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GHG BACT – Top Down Review

December 7, 2010

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AGENDA

- Introduction
- PSD applicability
- BACT analysis
- BACT technologies
  - Source
- Recent experience
  - Boiler projects
- Energy efficiency

EPA OFFICE OF AIR QUALITY PLANNING AND STANDARDS DOCUMENTS

- PSD and Title V Permitting Guidance for Greenhouse Gases
  - Published November 17, 2010
  - Comments due December 1, 2010
- Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from Industrial, Commercial, and Institutional Boilers
  - October 2010
- Greenhouse Gas Permitting Guidance
  - Fall 2010

GREENHOUSE GASES (GHGS) FOR PURPOSES OF PSD

Greenhouse Gas	Global Warming Potential
Carbon Dioxide (CO_2)	1
Nitrous Oxide (N_2O)	310
Methane (CH_4)	21
Hydrofluorocarbons (HFCs)	12 – 11,700
Perfluorocarbons (PFCs)	6,500 – 17,340
Sulfur Hexaflouride (SF_6)	23,900

CALCULATION OF CO_2e EQUIVALENT

GHG	Tons Per Year	Global Warming Potential	CO_2 Equivalent CO_2e
CO_2	50,000	1	50,000
N_2O	1	310	310
CH_4	60	21	1,260
HFC-32	5	650	3,250
PFC-14	3	6,500	19,500
Total GHGs	50,069	Total CO_2e	74,320

HOW DID WE GET HERE

MAY 2007

Supreme Court ruling requires EPA to reexamine if GHG emissions from cars and trucks should be regulated

DECEMBER 2009

EPA issues endanger-ment finding and cause and contribute finding

APRIL 2010

EPA issues interpretation that a pollutant becomes subject to regulations when a regulations / rule “takes effect”

MAY 2010

EPA issues light duty vehicle rule that takes effect January 2, 2011

JUNE 2010

EPA issues “tailoring rule” enabling EPA / States to phase in GHG permitting requirements

PSD APPLICABILITY

- New sources or major modifications at major sources require a permit
- New source review
  - Attainment areas – prevention of significant deterioration
  - Nonattainment areas – Nonattainment NSR
- GHGs
  - No National Ambient Air Quality Standards
  - Subject to PSD

PSD APPLICABILITY

PSD Component	GHG Applicability	
	Yes	No
Best Available Control Technology (BACT) Analysis	•	
Dispersion Modeling		•
Ambient Monitoring		•
Class I Impact Analysis		•

PSD APPLICABILITY (NEW SOURCES)

Permits issued from January 2, 2011, to June 30, 2011	Permits issued on or after July 1, 2011
PSD applies to GHGs, if: The source is otherwise subject to PSD (for another regulated NSR pollutant); and The source has a GHG PTE equal to or greater than 75,000 TPY CO_2e	PSD applies to the GHGs if: The source is otherwise subject to PSD (for another regulated NSR pollutant); and The source has a GHG PTE equal to or greater than 75,000 TPY CO_2e OR The source has a GHG PTE equal to or greater than: 100,000 TPY CO_2e, and 100 / 250 TPY mass basis

PSD APPLICABILITY (MODIFIED SOURCES)

Permits issued from January 2, 2011, to June 30, 2011	Permits issued on or after July 1, 2011
PSD applied to GHGs, if: Modification is subject to PSD for another regulated NSR pollutant, and has a GHG emissions increase and net emissions increase: equal to or greater than 75,000 TPY CO_2e, and greater than -0- TPY mass basis	PSD applies to GHGs if: Modification is subject to PSD for another regulated NSR pollutant, and has a Equal to or greater than 75,000 TPY CO_2e, and Greater than -0- TPY mass basis OR BOTH: The existing sources has a PTE: Equal to or greater than 100,000 TPY CO_2e and Equal to or greater than 100 / 250 TPY mass basis Modification has a GHG emissions increase and net emissions increase: Equal to or greater than 75,000 TPY CO_2e and Greater than -0- TPY mass basis OR BOTH: The source is an existing minor source for PSD, and Modification alone has actual or potential GHG emissions: Equal to or greater than 100,000 TPY CO_2e and Equal to or greater than 100.250 TPY mass basis

DEFINITION: BACT ANALYSIS

BACT is: an emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under the Clean Air Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such facility through application of production processes and available methods, systems, and techniques, including fuel cleaning, clean fuels, or treatment or innovative systems, and techniques, including fuel cleaning, clean fuels, or treatment or innovative fuel combustion techniques for control of each such pollutant…

