



# ME<sub>2</sub>C

Midwest Energy Emissions Corp

# Best Available Control Technologies

Southern States Energy Board (SSEB) Associates Meeting

February 25, 2019 | Washington, D.C.

Richard MacPherson

President and CEO | ME<sub>2</sub>C





# U.S. is the Leading Exporter of Mercury Control Technologies

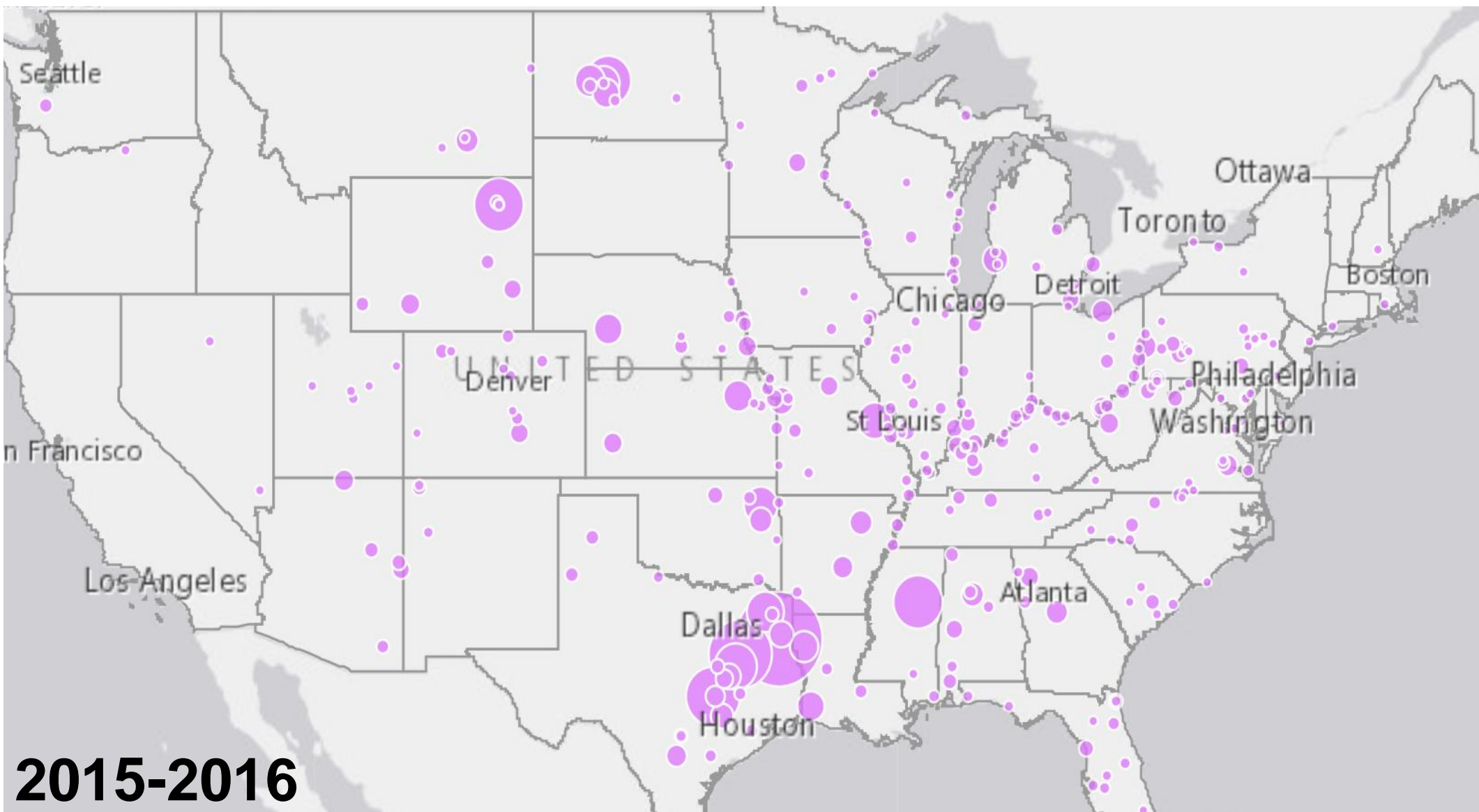
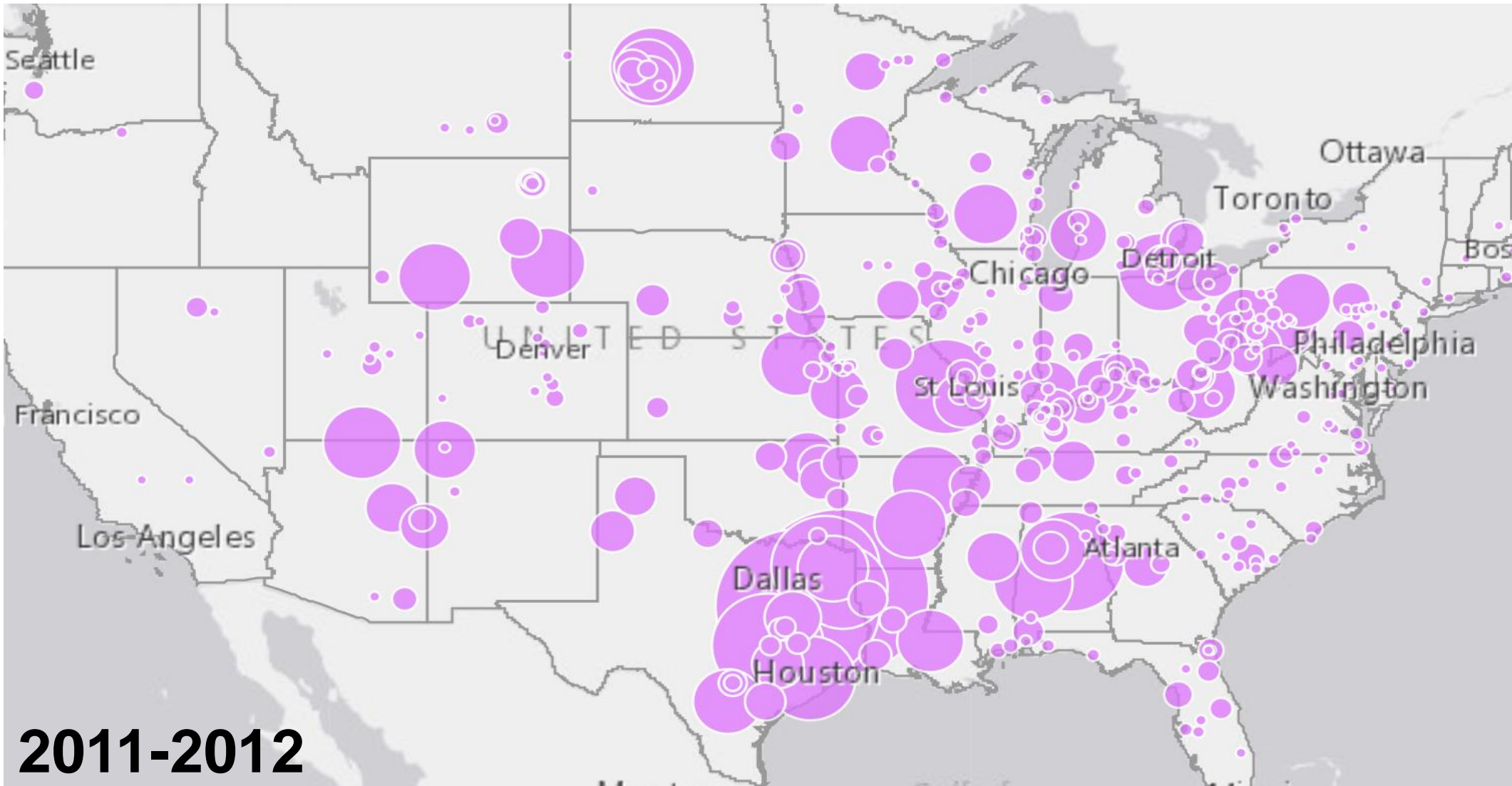
*U.S. Coal-Fired Power Plants Are Leading the Way Globally for Emissions Control*



