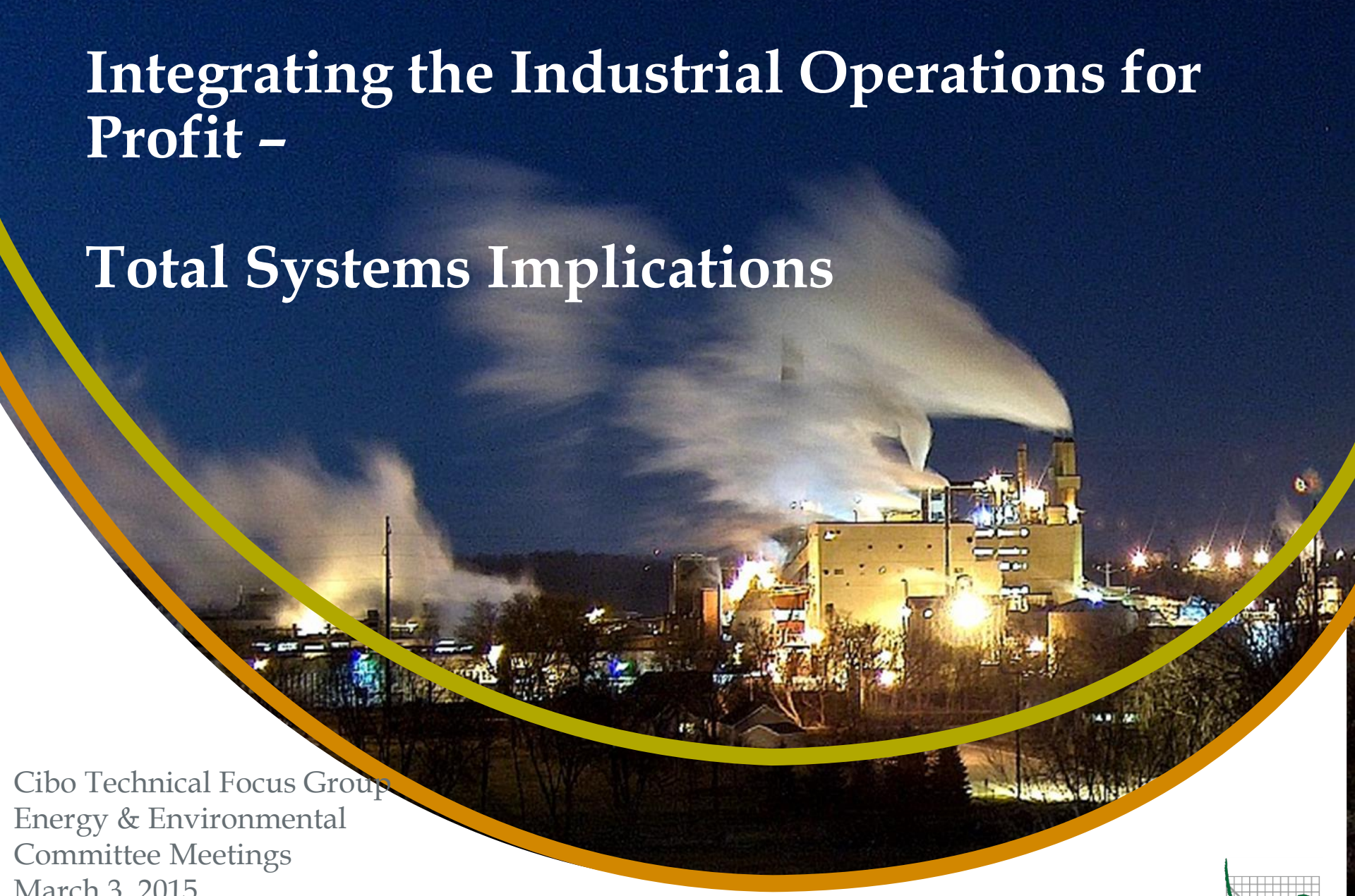
Integrating the Industrial Operations for Profit –

Total Systems Implications



Cibo Technical Focus Group
Energy & Environmental
Committee Meetings
March 3, 2015

Bob Fraser, QEP
Mike Zebell, P.E.