BACT GENERAL APPROACH

- Case by case
- Top down approach been around > 20 years
  - Recommended – may not be mandatory
- NSPS sets floor for BACT, when and if there is an NSPS
- GHG specific
  - Emphasizes energy efficiency
  - New facilities – source wide energy efficiency measures
  - Modified facilities – emission unit energy efficiency measures

BACT GENERAL APPROACH

- EPA's five-step "top down" process
  - BACT Step 1 – indentify all available control options
  - BACT Step 2 – eliminate technically infeasible options
  - BACT Step 3 – ranking remaining options by emissions control effectiveness
  - BACT Step 4 – evaluate economic, energy, and environmental impacts
  - BACT Step 5 – select best option as BACT for the source

STEP 1 – IDENTIFY ALL AVAILABLE CONTROL TECHNOLOGIES

- Concentrate on high performing technologies regardless of source type
- Air pollution control technologies include
  - Alternative production processes, methods and techniques
  - Clean fuels
  - Innovative combustion techniques
- Consider technology transfer
- Three categories
  - Inherently low emitting processes / practices / design
  - Add on controls
  - Combination of the above
- BACT should **not** fundamentally redefine a proposed source

STEP 1 – IDENTIFY ALL AVAILABLE CONTROL TECHNOLOGIES

- New facilities – source wide energy efficiency measures
- Modified facilities – emission unit energy efficiency measures
- Carbon capture and sequestration – large CO_2 emitters
  - Coal fired power plants
  - Hydrogen production
  - Ammonia production
  - Natural gas processing
  - Ethanol production
  - Ethylene oxide production
  - Cement production
  - Iron and steel manufacturing

STEP 2 – ELIMINATE TECHNICALLY INFEASIBLE OPTIONS

- Based upon physical, chemical, or engineering principles
- Consider availability
- Consider applicability
- Document Properly
- Availability and applicability of CCS will change over time

STEP 3 – RANKING OF CONTROLS

- Based upon control effectiveness
- Metrics – input basis or output basis

STEP 4 – ECONOMIC, ENERGY AND ENVIRONMENTAL IMPACTS

- Consider both direct and indirect impacts
- Economic – $ per ton removed
- Energy – consider on site power generated and power purchased
- Environmental
  - Pivotal part of analysis
  - Agency has great deal of discretion
  - Consider impact on non GHG emissions
  - Consider impact on solid waste, hazardous waste, water discharge, water use

STEP 5 – SELECTING BACT

- Specific limit
- Work practices may be included
- Should allow compliance on a consistent basis
- Can be adjusted based on actual performance
- Role of regulatory agency
  - Determines averaging period and units of measurement
  - Ultimately responsible for determining BACT limit
  - Ensure that applicant has addressed most effective options
  - Ensure that applicant has adequately addressed impacts

BACT TECHNOLOGIES – BOILER SPECIFIC

GHG Measure	Applicability	Efficiency Improvement (percentage pt)	CO_2 Reduction (%)	Capital Costs	Notes / Issues
Energy Efficiency Improvements					
Replace/ Upgrade Burners	All, except for Stoker-type boilers and fluidized bed boilers	Up to 4 to 5%. 1 to 2% may be acceptable	Up to ~ 6%.	$2,500 – 5,100 per MMBTU per hour	Site specific considerations (retrofit ability) and economic factors may affect the installation of burners
Tuning	All	CO from 1000-2000 to < 200 ppm Unburned carbon (UBC) from 20 to 30%, to 10 to 15%	up to ~3%	Up to $3000	Manual tuning with parametric testing
Optimization	All	0.5% to 3.0%	up to ~ 4%	$100,000	Neural network-based
Instrumentation& Controls	All, especially at large plants	0.5% to 3.0% (in addition to optimization)	up to ~ 4%	>$1million	System integration, calibration, and maintenance