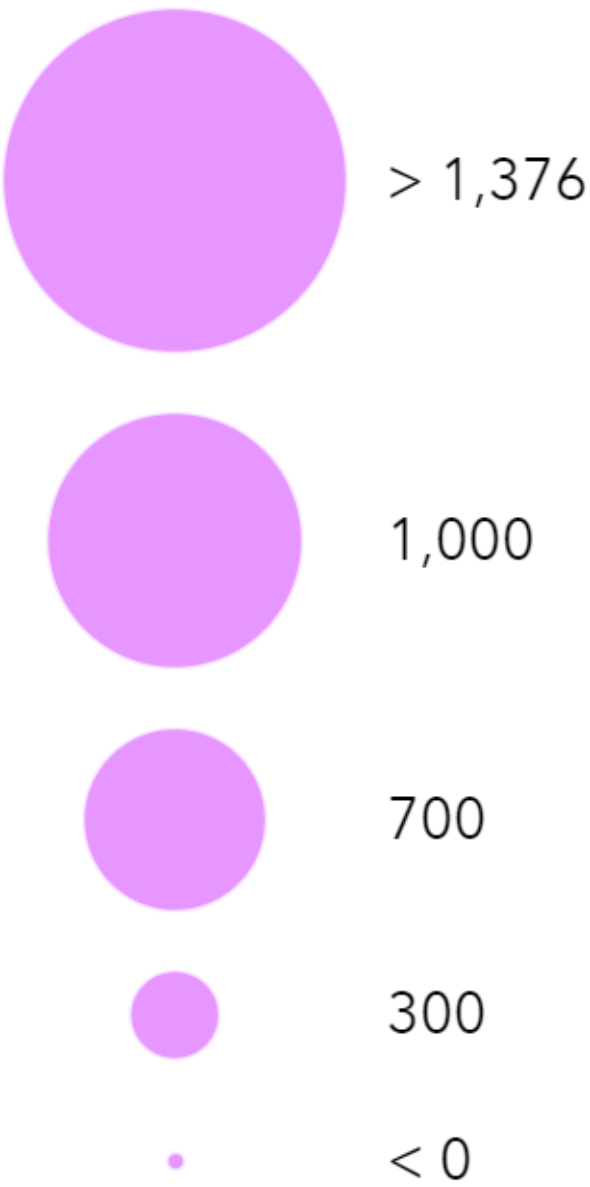
U.S. Achievements in Mercury Emissions

# Significant Mercury Emissions Reductions in U.S.

Reduction Comparisons for 5-Year Period



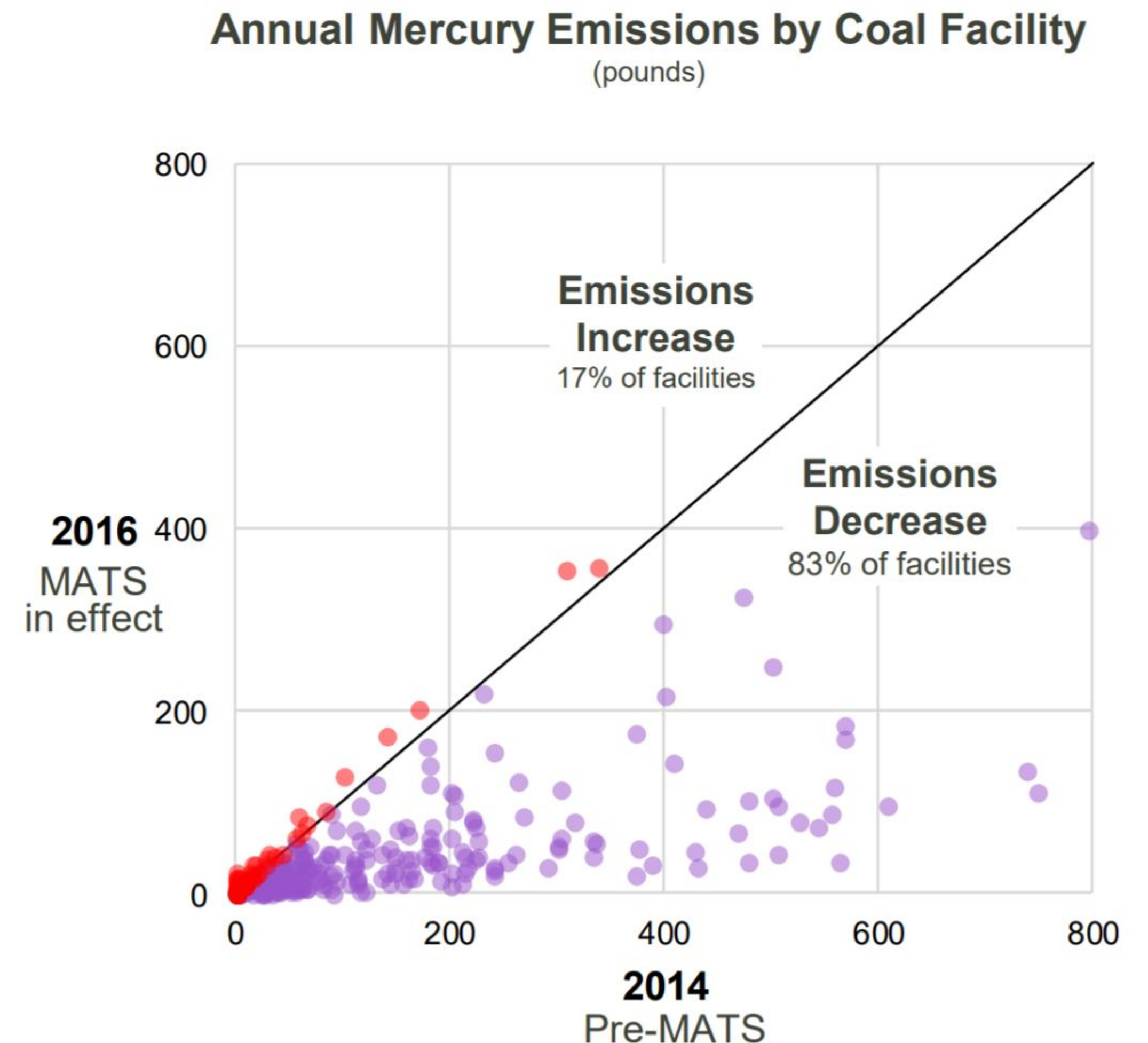
Total mercury emissions in pounds 2012 through 2016





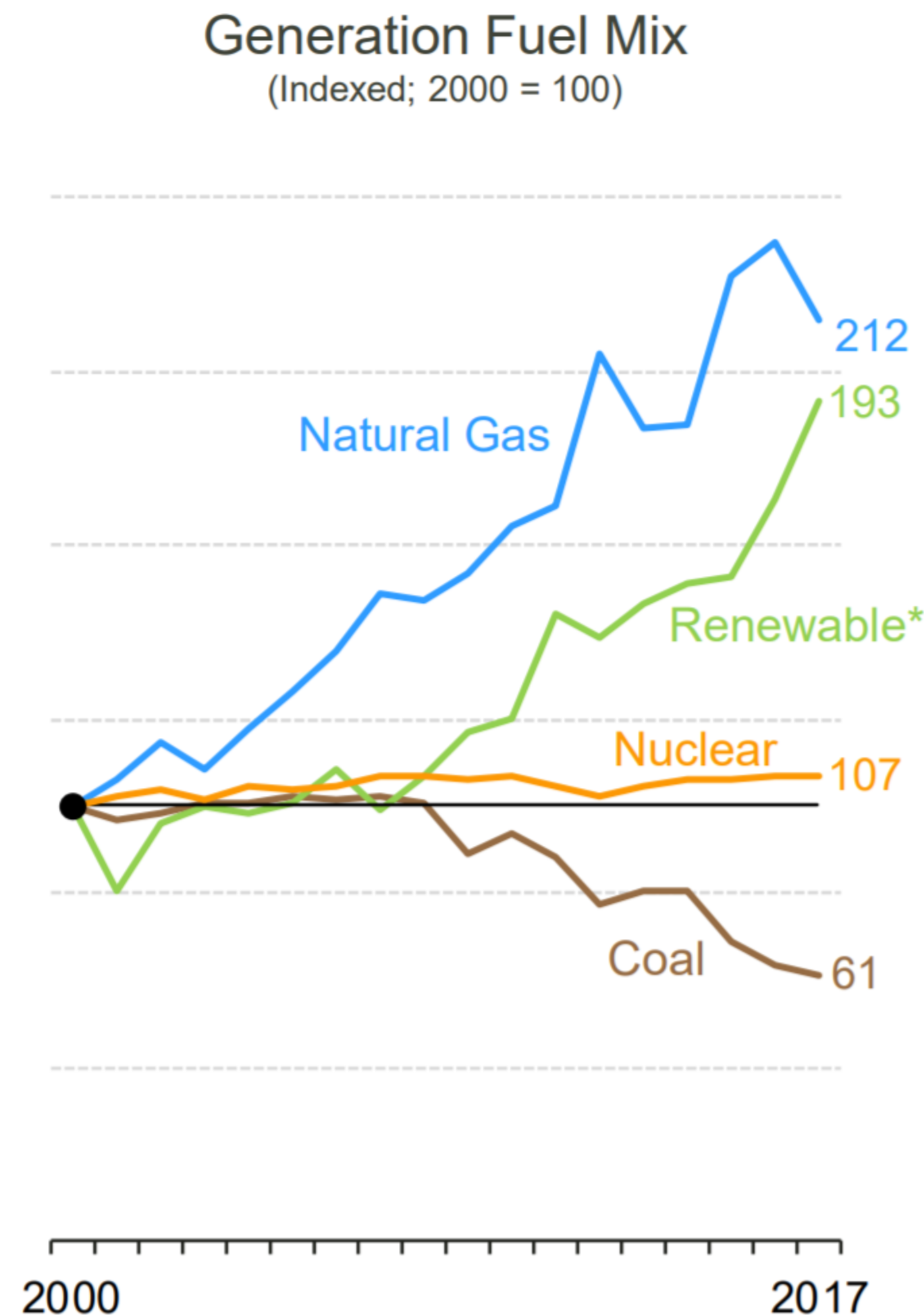
# MATS Effect: Mercury & Air Emissions Decline in U.S.

- A recent energy report published June 2018 notes that mercury emissions levels declined at 83% of coal facilities between 2014 to 2016<sup>1</sup>.
- Across these facilities, emissions decreased by an average of 63%
- The EPA Toxic Release Inventory (TRI) reported in 2018 that mercury air emissions from power plants have **decreased 86%** since 2000



<sup>1</sup>MJ Bradley Benchmarking Air Emissions Report June 2018. Data compiled from the EIA and EPA findings.  
[https://www.mjbradley.com/sites/default/files/Presentation\\_of\\_Results\\_2018.pdf](https://www.mjbradley.com/sites/default/files/Presentation_of_Results_2018.pdf)

# “Greening” of the U.S. Generation Fuel Mix



- As of 2017, the U.S. produced 4.03 trillion kWh of electricity with 30% generated by coal.<sup>2</sup>
- The electric power sector has made significant progress in terms of reducing its NOx and SO2 emissions.
- From 2000 through 2017, emissions from NOx decreased 79% and SO2 decreased 88%.
- From 2005 to 2017, CO2 emissions decreased 24% while GDP grew 20%. Over the same period, generation from renewables grew 92%

<sup>2</sup> MJ Bradley Benchmarking Air Emissions Report June 2018: [https://www.mjbradley.com/sites/default/files/Presentation\\_of\\_Results\\_2018.pdf](https://www.mjbradley.com/sites/default/files/Presentation_of_Results_2018.pdf)

# Mercury Control Cost History

## Early 2000s

Mercury control costs estimated up to \$160,000+ per pound of Hg captured

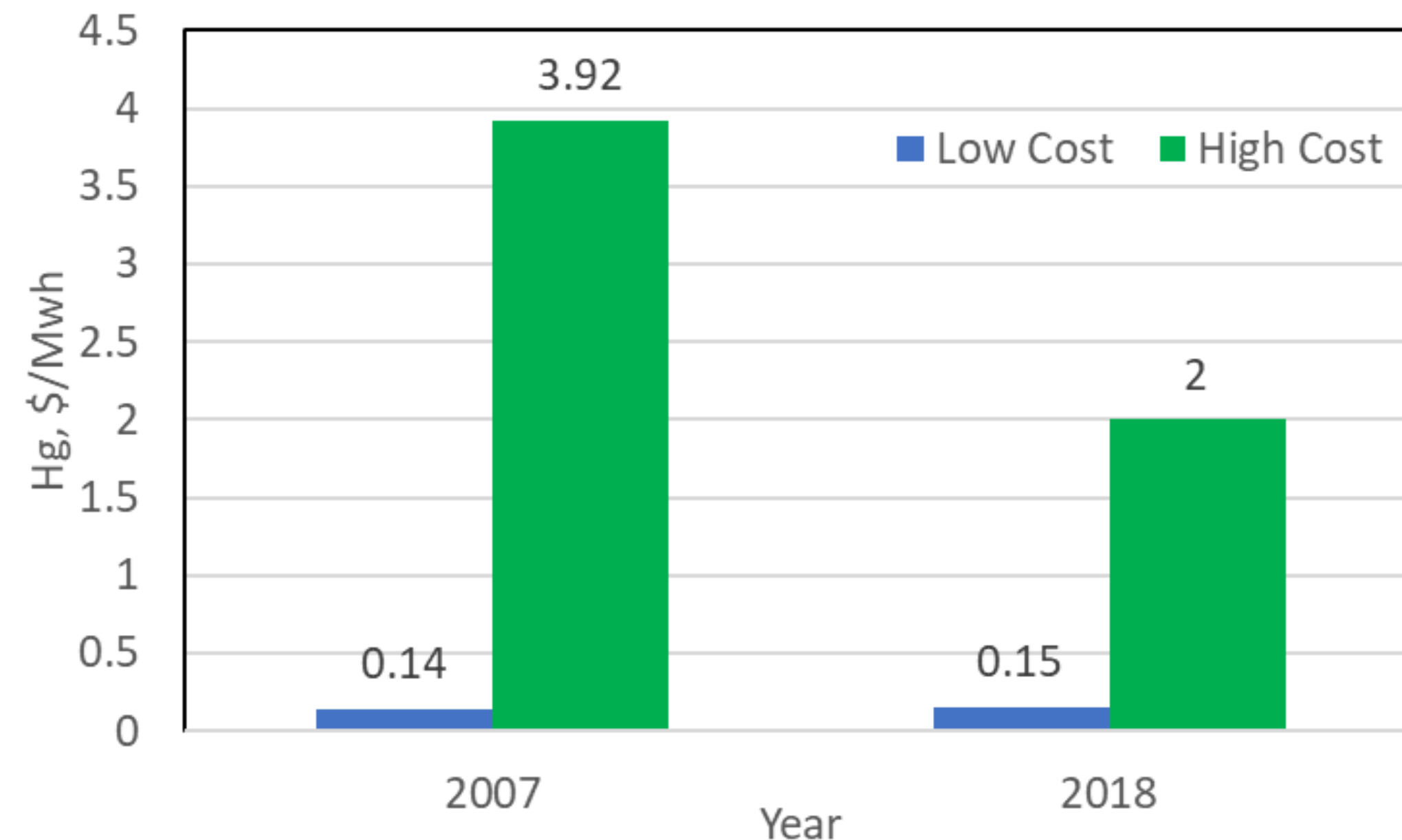
- Technologies derived from municipal solid waste Hg removal
- Early basic activated carbons

