activated carbon consumption
  - Lower particulate load on ESP
  - Reduced maintenance requirements & less equipment wear
  - Potential for baghouse capital avoidance
- Steeper Hg capture efficiency
  - Greater than 95+% Hg capture capability
  - Active control capabilities
  - Broader operational flexibility to meet compliance
  - Extend useful life of plant operations as opposed to shutdown
- Concrete Capability
  - Acceptance by fly ash marketer
  - Lower ash carbon content
  - Rapid Foam Stability

We Take Pride in Leading the Activated Carbon Performance Landscape

PAC Platform	Introduction	Attributes
FastPAC™ Premium	Spring 2011	• Fast Reaction & Adsorption Kinetics • High Hg capture efficiency - low PAC dosage • Low Hg residual in flue gas
Concrete Compatible	Summer 2011	• Low Foam Index – low AEA requirement • Rapid Foam Stability – constant AEA over time
FastPAC™ Premium 80	Spring 2012	• SO_3 Tolerant • Low or no DSI requirements
Other Developmental Products	Fall 2012 – Spring 2014	• Address niche concerns identified by customers such as optimization for specific unit configurations, higher flue gas temperatures

We continue to focus R&D resources on developing new carbons that lead the industry in providing cost-effective, reliable options for MATS compliance

Contact Us

Thank you!

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