BACT TECHNOLOGIES – BOILER SPECIFIC

GHG Measure	Applicability	Efficiency Improvement (percentage pt)	CO_2 Reduction (%)	Capital Costs	Notes / Issues
Economizer	Units with capacity over 25,000 pounds of steam per hour;	40 F decrease in flue gas temperature equals 1% improvement	Relates to efficiency gain in boiler	$2.3 million (for 650 MMBTU per hour)	Larger units; must consider pressure loss, steam conditions
Air Preheater	Units with capacity over 25,000 pounds of steam per hour;	A 300 F decrease in gas temperature represents about 6% improvement	~ 1% per 40 F temperature decrease	$200,000 – 250,000 (for 10 MMBTU per hour)	Used in large boiler applications , not widely used in ICIs due to increase in NO_X
Create turbulent flow within firetubes	Single or two pass firetube boilers	1% efficiency gain for 40 F reduction in flue gas temperature 100 F to150 F temperature decrease potential	~ 1% per 40 F temperature decrease up to ~ 4%	$10 – 15 per tube	Widely accepted with older boilers ;

BACT TECHNOLOGIES – BOILER SPECIFIC

GHG Measure	Applicability	Efficiency Improvement (percentage pt)	CO_2 Reduction (%)	Capital Costs	Notes / Issues
Insulation	All, most suitable for surface temperatures above 120ºF	Dependent on surface temperature	Up to 7%		Radiation losses increase with decreasing load
Reduce air leakages	All	1.5 – 3% potential (Effect similar to reducing excess air)	Up to ~ 4%	Site-specific (None to cost of maintenance program)	Requires routine maintenance procedures
Capture energy from boiler blowdown	Most suitable for units w/ continuous boiler blowdown exceeding 5% of steam rate	Site specific depending on steam conditions Up to ~ 7%	Up to ~ 8% See efficiency comment	NA	Water quality issue important
Condensate return system	All; However, larger units more economical to retrofit	Site specific - depends on condensate temperature and % recovery	Same as efficiency improvement, ratio of MMBTU per hour saved from condensate to MMBTU per hour input	$75,000	Energy savings is the energy contained in the return condensate, condensate quality affects use

BACT TECHNOLOGIES – BOILER SPECIFIC

GHG Measure	Applicability	Efficiency Improvement (percentage pt)	CO_2 Reduction (%)	Capital Costs	Notes / Issues
Reduce slagging and fouling of heat transfer surfaces	Watertube boilers	1% to 3% Site specific; fuel quality/operating condition have large impact	Up to ~ 4%	$50,000 to $125,000	Downtime / economic factors, regain lost capacity
Insulating jackets	Surfaces over 120 F		Same as efficiency improvement	Depends on length / type of insulation required for implementation	No deployment barriers
Reduce steam trap leaks	All			None to cost of maintenance program	No deployment barriers
Post-Combustion					
Carbon capture and storage					demonstrated at the slip-stream or pilot-scale

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BACT TECHNOLOGIES – BOILER SPECIFIC

GHG Measure	Applicability	Efficiency Improvement (percentage pt)	CO_2 Reduction (%)	Capital Costs	Notes / Issues
Other Measures					
Alternative fuels – biomass	All fossil fuels				Less caloric content than fossil fuel
Co-firing	Coal-fired and oil-fired boilers	reduction up to 2% for biomass co-firing	20-30% reduction with gas co-firing		Negative impact of boiler efficiency
Fuel switching	Coal-fired and oil-fired boilers		20-35% reduction switching from coal to oil; 20-35% reduction switching from coal to natural gas		Change in hardware to accommodate 100% fuel switch
Combined heat and power	All	Overall efficiency improves from 30 to 50%, to 70 to 80%		$1,000 to $2,500 per kW	High capital investment

BACT TECHNOLOGY – BOILER SPECIFIC – STATUS OF CCS

- Interagency task force on carbon, capture, and storage – August 2010
  - Four CCS sites globally with a total of 25 years experience
  - Biggest potential is for coal fired power plants
  - Estimated cost is \$60 to \$90 per ton of CO_2
  - DOE intends to have up to 10 CCS projects in operation by 2016
  - Biggest barrier is economics

STATUS OF CARBON CAPTURE EXPERIENCE IN US POWER PLANTS

Location	SO2 Capture System	Tonnes Per Year	Disposal
AES Warrior Run Cumberland, Md.	Amine Scrubber	110,000	Food Processing
AES Shady Point Panama, Okla	Amine Scrubber	66,000	Food Processing
Searles Valley Minerals Trona, Calif.	Amine Scrubber	270,000	Carbonation of Brine
AEP Mountaineer Plant New Haven, WVa.	Chilled Ammonia	100,000	Geologic Storage
Dakota Gasification company	Pre Combustion Rectisol	1,600,000	Oil Field Injection
VattenFall Plant Germany	Oxy-combustion	70,000	Compressed into liquid