## Two Decades of Development

Corporate and government investment in R&D has significantly lowered Mercury control costs, leading to:

- Development of new technologies
- Development of new sorbents
- More accurate and reliable measurement techniques

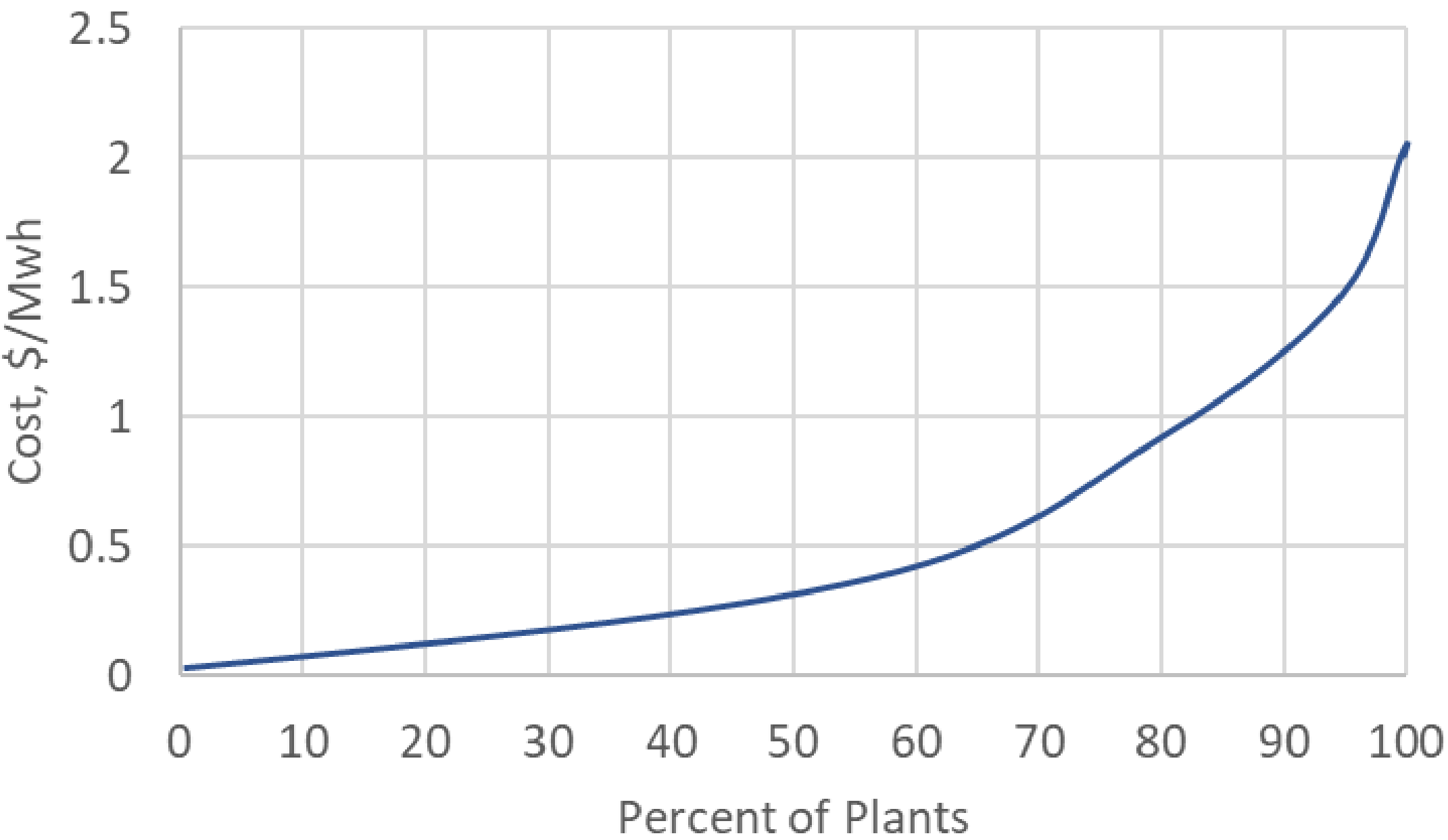
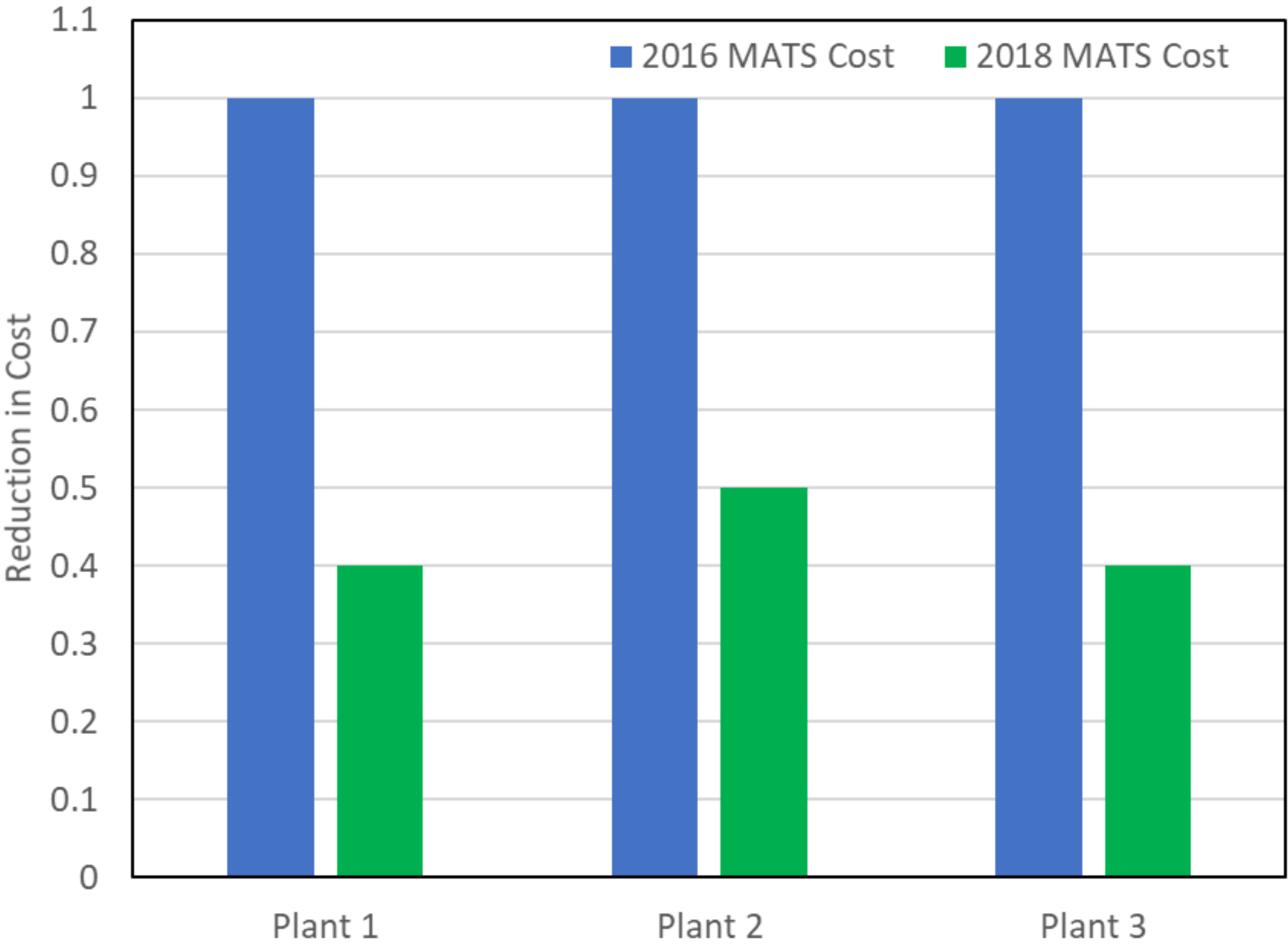
Market dynamics have lowered product pricing



# Current 2018 Mercury Air Toxic Control (MATS) Cost

Around 80% of plants are **spending \*\$1/Mwh or less** in 2018 for Hg control.

Control costs can be much higher (\$2+/Mwh) for challenged plants.



\*Based on ME<sub>2</sub>C data.



