Industrial Boiler MACT Cost Analyses for Coal and Liquid Units

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Today's Presentation

- Quick background on MACT limits
- Original CIBO/URS cost study
- Revised cost study
- New analysis of coal versus natural gas operating cost

How MACT limits are developed

- 2004 rule looked at performance of control technologies, so MACT limits were tied to use of a control technology. Only 2 subcategories with limits for existing units – large solid fuel, large solid limited use.
- 2010/2011/2013 rules looking at lowest 12 percent of emissions values for those units that have stack test data (so even if there are 500 units in a subcategory, if only 100 have stack test data, only 12 units make up the MACT floor limit.
- A 99 percent upper prediction limit (99 UPL) is calculated from the run by run stack test data for the top performers.
- MACT limits may not represent use of a particular technology, but may represent inherently low emitting or over designed units. The only 2 coal-fired boilers with activated carbon injection are not among the top performing solid fuel units for Hg.
- This is EPA's most expensive air rule.

URS/CIBO Boiler MACT Cost Study

- EPA Boiler MACT database – 1,742 units with numerical limits.
- Our MS Excel spreadsheet takes data from the EPA Boiler MACT database, assigns either average site specific data or baseline emission factor developed using data from similar fuel/design units to each unit. Emissions and existing control device information are used to determine whether control upgrades are required and estimate capital cost.
- The initial analysis assumed that all units would install controls to comply if emissions were above the limits.
- Base capital costs for PM, HCl, CO controls scaled by boiler size. If Hg controls needed, capital cost is fixed at $1M.
- Cost spreadsheet can be used to determine how many units in a particular subcategory are expected to be able to comply with each limit or all limits with no capital cost expenditure.

Base Capital Cost Analysis

Base Control – Unit Size	250 MMBtu/hr
Fabric Filter Base Cost	$7,000,000
Scrubber Base Cost	$8,000,000
Scrubber/FF/ESP upgrade Base Cost	$4,000,000
Carbon Injection for Hg (not scaled with size)	$1,000,000
Combustion/Fuel System Improvements for CO for Biomass Wet Stokers - Base Cost	$6,000,000
Coal stokers with CO>500 ppm and no existing NOx controls, increase base cost to account for addition of NOx controls to prevent NOx increase with CO decrease	$5,000,000
Combustion/Fuel System Improvements or Catalyst for CO – all other units Base Cost	$3,000,000
Control Cost = Base Cost x $(\text{actual unit size}/250)^{0.6}$	

Summary of Base Capital Cost Analysis

Fuel	Sum of PM Upgrade Cost	Sum of HCl Upgrade Cost	Sum of Hg Upgrade Cost	Sum of CO Upgrade Cost	Sum of Total Capital Cost
Bagasse	$0	$0	$1M	$49M	$50M
Coal	$1.2B	$3.3B	$71M	$1.0B	$5.6B
Dry Biomass	$18M	$28M	$5M	$96M	$147M
Heavy Liquid	$1.1B	$1.4B	$303M	$4.9M	$2.9B
Light Liquid	$878M	$1.2B	$254M	$0	$2.3B
Process Gas	$0	$28M	$1M	$0	$29M
Wet Biomass	$865M	$129M	$6M	$102M	$1.1B
Grand Total	**$4.1B**	**$6.1B**	**$641M**	**$1.3B**	**$12.1B**

Subcategory	Total # Units	# No Capital Cost Units	% No Capital Cost Units
Biomass Wet Stoker	290	135	47%
Biomass Kiln-Dried Stoker	70	50	71%
Biomass Fluidized Bed	24	18	75%
Biomass Dutch Oven/Pile	15	13	87%
Biomass Suspension Burner	48	45	94%
Biomass Fuel Cell	14	12	86%
Biomass Hybrid Suspension Grate	20	7	35%
Coal pulverized	185	31	17%
Coal stoker	387	10	3%
Coal Fluidized Bed	34	13	38%
Coal FB with HE	1	1	100%
Oil - Heavy	295	32	11%
Oil - Light	262	26	10%
Oil non-continental	19	1	5%
Gas2	78	76	97%
	1742	**470**	**27%**

Alternate Cost Analyses

- Original cost analyses assumed all boilers would install controls to reduce emissions and comply with limits. Did not address replacement units or fuel switching.
- EPA's final BMACT cost of $4.7B assumes that any liquid units that do not comply and have ability to fire gas will fuel switch rather than install controls.
- URS/CIBO alternate cost analysis looks at replacement natural gas units and fuel switching for coal and liquid units.
- We also made some refinements to the base cost analysis to reflect differences in approaches between types of boilers that would install controls.

Analysis No. 1

- For all coal and liquid boilers, compare cost of controls to cost of new gas-fired package boiler.
- We assumed that biomass units would not fuel switch to natural gas, so we only looked at coal and liquid units.
- $10MM base cost for 250MMBtu/hr unit, size new unit 3% bigger than existing unit.
- It seems to be more cost effective from a capital cost standpoint for most of the liquid units to make the change, but not as cost effective for most coal units other than stoker units.