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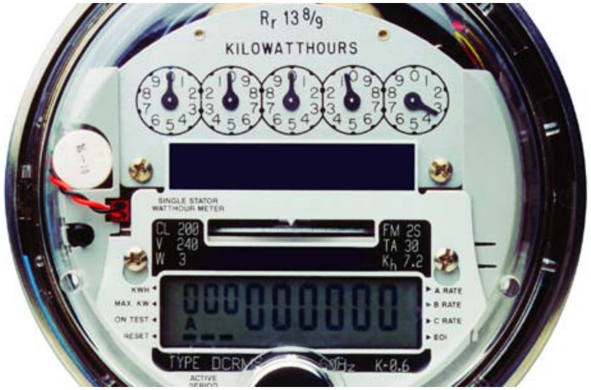
RECENT EXPERIENCE – BOILER PROJECTS

- Six current boiler projects in various stages
- One permitted before tailoring rule
- Two trying to get permits before 2011
- Three in planning phase – hope to avoid GHG BACT



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ENERGY EFFICIENCY

Date: 1 July 2011

To: CIBO PSD Permit Applicant

Subject: Additional Information Required for Permit Review

Dear Sir,

Thank you for your recent PSD application. Please be advised that in addition to the numerical emission limits established via the BACT analysis, your proposed permit will require your use of an Environmental Management System (EMS) work practice focused on energy efficiency. Please provide your data and plan forward so we can further review your application.

Thank you and be safe this 4th of July (Please dispose of fireworks properly)

From: Your Friendly Permitting Representative

ENERGY EFFICIENCY

Quote from November 2010 PSD and Title V Permitting Guidance

"*EPA believes it is important in BACT reviews for permitting authorities to consider options that improve the overall energy efficiency of the source or modification – through technologies, processes and practices at the emitting unit*"

<u>Source / modification</u> energy efficiency has been discussed today by Tom Fitzpatrick and during the last quarterly Focus Group Session (Paul Goggins and Clark Conley)

ENERGY EFFICIENCY

More Quotes from November 2010 PSD and Title V Permitting Guidance

"… it may be appropriate to include specific energy efficiency measures or techniques <u>in the permit</u> where such measures would clearly have a noticeable effect on energy savings."

"The application of methods, systems, or techniques to increase energy efficiency is a key GHG-reducing opportunity that falls under the category of "<u>lower-polluting processes / practices</u>""

ENERGY EFFICIENCY

More Quotes from November 2010 PSD and Title V Permitting Guidance

"… EPA recommends that permitting authorities consider technology or process improvements that impact the facility's energy utilization"

"Since lower-emitting processes should be considered in BACT reviews, opportunities to utilize energy more efficiently and therefore to produce less of it are appropriate considerations in a BACT review for a new facility."

THE EPA IS TELLING US...

- Energy efficiency will help you meet GHG BACT
- Permitting agencies will be looking for energy efficiency beyond what is done at the source / modification
- BACT reviews may look everywhere within the fence line of the facility

OTHER CONSIDERATIONS

- Boiler MACT proposed
  - Major sources (emit > 10 tpy single toxin or 25 tpy combined)
  - Industrial, commercial, institutional users
  - Boilers and process heaters
  - Regulates PM, HCl, Hg, CO and Dioxin / Furan
  - Out for comment now
  - Finalization and publishing in Federal Register soon
  - **Has energy assessment component requirement**

OTHER CONSIDERATIONS

- Proactive Energy Management Benefits
  - Meet corporate sustainability goals
  - Reduce operating costs
  - Better use of capital
  - Less unplanned downtime due to equipment problems
  - Energy information availability and use in decision making
  - Optimize (not necessarily maximize) life of assets
  - Creates a culture of efficiency and continuous improvement

CHOICE TO BE MADE…

1. Consider GHG BACT, boiler MACT and proactive energy management as separate requirements and programs

Or

2. Look at these together and optimize the approach to generate the required information and lay the foundation for a sustainable energy management program