# U.S. Coal-fired EGU Market: Hg Regs

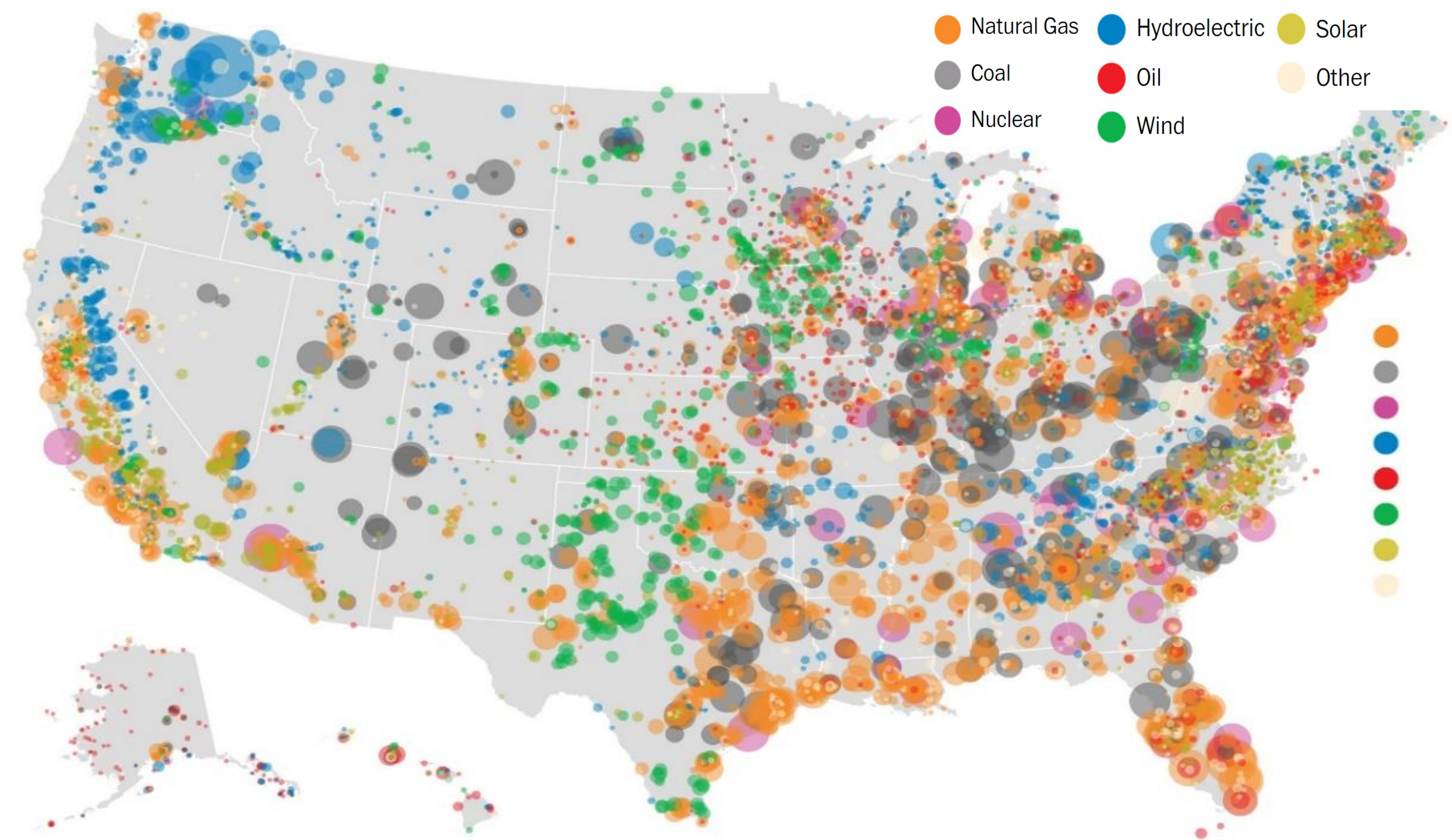
- Coal must compete with renewables and natural gas for generation.
- Renewables are dispatched first.
- Long-term low gas prices have changed dispatch orders in utility fleets.
- Increased costs associated with current and pending regulations.

## Hg Regulations (Existing Plants)

Coal Type	Hg Limit, lb/TBtu*	Hg Concentration, µg/dNm3 (@6% O2)**
Lignite	4.0	4 - 5
Subbituminous	1.2	1.2-1.6
Bituminous	1.2	1.2-1.6

\*30-day rolling average for Units greater than 25 Mw

\*\*Approximate, based on typical heat rate

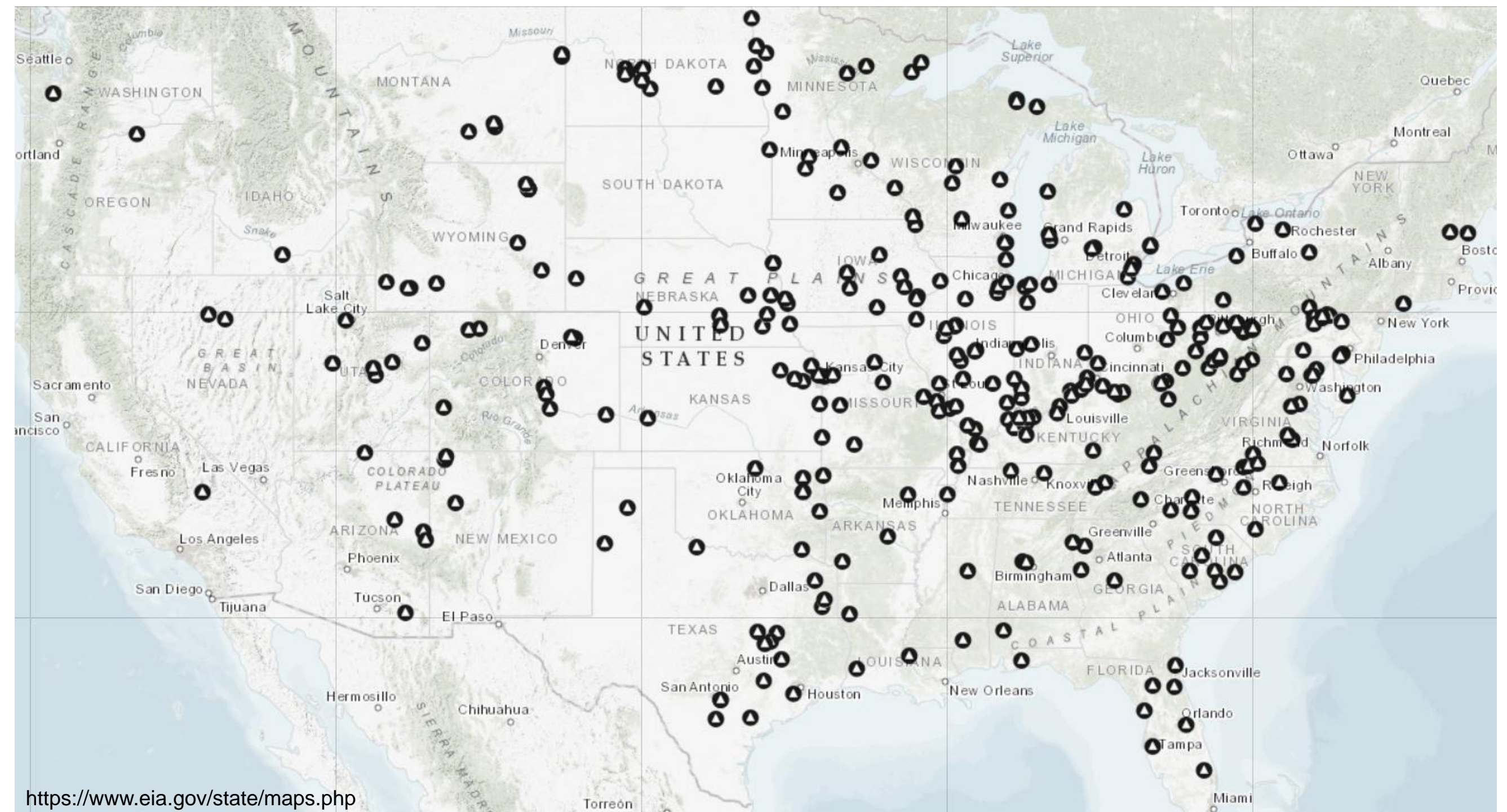


Map Source: Muyskens, John; Keating, Dan; Granados, Samuel. Mapping How the United States Generates its Electricity. The Washington Post. Online, Published 31 July 2015. [https://www.washingtonpost.com/graphics/national/power-plants/?utm\\_term=.7c077d47222](https://www.washingtonpost.com/graphics/national/power-plants/?utm_term=.7c077d47222)



# U.S. Coal-fired EGU Market

- 90% of U.S. coal is used for power generation
- US is the 3<sup>rd</sup> largest producer of coal (661 Millions of Tons)<sup>1</sup>
- US exported 63 Millions of Tons of Coal<sup>2</sup>
- Coal is the most-used source of power in 18 states<sup>3</sup>
- The U.S. exported 97 million short tons (MMst) of coal in 2017, a 61% increase from 2016. Exports to Asia doubled; Europe remains the largest recipient of US coal.<sup>4</sup>



<sup>1</sup><https://www.worldatlas.com/articles/15-countries-most-dependent-on-coal-for-energy.html>

<sup>2</sup><https://www.worldatlas.com/articles/coal-production-by-state.html>

<sup>3</sup><https://www.eia.gov/todayinenergy/detail.php?id=37034>

<sup>4</sup><https://www.eia.gov/todayinenergy/detail.php?id=35852>

# Mercury Capture Technologies

*Innovation & Results Across the Coal Market*



**ME<sub>2</sub>C**  
Midwest Energy Emissions Corp



# Technologies in Use Throughout The Coal-fired Market

## Scrubber & SCR Combo

*Infrastructure Alternative*

- Utilized to achieve high SO<sub>x</sub> & NO<sub>x</sub> reduction for earlier Clean Air Act regulations
- Large, complex and capital intensive systems with extended plant disruptions
- Hundreds of millions of dollars for a medium EGU
- Modest mercury capture impact
- Requires sorbent add-on technology
- Requires Hg reemission additive

## PAC or BAC

*Sorbent Alternative*

- Effective at reduction levels of 70% or less with minimal material required
- Over 70% of PAC or BAC installations are utilizing ME2C's [SEA] process to optimize cost and effectiveness.
- Above 80% reduction levels, injection rates dramatically increase, causing ash and BOP issues
- Costs can range from \$2M to \$10M per year at 80% to 90% mercury removal