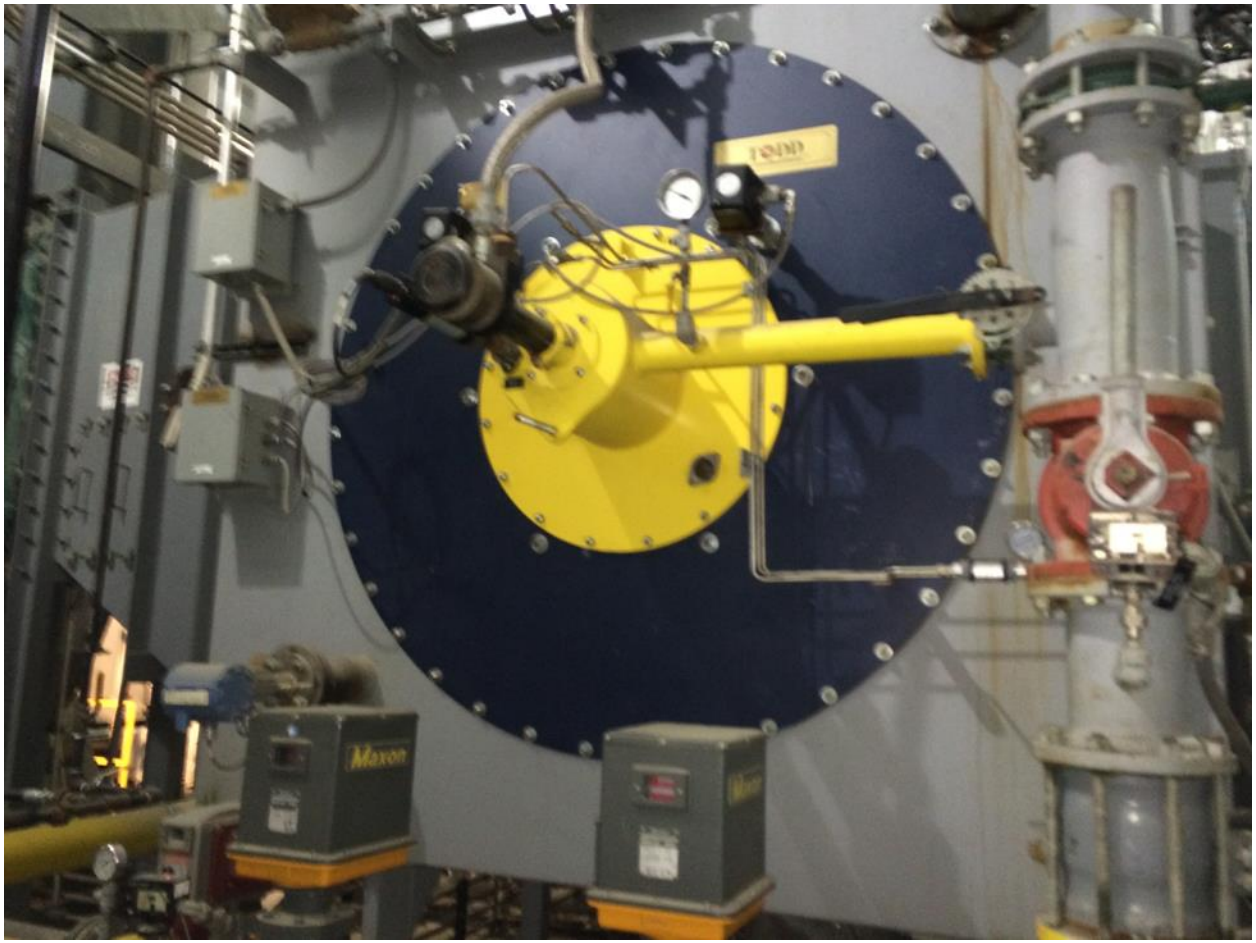
The world's leading sustainability consultancy