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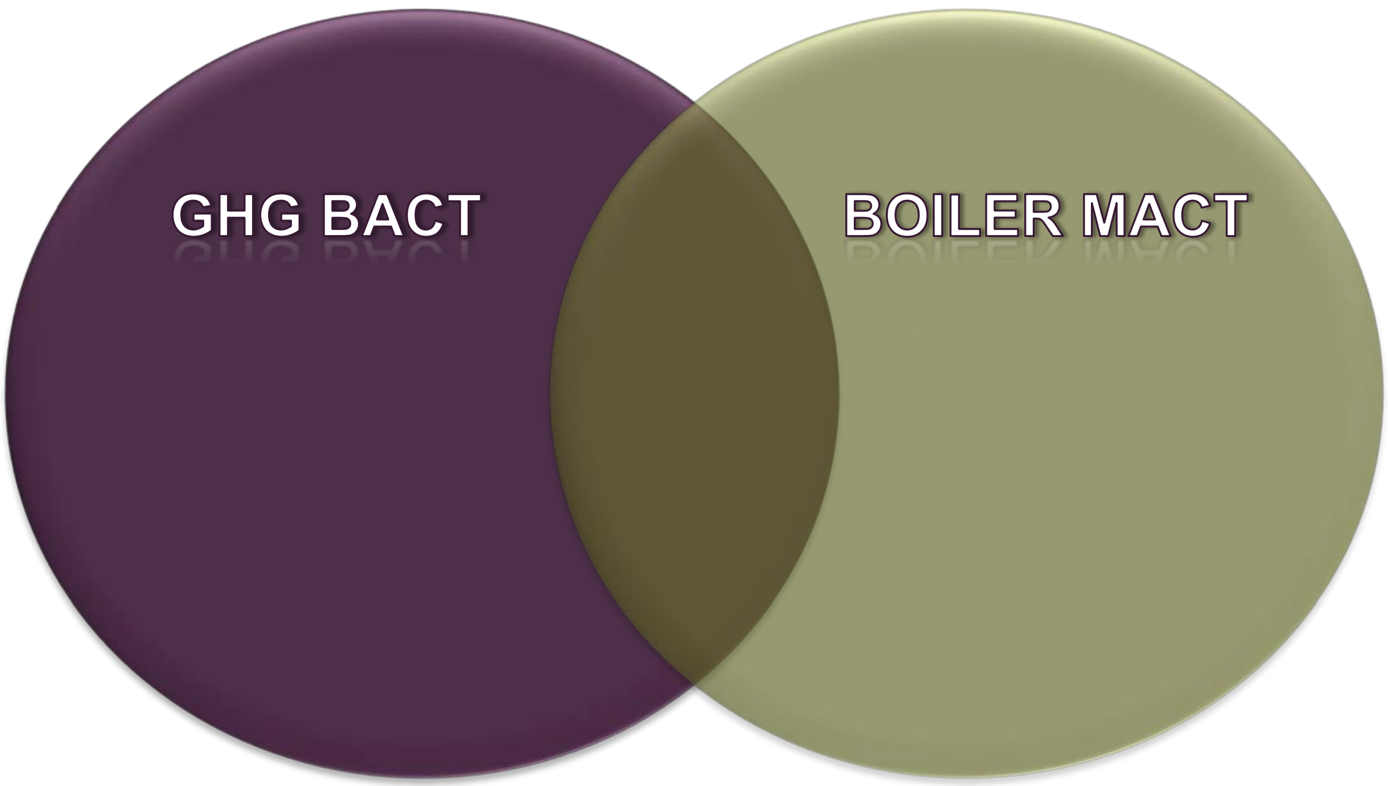
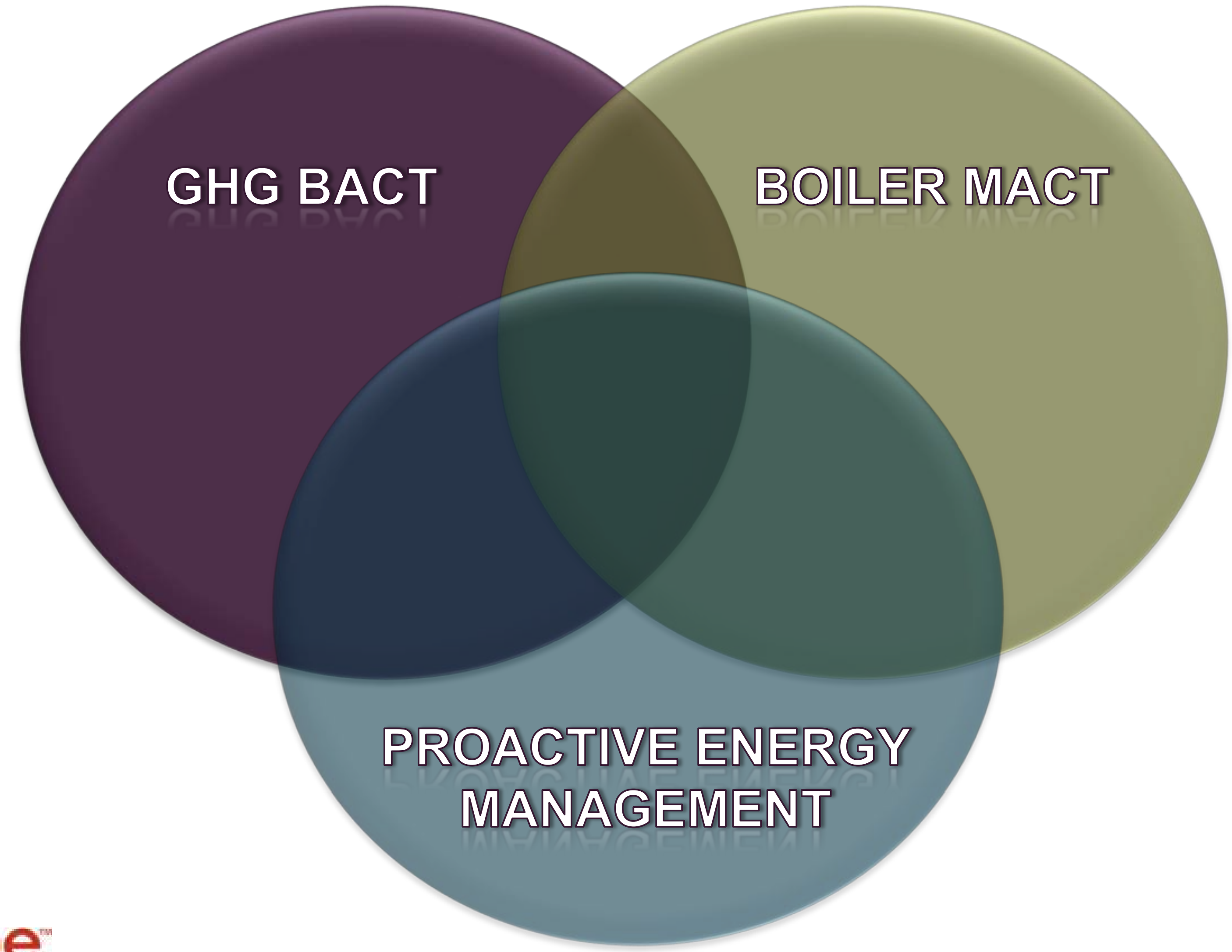
GHG BACT


