CIBO Estimated Capital Costs For Air Pollution Control Equipment For Coal-Fired Industrial Boilers[i]

Pollutant	Particulate Matter (PM)	Hydrogen Chloride (HCl)	Carbon Monoxide (CO)	Dioxin/Mercury (Hg)
Likely Additional Control Required	Fabric Filter (FF)	Scrubber (e.g., spray dryer or wet scrubber)	Catalytic Oxidation (CATOX) or other combustion improvement projects	Carbon Injection (CI)
# of Coal-Fired Boilers	259 of the 544 coal-fired units will need a new FF or an upgrade to their current FF or electrostatic precipitator (ESP).	380 of the 544 coal-fired units need scrubbers or upgrades	293 of the 544 coal-fired units need CATOX or combustion improvements	538 of the 544 coal-fired units need CI
Comments/ Assumptions	• If a unit did not already have a FF or ESP and there was information in the EPA database that indicated the unit cannot meet the limit or there was no emissions information, we assumed a new FF based on EPA baseline emission factors for various control devices for coal fired boilers[ii]. • If the unit already had a FF or ESP and there was information in the EPA database that indicated the unit cannot meet the limit, we assumed an upgrade to the existing FF or ESP. • If unit had a FF and no emissions information, we assumed no upgrade necessary. • If unit had ESP and no emissions information, we assumed upgrade to ESP was necessary based on EPA baseline emission factors. • FF base capital cost $7 MM[iii]; FF/ESP base upgrade capital cost $4 MM. [iv]	• If there was information in the EPA database that indicated the unit cannot meet the limit, we assumed either a scrubber upgrade or new scrubber depending on whether the unit currently had a scrubber.[ii] • If there was no emissions information in the database and the unit did not already have some type of scrubbing control, we assumed a new scrubber would be needed. • Scrubber base capital cost $8 million; scrubber base upgrade capital cost $4 million.[iv]	• If there was information that indicated the unit cannot meet the limit, then we assumed that capital would be necessary to either perform combustion/fuel feed improvements or other boiler improvement projects to reduce CO or install a CO catalyst. [ii] • Base capital cost of $3 million was assumed for CO controls (either projects to improve combustion or fuel feed or installation of a CO catalyst).[iv] • NOTE: It is uncertain whether a CO catalyst can be applied effectively and efficiently to coal-fired industrial boilers.	• Based on EPA baseline emission factor memorandum, if boiler had no Hg emissions data, we assumed boilers with fabric filters and venturi scrubbers would need CI. • Based on EPA baseline emission factor memorandum, we assumed all coal fired boilers with no DF emissions information needed CI. [ii] • If there was information in the EPA database that indicated the unit cannot meet the proposed limit, we added carbon injection. • A fixed cost of $1 million was assumed for installation of a Carbon Injection system for Hg and/or dioxin control.
Total Capital Cost to Coal-Fired Boilers: <u>$5.1 billion</u>	$1.2 billion	$2.7 billion	$711 million	$538 million

Pollutant	Particulate Matter (PM)	Hydrogen Chloride (HCl)	Carbon Monoxide (CO)	Dioxin/Mercury (Hg)
Capital Cost Per Unit	• Range of Costs Per Unit: $719k to 14.3MM • Average Per Unit Cost: $4.5MM[v]	• Range of Costs Per Unit: $1.2 to 25.9MM • Average Per Unit Cost: $7.0MM	• Range of Costs Per Unit: $435k to 9.7MM • Average Per Unit Cost: $1.3MM	• $1 million per unit

[i] The chart includes data for 544 coal-fired units >10 MMBtu/hr. The 544 units are derived from 540 units in the coal MACT subcategory in EPA's Boiler MACT survey database available here: http://www.epa.gov/ttn/atw/boiler/boilerpg.html#TECH and 4 units in the forest products industry that are coal fired boilers at major sources but were not in EPA's database. Capital cost estimates are not intended to represent a worst case analysis. Rather, they represent typical retrofit costs for the various scenarios based on published reports, industry information on specific project costs, EPA reports or control device fact sheets, or actual BACT or BART analyses submitted to permitting agencies. A primary resource was the document "Evaluation of Air Pollution Control Costs for the Pulp and Paper Industry," prepared by National Economic Research Associates (NERA) in May 2003. Note that costs were not scaled from the date of the reference used to 2011 dollars as the intent was to develop an order of magnitude estimate for each control scenario.

[ii] Where no emissions data were available in the EPA database for a particular type of unit, EPA's baseline emission factors identified in the memorandum "Revised Development of Baseline Emission Factors for Boilers and Process Heaters at Commercial, Industrial, and Institutional Facilities," January 2011, Appendix D were used to determine if typical emissions from the type of unit (fuel/design/control device) would meet the MACT limits.

[iii] MM stands for million

[iv] The base cost assumes a size of 250 MMBtu/hr, the boiler specific cost was calculated using a 0.6 power function and the actual boiler size in MMBtu (e.g., for a 100 MMBtu/hr boiler, the cost is the base cost times $(100/250)^{0.6}$).

[v] Average cost was calculated by adding up the per unit cost for every unit requiring controls to get the total cost for all units and then dividing the total cost by the number of units requiring controls.