ERM

Discussion Summary

- Lessons learned from Boiler MACT energy assessments
  - Tools for transformation
    - » *Better Information - Metering*
- Energy supply issues
  - *Reliability*
  - *Flexibility*
  - *Responsiveness*
  - *Communication*

Lessons from BMACT Energy Assessment



One-Time Energy Assessment for Existing Units

- EA will cover the boiler/process heater and the major energy use systems **within the Source's property**
- Requires an evaluation of the facility's "energy management practices" to identify and evaluate cost effective energy conservation measures
- EA to follow prescribed procedures; complete by compliance date
- "Qualified Energy Assessor" … *demonstrated capabilities (and knowledge) to evaluate energy savings opportunities for steam generation and major energy using systems…*
- An EA completed after January 1, 2008 that meets or is amended to meet the EA requirements of the rule satisfies the EA requirement.

What a MACT Energy Assessment Is

- A report that must be kept on site
- A highly prescribed regulatory requirement
- Certified complete in the NOCS
  - Electronically via CEDRI by March 16, 2015
- Limited to affected boiler(s), process heaters and their discreet "major" steam energy use systems
- Does not re-define the boiler or process
- A regulatory compliance document that may become public

Elements of a MACT EA (Table 3)

a) Visual Inspection of each boiler and process heater

b) Evaluation of operating characteristics
   - Specifications of the energy use systems
   - Unusual operating constraints

c) Inventory of major energy use systems

d) Review of applicable plans, O&M procedures, logs, fuel records

Elements of a MACT EA (Table 3)

(e) Review of energy management procedures with recommendations

(f) List of cost effective conservation measures

(g) List of energy savings potential

(h) Report detailing 1-2 yr payback opportunities to improve efficiency

- Costs
- Benefits / payback

Beyond the Boiler - Discreet Energy Use Systems

- Individual Pieces of Equipment
- Major Energy Use System – Device that Uses > Applicable Threshold%
- Common Concerns
  - "This is a huge facility – it will take months to walk down every energy use system"
  - "100% of our steam is used for heating"
  - "All the steam goes to the dryers"
  - "Steam is distributed to each building on campus. Students are always opening the windows."
  - "But then we wouldn't have any Major Energy Use Systems to evaluate"

Caution

- Business confidential
- Way more than boilers evaluated
- Major energy use systems identified
- Roadmap to GHG BACT AOC?
- Sustainability report consistency

Data Requests

- Boiler cross section elevation drawing, front and side elevation
- Plan view arrangement drawing at 1st level
- Facility layout drawing, plan view
- OEM boiler spec
- Annual fuel usage, gross and net generation, heat rate (Btu/kW-hr), $\%O_2$, load profile, stack exit temperature
- List of major energy use systems, motors > 20 Hp
- O&M procedures
- All prior energy efficiency improvement studies, payback estimates, reports
- List of all energy efficiency improvements already implemented

Case Study

Affected Boilers

- Base loaded 120 MW Cogeneration Plant
- HAP Major Source
- 3 Coal-fired CFB Boilers
  - 1- mid-1980s
  - 1 – mid-1990s
  - 1 – early-2000s
- ~ 2 MPPH Steam
- ~ 105 MW
- Blend PRB & Bituminous coal

- 2 Natural Gas-fired Package Boilers
- Several Direct-fired Process Heaters

Energy Efficiency Features – Wow!

- 1,250 PSIG / 900 ^{o}F
- Cogeneration, Ash Re-injection (CFB), Dual Air Heaters, Economizers
- Stack exit temperature ca 310 - 350 F (just above acid dew point)
- Computerized O_2 trim 3 - 4 ½ %, Sate-of-the-art Predictive Computer Controls (Upgrading I&C to Further Improve)
- Multiple Sootblowers, Excellent Insulation & Lagging
- Parasitic Load - < 10% of Power Generated (<< 10% of Total Energy)
- Ash Coolers
- 65-68% Condensate Return
- Blow Down, Flash Steam to DA's, Waste Heat Recovery
- Dome Dry Fuel Storage / Enclosed Conveyors