GHG BACT
BOILER MACT



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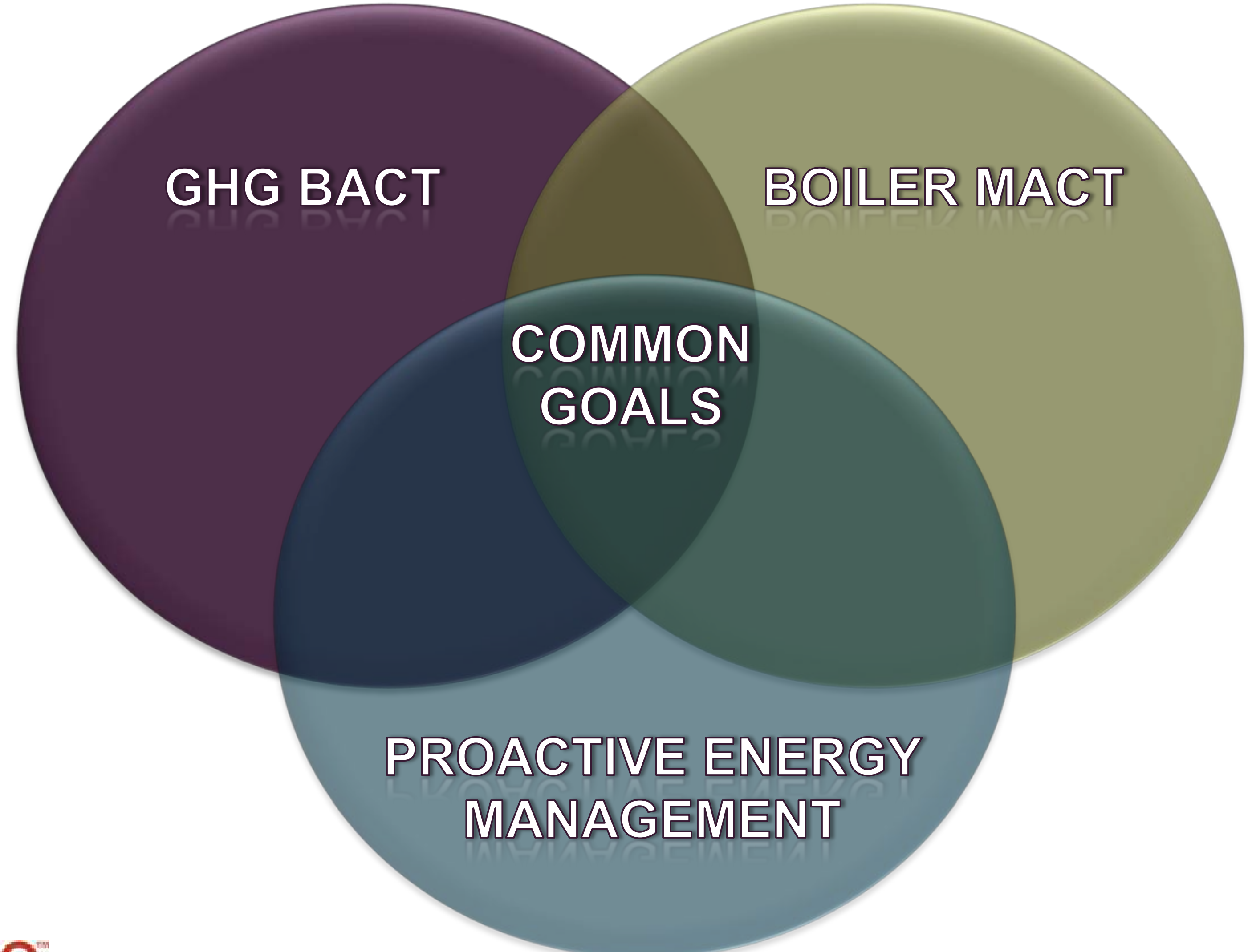
GHG BACT
BOILER MACT
COMMON GOALS
PROACTIVE ENERGY MANAGEMENT

GHG BACT

- Unique features
  - Classification of “suites of technology” that can be reviewed as part of the BACT process
  - Should document uncertainty in expected versus guaranteed efficiency improvement
- Common features
  - Need to identify large users first then small users
  - Measurement and data reporting
  - Plan to manage energy use and implement ideas
  - Performance benchmarking is particularly useful

BOILER MACT

- Unique features
  - One-time energy assessment and report required
  - Qualified Personnel (CEM) required
- Common features
  - Need to identify large users first then small users
  - Measurement and data reporting
  - Plan to manage energy use and implement ideas
  - Performance benchmarking is particularly useful

PROACTIVE ENERGY MANAGEMENT

- Unique features
  - Business objectives and considerations
  - Holistic view of all energy generating and consuming equipment
  - Energy Master Plan integrates all points together
- Common features
  - Need to identify large users first then small users
  - Measurement and data reporting
  - Plan to manage energy use implement ideas
  - Performance benchmarking is particularly useful

COMMON FEATURES

- Need to identify large users first then small users
  - Most facilities have done this already
    - Is there a formal list or simple spreadsheets?
    - Is it current?
    - What information is included on this list of assets?
    - Is it the right information?
    - Does it show if (when) there was any energy conservation measure completed and the benefits achieved?
    - Does it include relevant O&M requirements?
    - Does it include best practices and a future review date?

COMMON FEATURES

- Measurement and data reporting
  - Some facilities have a common system
    - Is the right submetering in place to capture the data?
    - Are the time intervals sufficient to identify trends and review data?
- Plan to manage energy use and implement ideas
  - Some facilities have a forward plan
    - Use of ENERGY STAR or other structured program
    - Is there a prioritized list with expected (estimated) dates for the key energy efficiency improvements?
    - Is there a process in place to feed this back to the users list?

