Sector-Based Pollution Prevention: Toxic Reductions through Energy Efficiency and Conservation Among Industrial Boilers

A Report to the Great Lakes National Program Office (GL97514402)
Submitted by The Delta Institute

July 2002

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Acknowledgements

This work was funded by the U.S. EPA's Great Lakes National Program Office and the Council of Industrial Boiler Owners. The Delta Institute would like to thank the facilities that participated in the audits, the Wisconsin Department of Natural Resources and the Wisconsin Focus on Energy for their involvement in this project.

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Executive Summary

In July of 1999, the Delta Institute launched a partnership with the Council of Industrial Boiler Owners to achieve emission reductions of Binational Toxics Strategy Level I and Level II pollutants from industrial boilers through the implementation of selected energy efficiency technologies and methods. The project hypothesized that energy efficiency measures offer significant opportunities to reduce both energy consumption and emissions of Binational Toxics Strategy substances from industrial boilers.

To test this hypothesis, the Delta Institute, working with the Council of Industrial Boiler Owners and the Wisconsin Department of Natural Resources, performed energy efficiency assessments at nine Wisconsin facilities, with a total of 34 industrial boilers. Through these assessments, we found that optimizing energy needs (e.g., reducing the amount of fuel input) can result in reductions of toxics and greenhouse gas emissions because of reduced fuel use.

This correlation was also confirmed through an aggregations analysis of emissions from over 20,000 industrial boilers located at facilities in eight Great Lakes states. This analysis showed that twelve percent, or 2,900, of industrial boilers located in the Great Lakes region that use coal and residual fuel oil as the primary fuel emit the majority of toxic emissions. For example, almost all of the 4.5 tons per year of mercury emitted by industrial boilers are from coal and residual fuel fired units. Our analysis of industrial boiler emissions shows that a conservative 10% efficiency improvement would reduce over 900 pounds of mercury emissions to the Great Lakes Basin. Furthermore, a 10% energy efficiency improvement would result in important reductions of criteria pollutants such as carbon monoxide, sulfur dioxide, nitrogen oxides, particulate matter, and carbon dioxide.

Because of the significance of industrial boilers as a source of air toxics and the potential for reductions through energy efficiency measures, resources should be dedicated to designing a large-scale pollution prevention outreach initiative that links toxic reduction and energy efficiency. By doing so, the “natural” cost savings incentive of energy efficiency can be used to achieve quantifiable reductions of toxics as well as criteria pollutants. Given the relatively large number of facilities and ubiquitous nature of industrial boilers, achieving meaningful reductions from this “sector” will require new approaches to outreach and implementation incentives such as closer alliances between local pollution prevention and energy technical assistance resources and improved access to capital and other financial incentives.

Current regulations will only go so far to attain the necessary reduction in air emissions. Even if all of the needed reductions from regulations could be achieved, the implementation timeframe would be too long. With respect to greenhouse gases, states are only just beginning to formulate policies and programs that reduce greenhouse gases. Pollution reduction opportunities that go beyond existing programs need to be sought out and implemented if permanent, ecosystem improvements in the Great Lakes region are ever to be realized.

SECTION 1: Introduction

In July of 1999, the Delta Institute launched a partnership with the Council of Industrial Boiler Owners (CIBO) to achieve emission reductions of Binational Toxics Strategy (BTS) Level I and Level II pollutants from industrial boilers through the implementation of selected energy efficiency technologies and methods.[1] The project hypothesized that energy efficiency measures offer significant opportunities to reduce both energy consumption and emissions of BTS substances from industrial boilers. The project focused on industrial boilers, as compared to larger utility boilers, because the local contribution of toxics deposited to the Great Lakes may be disproportionately higher from smaller facilities.

To test this hypothesis, the Delta Institute, working with CIBO and the Wisconsin Department of Natural Resources (DNR), developed a program to provide technical assistance to industrial boiler owners in order to evaluate energy efficiency opportunities and emissions of BTS compounds. A series of boiler audits were subsequently performed at nine private and public sector facilities. Participants agreed to have a free assessment performed by a combustion expert hired by the Delta Institute. Each assessment included interviews with facility managers and power plant personnel, a site walk-through of the power plant facility, and a facility report documenting recommendations for energy efficiency improvements. In exchange, each facility agreed to consider implementing several recommendations for achieving greater energy efficiency and to explain why they would or would not implement the recommendations. A copy of a typical agreement letter is included in Attachment A. The Delta Institute identified potential facilities to audit by working in partnership with the Wisconsin DNR, Wisconsin Focus on Energy, and the Wisconsin Paper Council.

The energy efficiency assessments were performed from May to July 2001. One additional assessment was completed in April 2002 to take advantage of an opportunity to work with the Wisconsin Focus on Energy project in order to understand the connections between energy efficiency opportunities associated with the manufacturing process and the power plant.