Analysis #1 Results

Category	# of Units	Total Capital BMACT Cost	Number Where New Gas Fired Package Boiler Cheaper	Total Capital BMACT Cost with Replacement Unit If Cheaper	Percent Replaced Instead of Controlled
Coal	**607**	**$5.6B**	**381**	**$4.6B**	**63%**
FB	34	$274M	0	$274M	0%
FB-HE	1	$ -	0	$-	0%
PC	185	$1.7B	73	$1.5B	39%
Stoker/Other	387	$3.7B	308	$2.8B	80%
Heavy Liquid	**312**	**$2.9B**	**266**	**$1.9B**	**85%**
Light Liquid	**264**	**$2.3B**	**239**	**$1.5B**	**91%**
Grand Total	**1183**	**$10.8B**	**886**	**$7.9B**	**75%**

Analysis No. 2

- For liquid, coal stoker, and PC boilers – compare cost of controls to cost to upgrade unit to natural gas firing.
  - base stoker conversion cost $1.5MM for 250 MMBtu/hr unit,
  - base PC conversion cost $5MM for 250 MMBtu/hr unit,
  - base liquid conversion cost $1MM for 250 MMBtu/hr unit,
  - size new unit 3% bigger than existing unit.
- Assumed FB boilers would not convert to gas.
- Assumed Biomass boilers would not convert to gas.
- This seems to be very cost effective across the board (from a capital cost standpoint), especially for the liquid units and the coal stoker units.

Analysis #2 Results

Category	# of Units	Total Capital BMACT Cost	Number of Natural Gas Conversion Cheaper	Total Capital BMACT Cost with NG Conversion if Cheaper	Percent Where Fuel Switching is Cheaper than Controls
Coal	**572**	**$5.4B**	**512**	**$1.5B**	**90%**
PC	185	$1.7B	135	$1.0B	73%
Stoker/Other	387	$3.7B	377	$460M	97%
Heavy Liquid	**312**	**$2.9B**	**303**	**$196M**	**97%**
Light Liquid	**264**	**$2.3B**	**264**	**$12M**	**100%**
Grand Total	**1148**	**$10.5B**	**1079**	**$1.8B**	**94%**

Operating Cost Analysis

- Tune up cost
  - $5k for gas and liquid
  - $10k for any stoker, any biomass, any fluidized bed
  - $15k for PC
- Energy assessment cost
  - EPA assumed $75k for facilities in certain NAICS codes. We started with $75k for facilities that have the highest annual heat input (based on unit design capacity and assumed 55% utilization) and then ratioed that cost down for the other 2 tiers of the energy assessment requirement.
- Annual costs for controls and testing based on combination of EPA analysis and site examples.

Analysis No. 3

- Objective is to compare operating cost of keeping current fuel and installing/operating controls as a coal or liquid unit vs. operating costs as a natural gas unit.
- Fuel cost:
  - coal $4/MMBtu
  - gas $4.50/MMBtu if you have gas, $7.50/MMBtu if you don't
  - light liquid $22/MMBtu
  - heavy liquid $17/MMBtu
  - Assumed 55% capacity when calculating annual fuel costs
- Compare the year 1 operating costs – initial tune up, initial energy audit, initial testing, purchase of new monitors, operating cost of control equipment, fuel cost, etc.

Simple Analysis for Site with 2 Units

Cost Item	Coal	Natural Gas at Site	Natural Gas not at Site
Labor	$2,736,000	$952,000	$952,000
APCD Operation	$1,150,000	-	-
Testing/Monitoring	$100,000	$30,000	$30,000
Fuel	$8,431,500	$12,647,250	$20,235,600
Maintenance	$2,000,000	$1,000,000	$1,000,000
Ash disposal	$200,750	-	-
Total	$14,618,250	$14,629,250	$22,217,600

CIBO Analysis #3 Initial Cost

Category	Count of Units	Total Initial BMACT Cost	Count of Natural Gas Conversion Cheaper	Total Initial BMACT Cost with NG Conversion if Cheaper	Percent Convert to Natural Gas
Coal	**572**	**$5.5B**	**516**	**$1.5B**	**90%**
PC	185	$1.7B	139	$1.05B	75%
Stoker/ Other	387	$3.7B	377	$473M	97%
Heavy Liquid	**312**	**$2.9B**	**305**	**$204M**	**98%**
Light Liquid	**264**	**$2.35B**	**264**	**$157M**	**100%**
Grand Total	**1148**	**$10.8**	**1085**	**$1.9B**	**95%**

Includes monitor installation, initial testing, energy assessment, initial tune-up, capital cost of APCD.