COMMON FEATURES

- Performance benchmarking
  - At source or modification level
    - Can be difficult due to differences in equipment
    - Competitors don’t want to share this data
    - Manufacturers can provide baseline data to compare
  - At facility level
    - Still difficult due to differences in systems
    - Competitors still don’t want to share this
    - ENERGY STAR and other sources may provide useful data

ENERGY STAR

- Energy Performance Indicators (EPIs) for
  - Cement manufacturing
  - Container glass manufacturing plants
  - Cookies and crackers
  - Corn refining
  - Flat glass manufacturing plants
  - Frozen fried potato processing plants
  - Juice processing plants
  - Motor vehicle manufacturing
  - Pharmaceutical manufacturing

ENERGY STAR

- Energy Performance Indicators (EPIs) being developed for
  - Food manufacturing
  - Iron and steel (December 2010 guidance)
  - Petrochemical
  - Petroleum refining
  - Pulp and paper

ENERGY STAR

- Qualifications
  - Most data is non-manufacturing / industrial use
  - Even though permitting authorities may be looking at this, the data may not be relevant to your specific facility operations
  - Data may be skewed as inefficient facilities are less likely to submit their data
  - Data for many industries still unavailable

MANUFACTURING ENERGY CONSUMPTION SURVEY (MECS)

- 2006 energy consumption by manufacturers
  - Consumption of energy for all purposes
    - Table 1.2 – by manufacturing industry and region (trillion BTU)
  - Ratios of manufacturing fuel consumption to economic characteristics
    - Table 6.1 – by manufacturing industry and region (MMBTU / employee)
    - Table 6.4 – by manufacturing industry and employment size (by size)
  - Floorspace and building counts
    - Table 9.1 – by enclosed floorspace and number of establishment buildings (SF and quantity)

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SSOE ENERGY EXPERIENCE

- Project Scopes
  - Specific issue resolution
    - Focused / targeted analysis of one or a few items
    - Identify how issue interacts with the rest of the facility
  - Small (one-day onsite) reviews
    - Determine simple list of opportunities and priorities
    - Justification for more detailed analysis
  - Detailed (one week or more onsite) detailed analysis
    - Investment grade energy audits for use in capital plans
    - Justification for detail design of energy conservation measures
  - Strategic Energy Master Plans
    - Adds all other aspects involved in Energy Manager’s responsibilities
    - Connects future decisions to overall business plan

SSOE ENERGY EXPERIENCE

Expertise

- Demand Analysis
- Energy Conservation Measures
- Energy Modeling
- Load Profile Analysis
- Metering Systems
- O&M Best Practices
- Process Optimization
- Peak Shaving / Load Shifting
- Recommissioning
- Utility Rate Analysis
- Energy Audits
- Energy Management Systems
- Energy Recovery
- ENERGY STAR Support
- Generation
- LEED® Certification
- Measurement and Verification
- Performance Contract Reviews
- Renewable Energy Systems

REVIEWING…

1. Understand GHG BACT source and non-source requirements for your application
2. Consider Boiler MACT requirements and Proactive Energy Management opportunities
3. Use an Energy Management tool (i.e. ENERGY STAR) to track data and establish protocols
4. Start with large consumers and generators and keep good records of efficiency improvements
5. Benchmark your performance using industry data where possible

RESOURCES

DOE 2006 Manufacturing Energy Consumption Survey (MECS) Tables:
www.eia.doe.gov/emeu/mecs/mecs2006/2006tables.html

DOE's Industrial Technologies Program (Best Practices):
www1.eere.energy.gov/industry/bestpractices/

ENERGY STAR Guidelines for Energy Management:
www.energystar.gov/guidelines

ENERGY STAR Industrial Energy Management Information Center:
www.energystar.gov/index.cfm?c=industry.bus_industry_info_center

ENERGY STAR Industrial Sector Energy Guides and Plant Energy Performance Indicators: www.energystar.gov/epis

EPA's Lean and Energy Toolkit: www.epa.gov/lean/toolkit/LeanEnergyToolkit.pdf

ENERGY EFFICIENCIES

Date: 7 December 2011

To: CIBO PSD Permit Applicant

Subject: Approval of PSD Permit

Dear Sir,

Thank you for the follow up to our 1 July 2011 letter. Please be advised that we have received and reviewed the Environmental Management System (EMS) document support requested of you and find that it exceeds our expectations. We are convinced that your plan will achieve our goals as defined in earlier discussions. Based on this, we are awarding you the permit you seek. Congratulations!

Thank you and have a very Merry Christmas (Please dispose of wrapping paper properly)

From: Your Friendly Permitting Representative

THANK YOU!