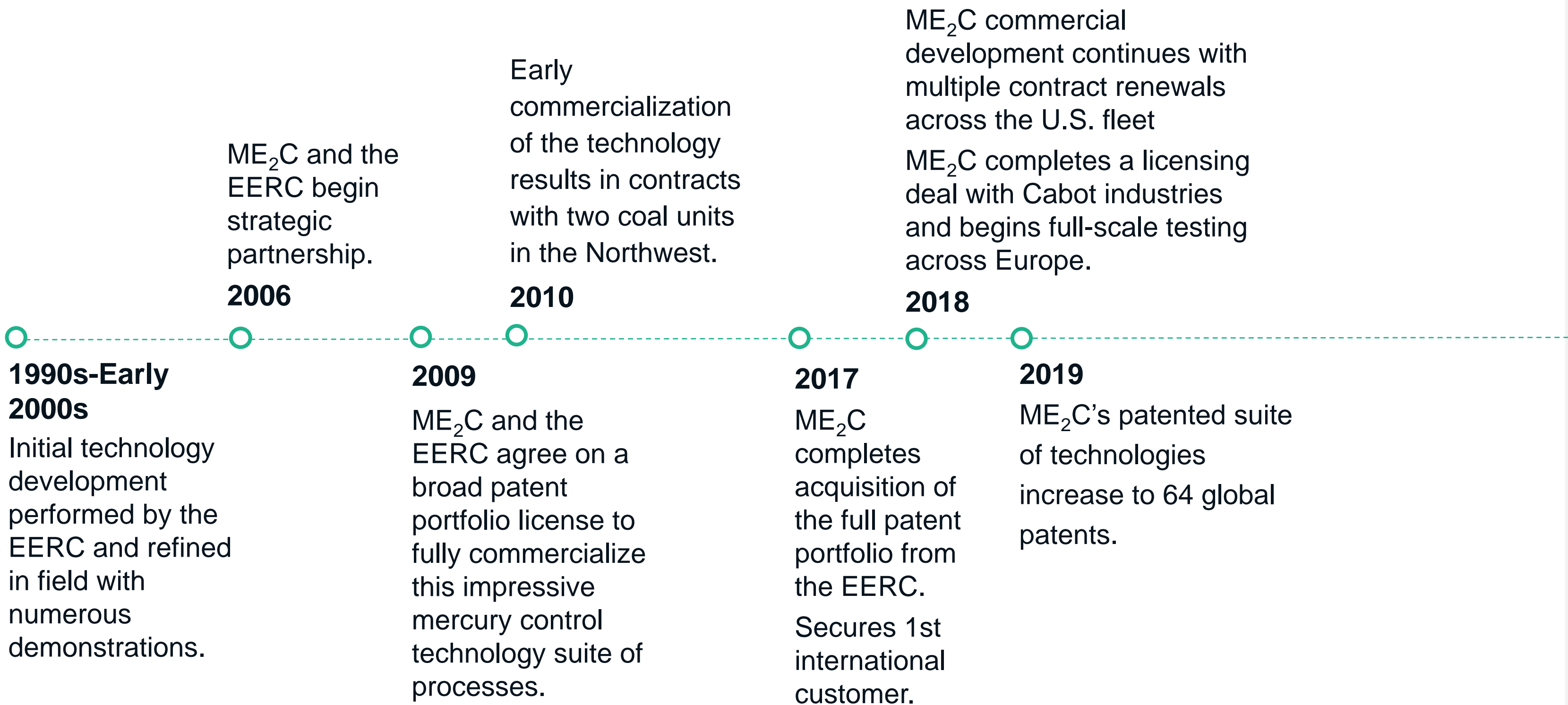
## ME<sub>2</sub>C's SEA® Technology

*Sorbent Alternative*

- Maximum efficiency in use of materials
- Allows for >90% mercury removal, meeting or surpassing new emissions regulations
- Least plant disruption
- Will maintain fly-ash salability
- Most economical, typically 40-50% less than BAC or PAC for O&M, greater savings EGUs

# Timeline of Two-Part Technologies Development & Commercialization

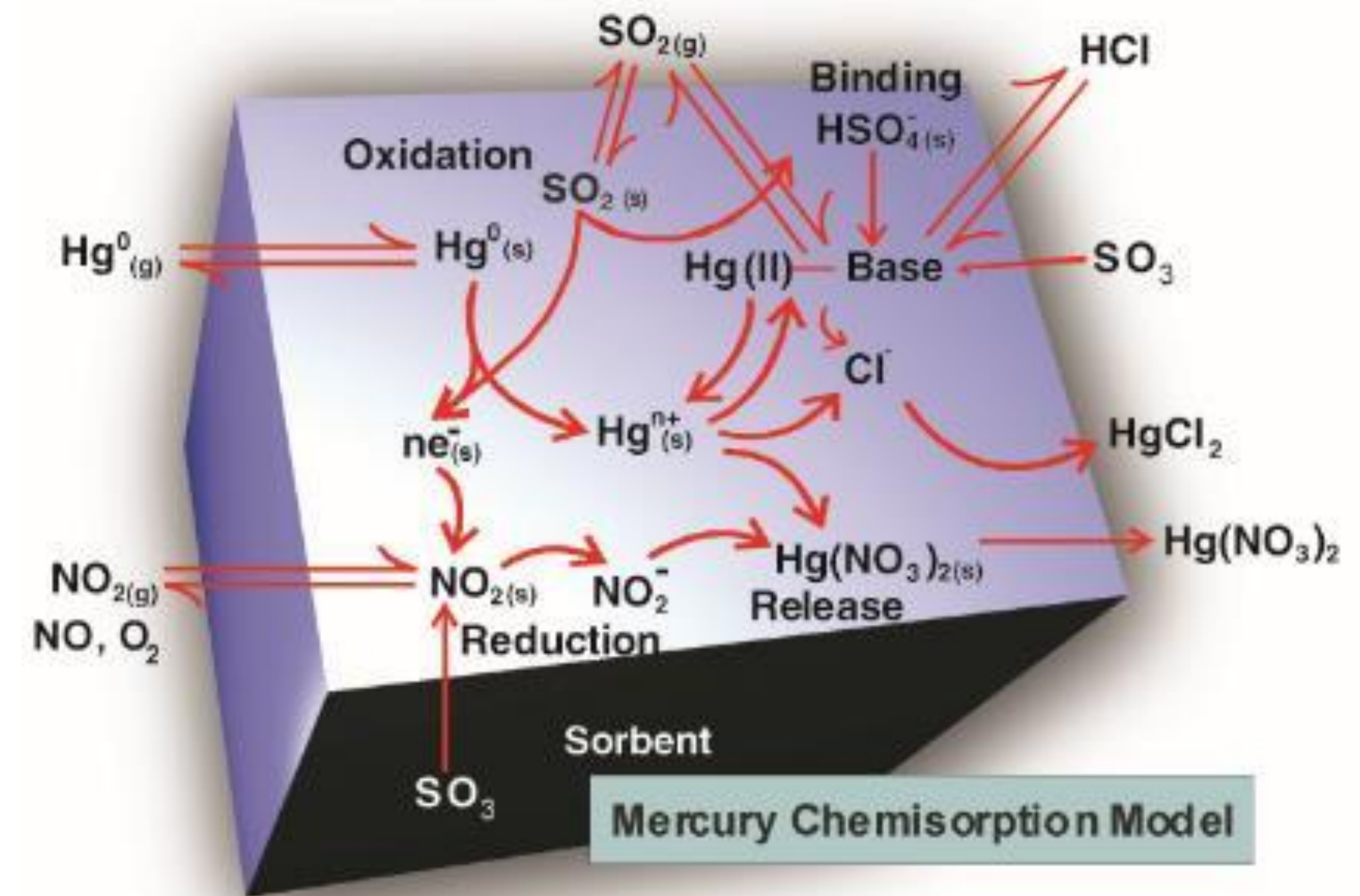
- In 1992, The Center for Air Toxic Metals® (CATM®) at the University of North Dakota Energy & Environmental Research Center (EERC) was established by the U.S. Environmental Protection Agency to focus national research efforts on trace element emissions.
- ME<sub>2</sub>C partnered with EERC to commercialize their technologies, resulting in a decade of growth.
- SEA® patented technologies are field-proven and have been refined during the last 20 years



- Since early 1990s, roughly \$90M spent on research, development & commercialization
- ME<sub>2</sub>C patented technologies are international in scope
- ME<sub>2</sub>C has contracts with major utility customers across North America
- 70% of the U.S. fleet is using this two-part approach
- **The U.S. is currently a leading exporter of proven, effective mercury capture technologies.** Cabot and ME<sub>2</sub>C are commercializing these technologies across Europe

# Mercury Control is Complex

- Sorbent interaction model developed at EERC shows complexity.
- Numerous reactions happening at the same time on a given sorbent particle.
- Interactions are further complicated by fuel type, boiler type, flue gas composition, emissions control equipment, and plant operations.





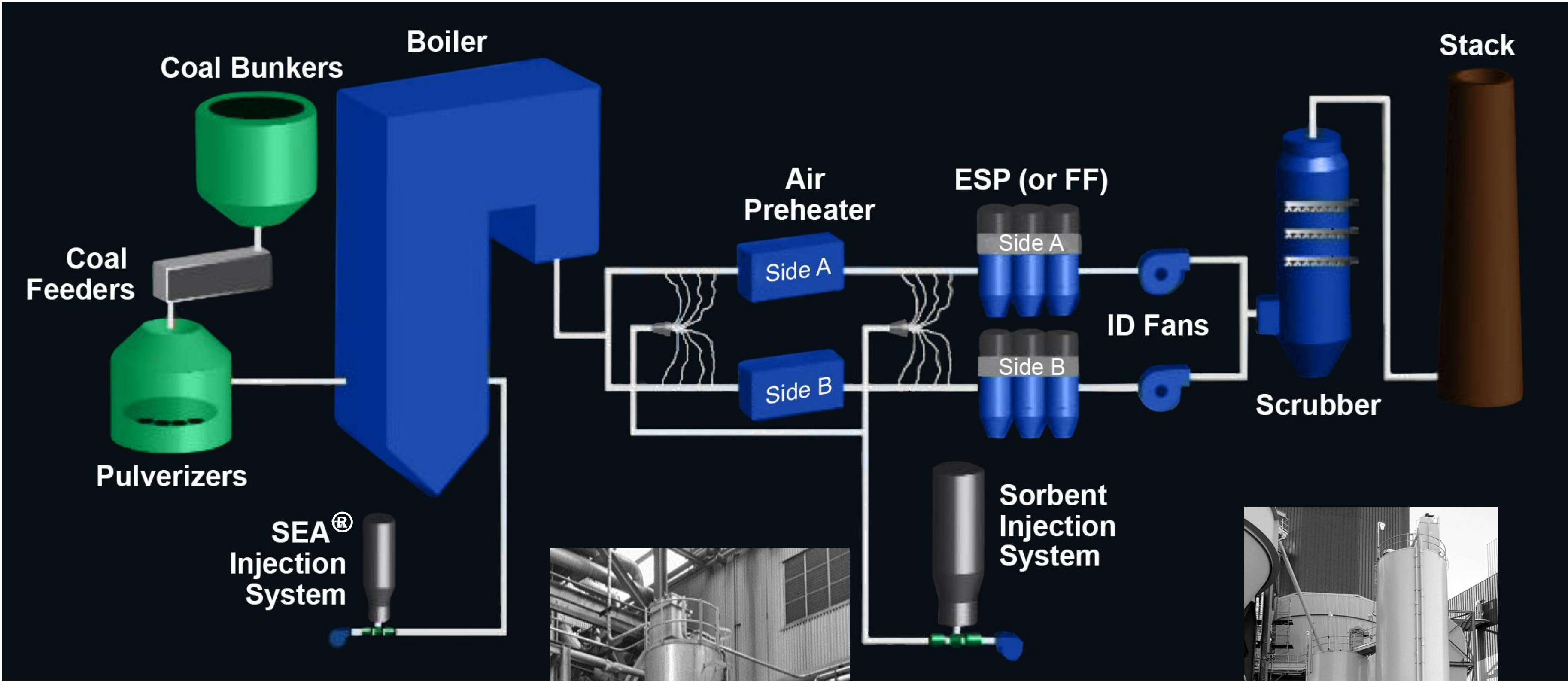
# Proven, Commercial Solution

**Benefits of a two-part,  
patented SEA<sup>®</sup> process:**

SEA enhances the back end  
sorbent's ability to capture  
mercury **by more than 50%** and  
bringing into compliance many  
boilers that otherwise could not  
comply with the traditional back  
end only process



