CIBO Estimated Capital Costs For Air Pollution Control Equipment For Biomass-Fired Industrial Boilers and Process Heaters

Pollutant	Particulate Matter (PM) or Total Selected Metals (TSM)	Hydrogen Chloride (HCl)	Carbon Monoxide (CO)	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 Biomass-Fired Boilers and Process Heaters	248 of the 487 biomass-fired units will need a new FF or an upgrade to their current FF or electrostatic precipitator (ESP).	18 of the 487 biomass-fired units need scrubbers or upgrades	301 of the 487 biomass-fired units need CATOX or combustion improvements	33 of the 487 biomass-fired units need CI (cost of required PM control device included in PM column as necessary)
Comments/ Assumptions	• If a unit did not already have a FF or ESP and there was information 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[i]. • If the unit already had a FF or ESP and there was information that indicated the unit cannot meet the limit, we assumed an upgrade to the existing FF or ESP. • FF base capital cost $7 MM[ii]; FF/ESP base upgrade capital cost $4 MM. [iii]	• 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. • If there was no emissions information in the EPA database, we assumed the unit would meet the HCl limit without additional control. [i] • Scrubber base capital cost $8 million; scrubber base upgrade capital cost $4 million.[iii]	• 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. • 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).[iii] • NOTE: It is uncertain whether a CO catalyst can be applied effectively and efficiently to biomass-fired industrial boilers.	• If there was information that indicated the unit cannot meet the limit for mercury, we added carbon injection. [i] • A fixed cost of $1 million was assumed for installation of a carbon injection system for Hg control, as these systems do not vary much in cost by boiler size.
Total Capital Cost to Biomass-Fired Units: $2.06 billion	$1.2 billion	$144 million	$636 million	$33 million
Capital Cost Per Unit	• Range of Costs Per Unit: $769k to 21.3MM • Average Per Unit Cost: $5.0MM[iv]	• Range of Costs Per Unit: $4.5 to 17.1MM • Average Per Unit Cost: $9.6MM	• Range of Costs Per Unit: $435k to 8.3MM • Average Per Unit Cost: $2.1MM	• $1 million per unit

[i] 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 2012, Appendix D were used to determine if typical emissions from the type of unit (fuel/design/control device) would meet the MACT limits.

[ii] MM stands for million

[iii] 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 or process heater, the cost is the base cost times $(100/250)^{0.6}$).

[iv] 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.