Boilers' Major Energy Use Systems

- All HP Steam Headered Together
- Six Topping STGs, 400 > 175 PSIG Steam for Distribution
  - Boilers Parasitic Load < 20%
- Total 175 PSIG Steam = ~1,200,000 pph
- LP Steam from Package Boilers Headered In
- Steam Balance (Major AREAS A & B)
  - 175 kpph
  - AREA A (<< 20%)
  - AREA B, 1,000,000 pph (>20%)
    - Energy Tracking – No Single Device in AREA A Consumes > 20% (240 kpph)
- Eureka Moment – EA Confined to Cogen and Boilers!

220 MMBtu/hr Package Boilers

- Efficiency Features
  - Supplemental LP steam
  - Efficient design, gas only, LNB's
  - Automatic O_2 Trim
  - 1-2% Blowdown
  - Economizers
  - Low stack temperature
  - Well insulated

- No 1-2 yr payback projects identified

Energy Efficiency Projects Considered

- STG Upgrades
  - Older, small STGs, may have no known “kits” available
- Sootblowing Optimization Study
- Electronic Damper Controls & Instrumentation - enable more precise O2 control
- VFD’s Large Motors
  - Primarily base loaded units, even ID Fans 5+ yrs
  - VFDs cooling tower pumps
- Power Factor, volt-ampere reactive support to Utility
- CFD Modeling of CFBs
  - Highly speculative – $200k investment, benefit unknown
- Others < 20% (information only) - steam traps, compressed air audit (5 yrs), improved tube cleaning – paybacks speculative

Lesson's Learned from BMACT EAs

- Energy Use Systems - Metering is the key
  - Top performers know monitor the quantity and quality of steam to each use
  - Build upon energy use mapping already being performed
- Limit the content of the EA report to what is prescribed by rule – the report is a compliance document and can be requested under FOIA
- Identify existing energy efficiency features and planned and completed projects

Lesson's Learned (continued)

- Major Energy Use Systems
  - Plants or production areas can be eliminated from further consideration if they do not consume 20% of the total boiler output
  - Each discrete piece of remaining equipment should be evaluated against the applicable threshold (e.g., 20%)
  - Establish that the boilers parasitic steam load is below the threshold including primary steam driven equipment (pumps & fans), soot blowers, deaeration, ejectors, and so on.
- Steam turbine generators in a cogeneration plant is an energy use system and should be evaluated – not the electricity use, the steam use

Lesson's Learned (continued)

- Document site visit with photo-log (preferable) and/or checklists
- Include a discussion of boiler operation (O_2 trend) and exhaust temperatures to document efficient boiler operation
- Do not append analyses that you do not want made public (e.g. boiler or system performance modeling)
- Limit the economic analysis to a simple payback
  - Do not include incentives or rebates,
  - Do not include information on carbon intensity
  - Do include the level of accuracy of capital cost estimates
  - Do include all assumptions

Common Themes

- Boiler O_2
- Fuel management (moisture, blending, heating value)
- VFD's ID fan, variable operation fans
- VFD's cooling tower fans, cooling water pumps
- Methods to minimize tube fouling
  - Soot blowing
  - Water cannons
  - Sonic horns
  - Fuel additives
- ESP on power management system

Common Themes (cont.)

- Boiler and steam piping insulation
- Tramp air
- Replacement motors specified high efficiency when replaced
- Over fire air system marginal, never worked, disconnected
- Combustion air intake near ceiling vs. outside
- STG upgrades available from OEM?
- Blow down heat recovery
- Steam traps / lost condensate

Energy Supply Issues

- Reliability is KING
- Communication between the supplier and user
- Flexibility to optimize for a given day/situation
- Responsiveness – efficiently meeting swings

Here to Make Your Life Easier

Michael Zebell, PE
Principal, ERM
700 W. Virginia Street, Suite 601
Milwaukee, WI 53204
414.977.4706
mike.zebell@erm.com