## ME<sub>2</sub>C's Patented SEA<sup>®</sup> Optimizes & Maximizes Sorbent Technology



**Front End SF**  
injected directly  
into the boiler in  
minimal amounts.



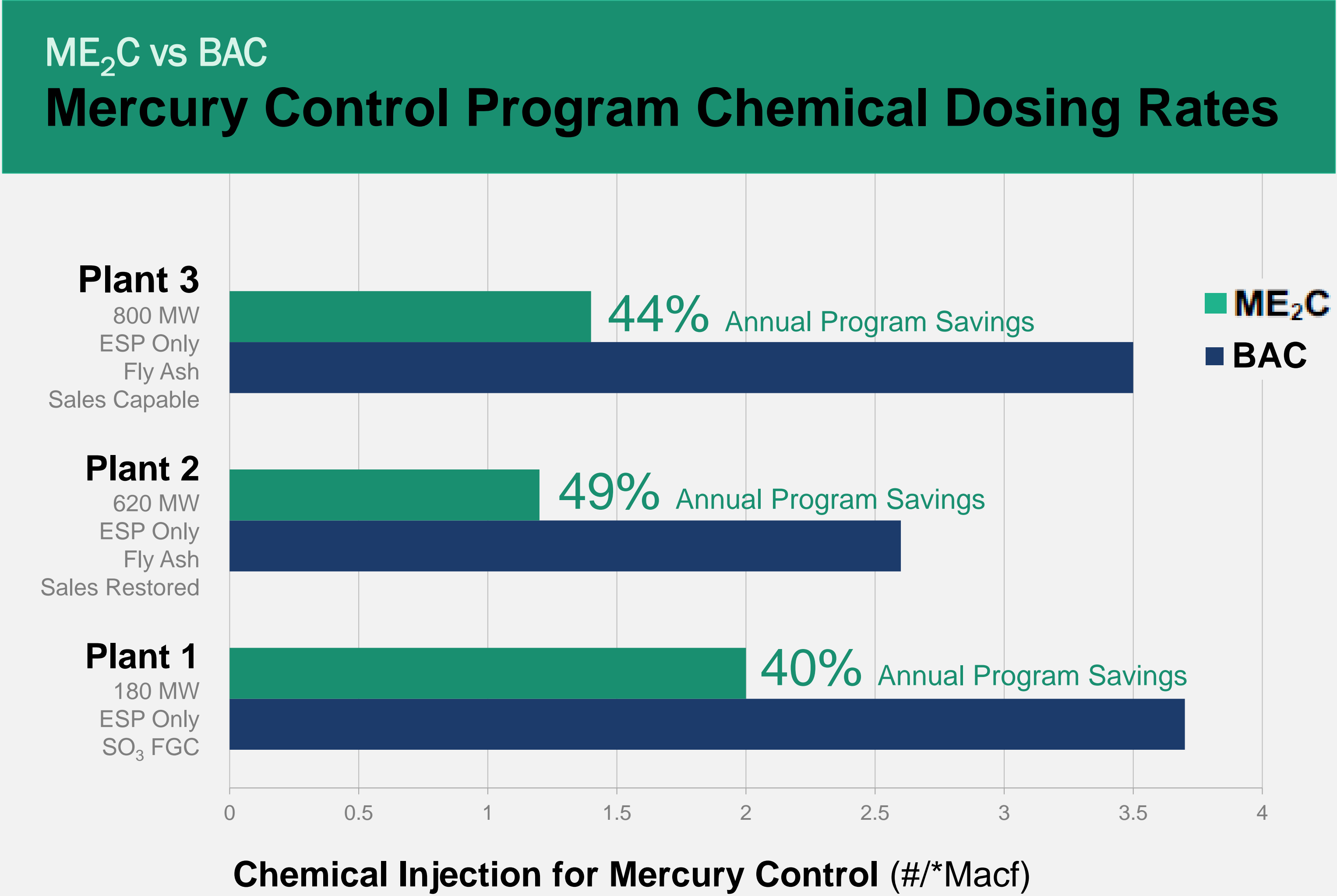
**Back End SB**  
sorbent system  
injected to ensure  
maximum mercury  
capture



Better  
Solution.  
Lower Cost.



*ME<sub>2</sub>C's Competitive Edge*  
Plant cost savings are generally a minimum of 30% and in most cases around 50%—while maintaining capture rate at greater than 90%.



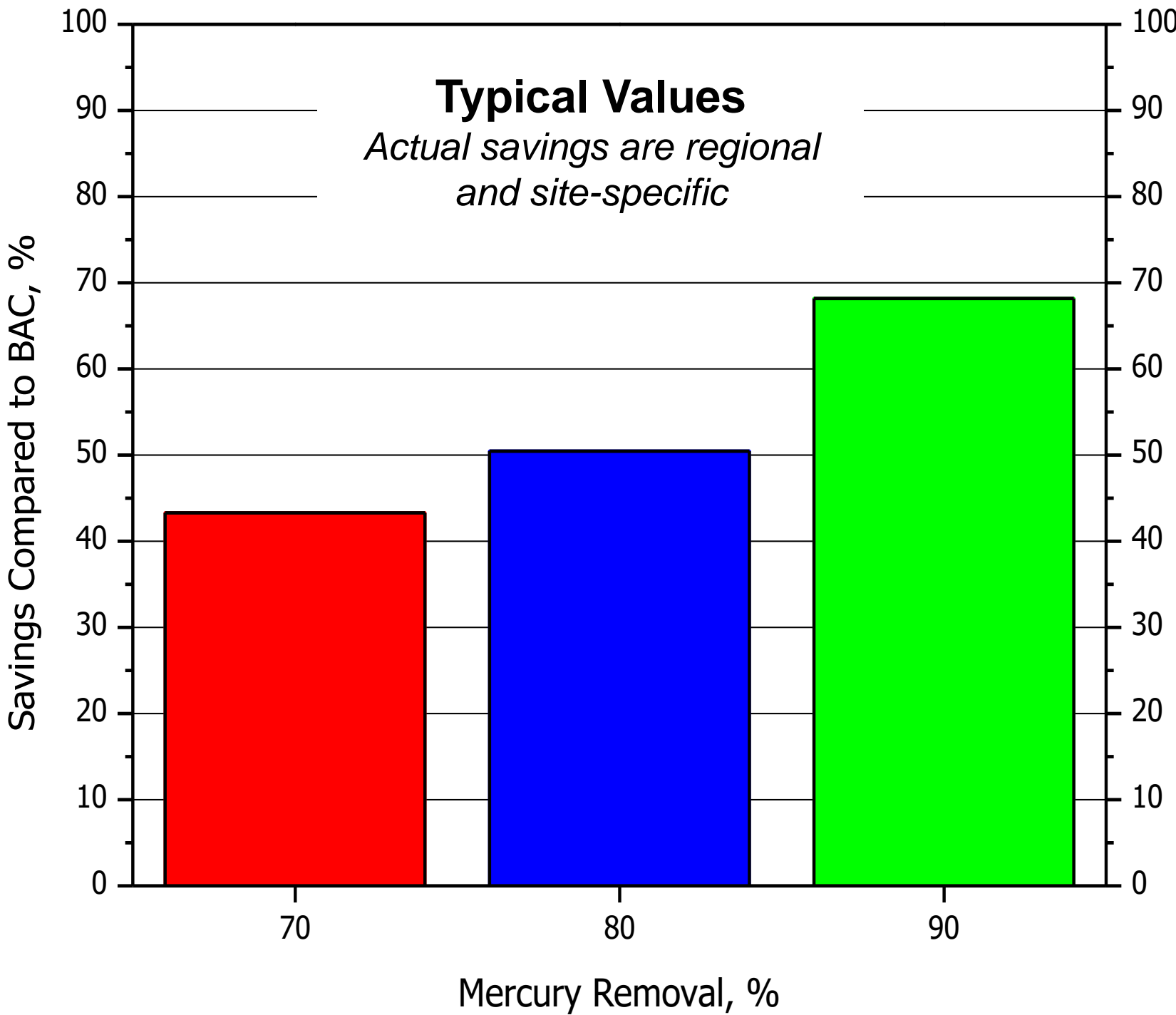
*\*Macf (or, mmacf) = Million Actual Cubic Feet*

# Savings Compared to Other Technologies

## Factors Impacting Mercury Capture Control & Costs

Technology Choice	Technology Material	Technology Confidence
Fuel Blending	Unit Operations	Instrumentation
Injection System Performance	Optimization	Personnel Commitment