CIBO Analysis #3 Annual Cost

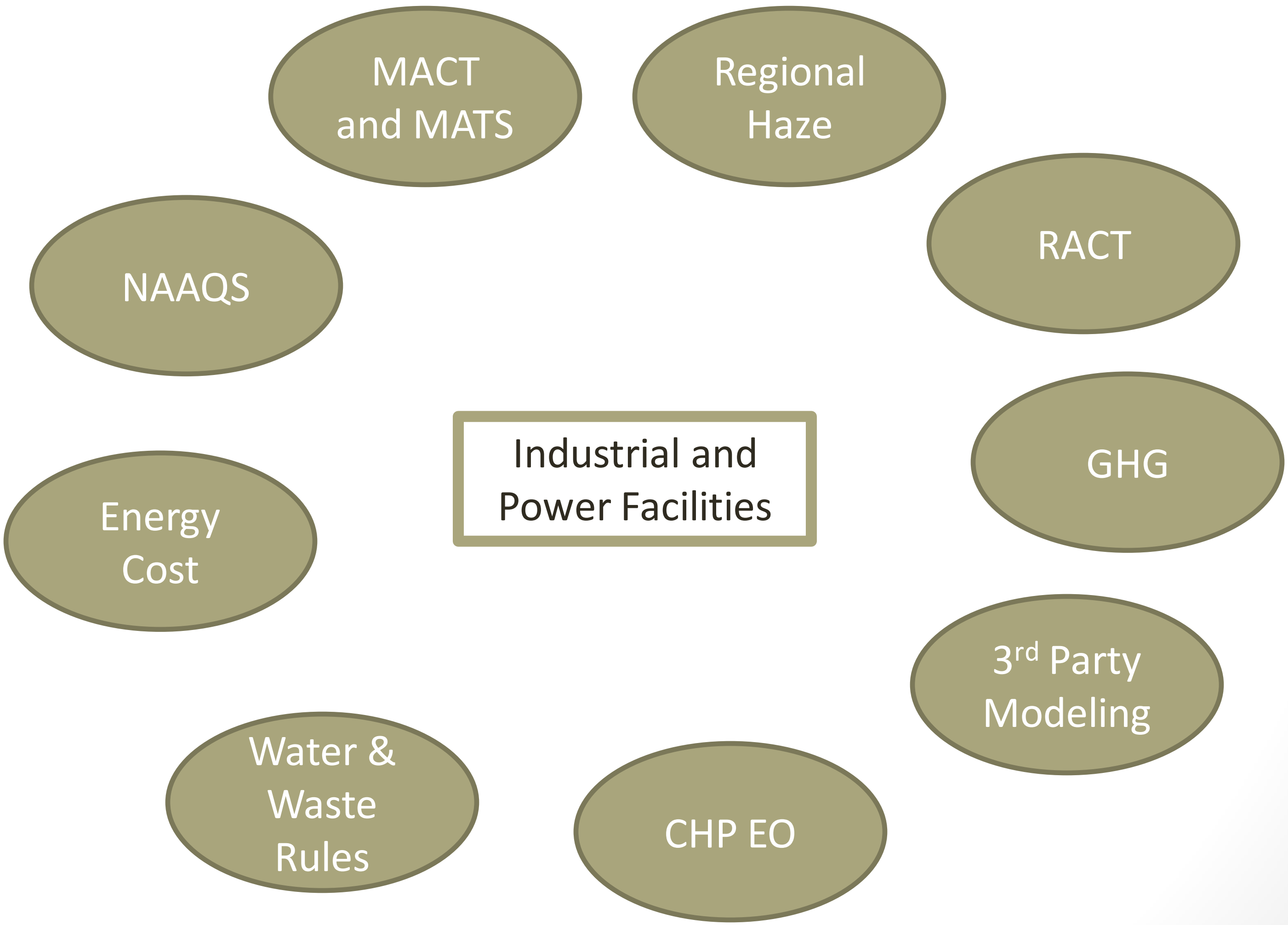
Category	# of Units	Total Annualized BMACT Cost	Number With Cheaper Natural Gas Costs	Total Annualized BMACT Cost with NG Conversion if Cheaper	Percent Cheaper to Switch to Natural Gas
Coal	**572**	**$4.2B**	**341**	**$3.7B**	**60%**
PC	185	$1.8B	85	$1.7B	46%
Stoker/ Other	387	$2.3B	256	$2.0B	66%
Heavy Liquid	**312**	**$1.5B**	**240**	**$1.2B**	**77%**
Light Liquid	**264**	**$1.1B**	**196**	**$923M**	**74%**
Grand Total	**1148**	**$6.7B**	**777**	**$5.84B**	**68%**

Includes annualized capital costs, annual operating costs, annual fuel cost, annual testing cost.

Summary

- Industrial Boiler MACT compliance costs for add-on controls are significant for coal and liquid units.
- Replacement with a natural gas fired package boiler or conversion of the unit to natural gas firing may provide a less costly compliance approach.
- Both capital and annual operating costs should be evaluated to determine which approach to implement.
- Consider importance of fuel flexibility to the site, other environmental requirements (current and future, all media), and future cost and availability of natural gas when making a decision.

Many Drivers for Boiler Projects and Controls to Consider



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