Two-Part, SEA® Technology Savings over BAC



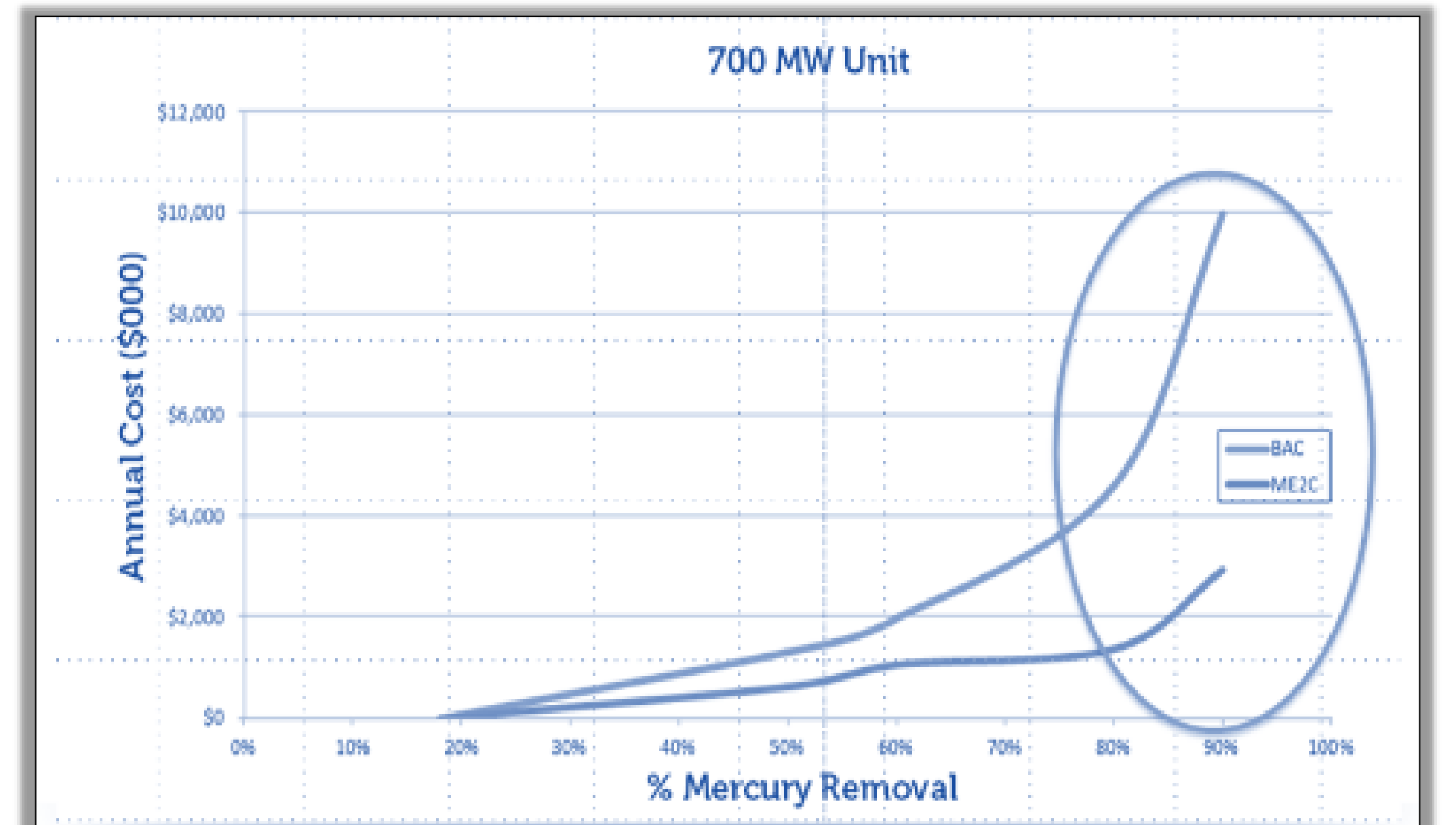
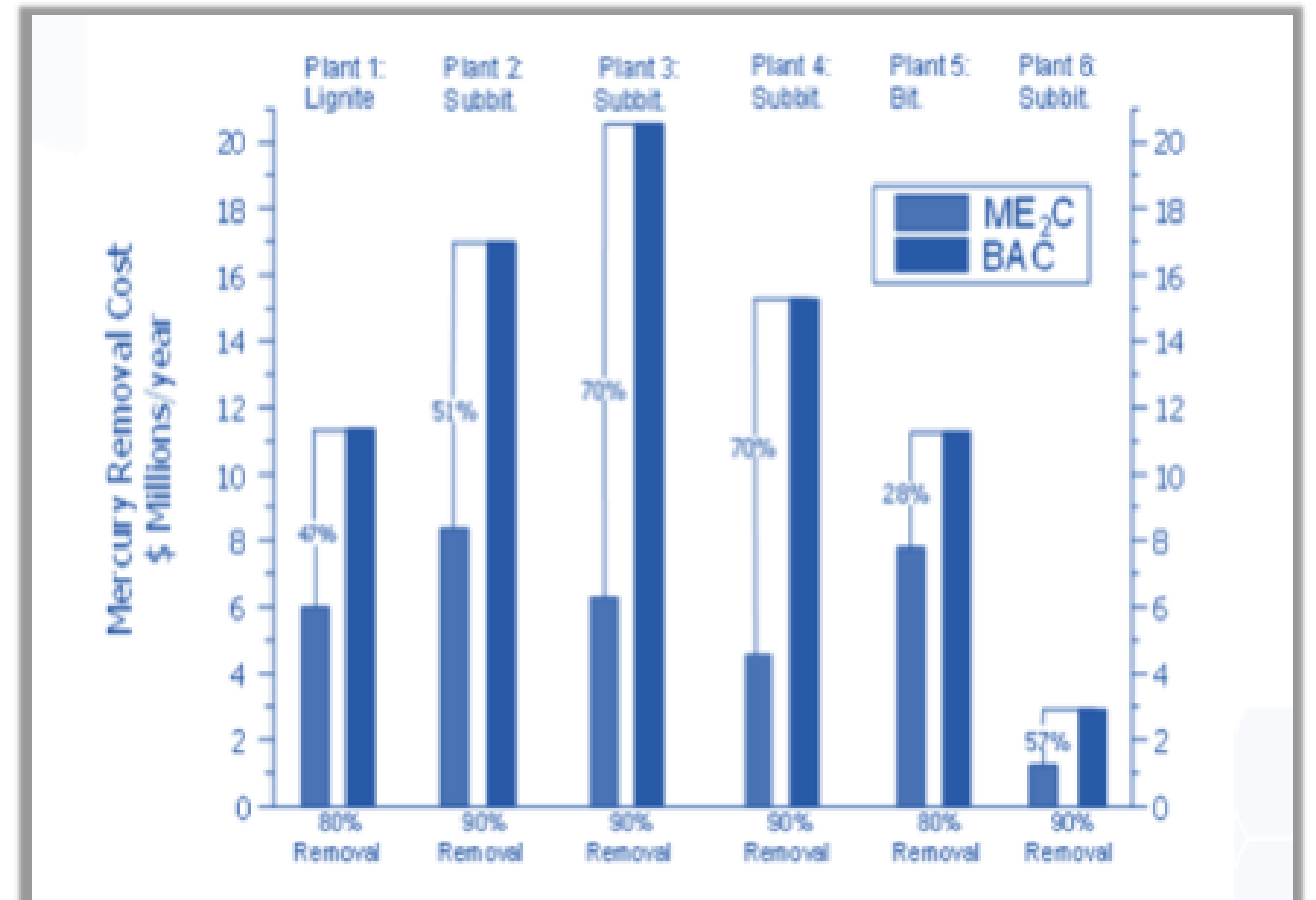


## Mercury Capture Technologies

**BETTER  
SOLUTION +  
LOWER COST =  
SUPERIOR  
PRODUCT**

**ME<sub>2</sub>C focuses on the maximum efficiency in the use of sorbent materials.** As the level of mercury capture escalates, so does the intensity of the process, as mercury emissions are measured in parts-per-trillion.

Across numerous demonstrations of the SEA<sup>®</sup> Technology program, **ME<sub>2</sub>C's cost advantage at 80% and 90% capture rates exceeded 30%, and in many cases, was well over 50%.** Primary cost-effectiveness is just one facet of the ME<sub>2</sub>C value proposition.



# Why Over 50% of U.S. Utilities Choose the Two-Part, SEA<sup>®</sup> Mercury Emissions Capture Approach

## 01 **MATS Compliant**

Guaranteed and proven to remove >90% of mercury.

## 02 **Dynamic, Turnkey Mercury Control**

Product customization with minimal to no downtime during conversion to ME<sub>2</sub>C.

## 03 **Cost-Effective Solution**

Low upfront capital equipment costs with meaningful future operating cost savings and efficiencies over competing solutions.

## 04 **Maximizes Plant Output**

EGU's can operate at full generating capacity without derate due to MATS or other compliance challenges, which can be experienced with competing technologies.

## 05 **Maximizes Efficiency**

ME<sub>2</sub>C process minimizes sorbent material use (up to 50% less than competitors) with maximum results, enabling boilers to avoid ESP overloading, backend corrosion and the degradation of fly-ash.

## 06 **Fly-Ash Income Advantage**

Fly-ash is a by-product of coal combustion that is sold to cement manufacturers worldwide. Competing solutions often render the fly-ash unusable; however, ME<sub>2</sub>C preserves the fly-ash integrity.

# Coal's Global Market & Expansion

*U.S. Exports Leading Mercury Technologies Across the EU & Asia*



**ME<sub>2</sub>C**  
Midwest Energy Emissions Corp



# U.S. Exportation of Leading Mercury Emissions Capture Technologies

- 140 Nations signed a global treaty to eradicate mercury emissions from air and water in October 2013 under the Minamata Convention
- ME<sub>2</sub>C expects Europe to become a significant opportunity by 2021 with testing to commence in 2018, recent Cabot agreement validates this expectation
- Asia will follow with commercialization by 2022 and **represents 6x-8x** the size of the U.S. Market
- Full-scale demonstrations are currently underway across Europe.
- The expertise of our staff and R&D partners positions **ME<sub>2</sub>C as a global leader in mercury control** and other regulated gases.
- Technologies' expansion into China and South Asia is currently under discussion with Asian partners.

*"In response to mandated government regulations, the USA is one of the leading countries in the world today in the field of mercury emissions capture and control... ME<sub>2</sub>C is actively working to export these effective 'born in America' coal technologies across other continents to improve coal emissions worldwide."*

**Richard MacPherson,** *CEO, ME<sub>2</sub>C*



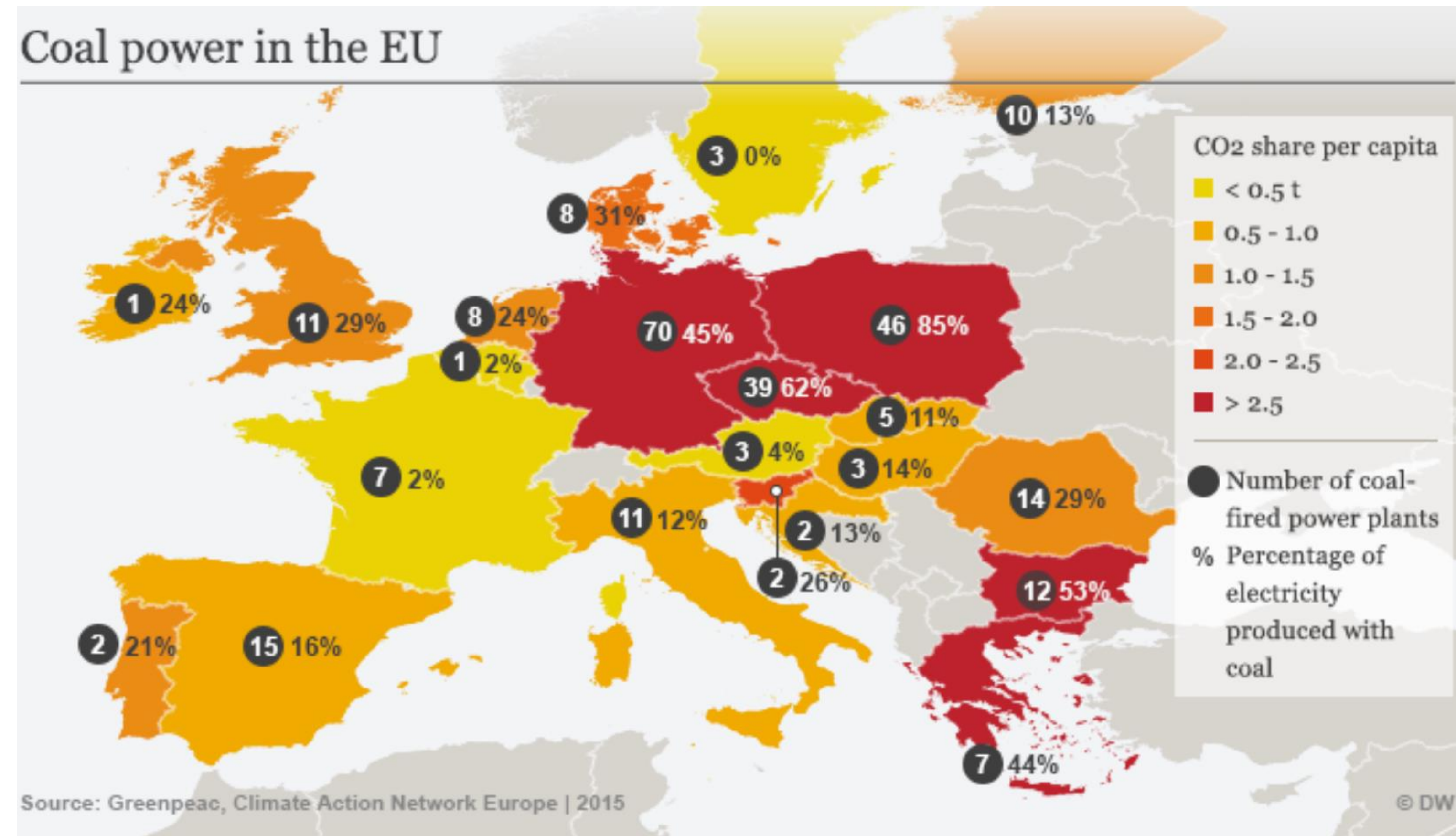
# Europe's Coal-fired Industry

- Europe has approximately 160GW of coal capacity
- Europe's growing coal market is currently more than half of the U.S. capacity of 279GW
- Germany and Poland currently have the largest coal fleets

## Europe's Current Mercury Capture Technology

Currently, 2/3 of Europe's coal-fired units use Wet Flue Gas Desulfurization (WFGD) for mercury emissions capture

- 914 Boilers in Eastern Europe; 538 Boilers in Poland
- **85% of Power from Coal**
- 2/3 of Plants are 30+ years old.
- **30 New Plants to be constructed through 2070.**



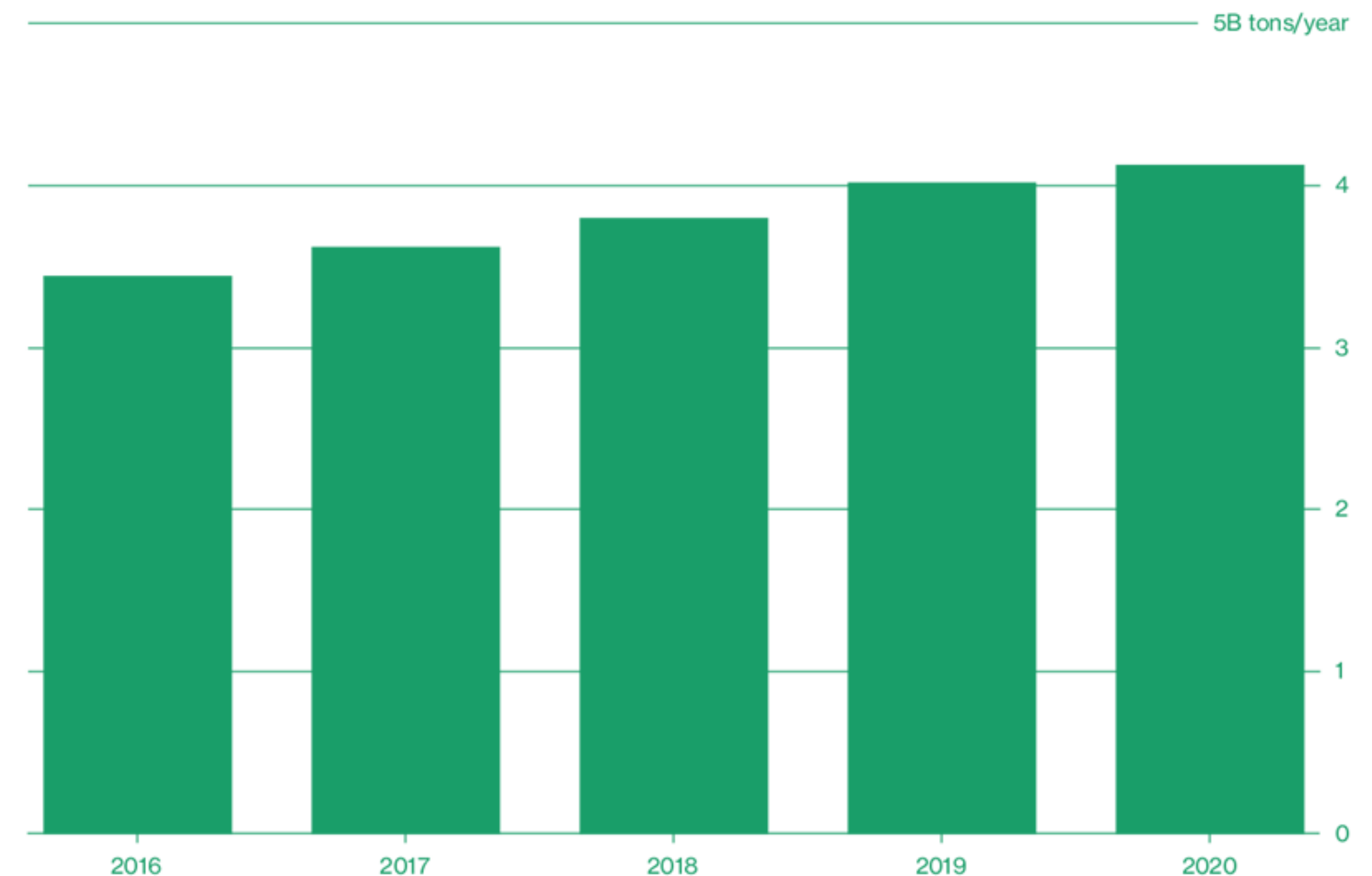


# China, the world's largest coal producer, continues to increase coal-fired power by more than 25% through 2020

- China's current coal-fired power (935,472 MW) and will increase by 259 GW (growing by nearly the size of the entire U.S. at 266 GW).
- According to a 2018 report by Coalswarm, a coal research and advocacy group, China is in the midst of a five-year growth plan that began in 2016 and culminates in 2020.<sup>1</sup>

## Fuel the Fire

China's coal capacity will increase amid government efforts to curb pollution

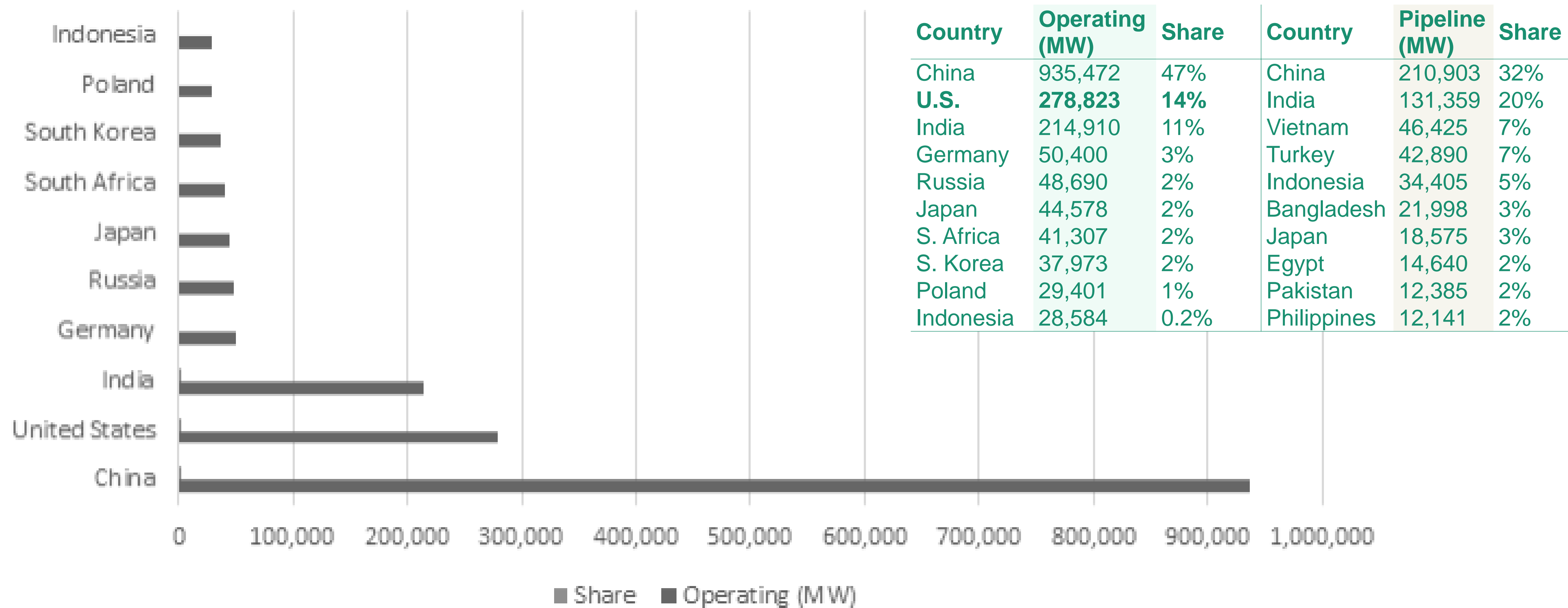


Note: 2018-2020 figures are estimates  
Data: Wood Mackenzie; graphic by Bloomberg Businessweek

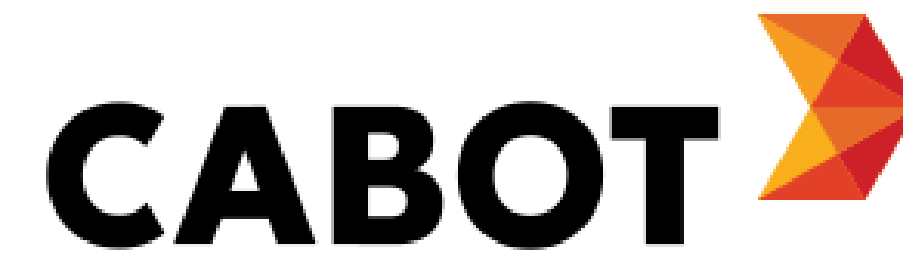
<sup>1</sup>Willuhn, Marian, PV Magazine. "China to add 259 GW of Coal Capacity Satellite Imagery Shows". September 2018



# The World's Top 10 Coal-Powered Countries



# U.S. Exports Leading Mercury Capture Technologies Across Europe



- ME<sub>2</sub>C entered into a licensing agreement in 2018 with Cabot Corporation (NYSE: CBT) representing a significant long-term opportunity across Europe
- Cabot leveraging ME<sub>2</sub>C's unique IP portfolio and team expected to result in accelerated growth for both entities
- European market is at least double the size of the domestic market with 1,384 coal-fired electric generating units (EGUs)
- European legislation regarding mercury capture expected to be in effect by 2021
- Initial demonstrations currently underway in leading coal-powered countries



# U.S. Leading Exportation of Mercury Emissions Capture Technologies in Global Coal-Fired Power Market



## Key Takeaways

**SEA® Technology Advancement.** Two-Part, SEA® technologies have been developed and advanced over the last 20 years. Successfully operating at numerous plants throughout North America. Providing significant savings and mercury emissions capture to 70% of the U.S. coal fleet.

**SEA® Technology Effectiveness.** Mercury removal of greater than 90-95%.

**SEA® Technology Adaptability.** Flexible and tunable technology platform that can adjust to changes in load, fuel, and operations.

**SEA® Technology Impacts.** Minimal-to-no impacts on plant and operations.

**SEA® Technology Cost.** Has shown to be among the lowest cost Hg control solution.

**SEA® Technology Availability.** Provided by Cabot-ME<sub>2</sub>C in Europe.



## Midwest Energy Emissions Corp

### Corporate Office

670 D Enterprise Drive  
Lewis Center, OH 43035

Main: 614 505 6115

[www.midwestemissions.com](http://www.midwestemissions.com)

### R&D Center

311 South 4<sup>th</sup> Street, Suite 118  
Grand Forks, ND 58201

### President & CEO

Rick MacPherson

Direct: 512 888 3815

[rmacpherson@midwestemissions.com](mailto:rmacpherson@midwestemissions.com)

*A Powerful Combination of Science and Engineering*



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