This report presents the results of the energy efficiency assessments performed by the Delta Institute's combustion expert and evaluates the opportunities associated with

[1] Binational Strategy Level I substances include: mercury, PCBs, dioxin, benzo(a)pyrene/hexachlorobenzene, octachlorosytrene, pesticides, and alkyl lead. Level II substances include: cadmium and cadmium compounds, 1,4-dichlorobenzene, 3,3'-dichlorobenzidine, dinitropyrene, endrin, heptachlor (and heptachlor epoxide), hexachlorobutadiene and hexachloro-1,3-butadiene, hexachlorocyclohexane, 4,4'-methylenebis(2-chloroaniline), pentachlorobenzene, pentachlorophenol, tetrachlorobenzene (1,2,3,4- and 1,2,4,5-), tributyl tin, and PAHs as a group, including anthracene, benzo(a)anthracene, benzo(ghi)perylene, perylene, and phenanthrene.

reducing both energy consumption and emissions of BTS substances from industrial boilers. The report is organized into the following sections:

> *Section 2- Background.* Provides an overview of industrial boiler units and the associated regulatory framework.
>
> *Section 3- Energy Efficiency Assessment.* Provides an overview of the energy efficiency assessments conducted by the Delta Institute's consultant and presents the energy efficiency recommendations developed for each participating facility.
>
> *Section 4- Implementation.* Describes opportunities and barriers to implementing the energy efficiency recommendations.
>
> *Section 5- Aggregation Analysis.* Presents an analysis of the emissions reduction potential to the Great Lakes region from industrial boilers that implement energy efficiency measures.
>
> *Section 6- Conclusions and Recommendations.* Presents a proposal for "getting to scale" to achieve significant emissions reductions from industrial boilers.

This work was funded by the U.S. EPA's Great Lakes National Program Office and the CIBO. The Delta institute would like to thank the facilities that participated in the audits, the Wisconsin DNR and the Wisconsin Focus on Energy for their involvement in this project.

SECTION 2: Project Background

2.1 Overview

Industrial boilers provide thermal energy in the form of hot water, saturated steam, or superheated steam needed to run processes or machinery or to produce electricity to power manufacturing operations. Each year, approximately 245 billion kilowatt hours of electrical energy or 6% of the total energy generated in the United States is produced by manufacturing industrial sources such as industrial boilers, kilns and furnaces (DOE 2001). The 51,000 industrial boilers and process heaters located throughout the U.S. (20,000 of which are located in the Great Lakes region) produce a significant portion of that energy load.

Industrial boilers are ubiquitous in industrial, commercial and institutional operations. It is estimated that over 800 industrial sectors use industrial boilers for generating electricity and steam (U.S. EPA 1998b). As shown on Table 2-1, approximately 50% of the total boilers in the U.S. are used by 17 industrial/institutional/commercial sectors to meet their energy needs.

Table 2-1: U.S. Industrial Boiler Use by Sector (1)

SIC	SIC Description	No. facilities	No. boilers	< 10 MM BTU	10 to <50 MM BTU	50 to <100MM BTU	100 to <250 MM BTU	> or =250 MM BTU	% of Total
9711	National Security And Intl. Affairs, National Security, National security	264	4,047	2,214	374	119	78	8	8%
8062	Health Services, Hospitals, General medical & surgical hospitals	849	2,283	517	901	102	35	8	5%
1311	Oil And Gas Extraction, Crude Petroleum and Natural Gas	371	2,011	318	113	81	25	9	4%
8221	Educational Services, Colleges and Universities	393	1,868	513	391	176	119	19	4%
8211	Educational Services, Elementary and Secondary Schools, Elementary and secondary schools	1,208	1,832	1,258	295	18	1	4	4%
2869	Chemicals And Allied Products, Industrial Organic Chemicals, Industrial organic chemicals, nec	328	1,373	158	185	107	216	155	3%
2911	Petroleum And Coal Products, Petroleum Refining, Petroleum refining	237	1,143	41	127	98	140	137	2%
2621	Paper And Allied Products, Paper Mills, Paper mills	286	1,030	47	92	85	141	146	2%
3312	Primary Metal Industries, Blast Furnace and Basic Steel Products, Blast furnaces and steel mills	122	1,009	73	71	44	63	17	2%
4961	Electric, Gas, And Sanitary Services, Steam and Air-conditioning Supply, Steam and air-conditioning supply	259	879	32	81	61	107	28	2%
2821	Chemicals And Allied Products, Plastics Materials and Synthetics, Plastics materials and resins	238	852	113	150	90	99	54	2%
2421	Lumber And Wood Products, Sawmills and Planing Mills, Sawmills & planing mills, general	462	829	83	158	45	21	5	2%
3714	Transportation Equipment, Motor Vehicles and Equipment, Motor vehicle parts and accessories	250	766	230	122	50	44	8	2%
2819	Chemicals And Allied Products, Industrial Inorganic Chemicals, Industrial inorganic chemicals, nec	222	704	139	125	52	49	31	1%
2834	Chemicals And Allied Products, Drugs, Pharmaceutical preparations	176	602	157	153	47	30	2	1%

SIC	SIC Description	No. facilities	No. boilers	< 10 MM BTU	10 to <50 MM BTU	50 to <100MM BTU	100 to <250 MM BTU	> or =250 MM BTU	% of Total
2752	Printing And Publishing, Commercial Printing, Commercial printing, lithographic	139	595	198	52	8	6	5	1%
2511	Furniture And Fixtures, Household Furniture, Wood household furniture	287	550	105	152	14	4	1	1%
9223	Justice, Public Order, And Safety, Public Order and Safety, Correctional Institutions	158	511	131	162	27	3	0	1%

(1) U.S. EPA. 1998b. Distribution of boilers by SIC Table. Office of Air Quality Planning and Standards. http://www.epa.gov/ttn/atw/combust/iccrarch/bo.html. April.

Many of the sectors shown on Table 2-1 are considered to be energy intensive industries. A comparison of these industrial sectors with industrial energy consumption data found in the Department of Energy 1998 Energy Consumption Survey shows the following sectors to be energy intensive and utilize industrial boilers to meet their energy needs:

- Primary Metals
- Petroleum Refining
- Paper
- Chemicals
- Transportation Equipment

2.2 Industrial Boiler Background

Sizes of industrial boilers range from off-the-shelf package boilers of less than 10 MM Btu (million British thermal units) heat input to custom installed units of more than 250 MM Btu heat input.[2] Even though some industrial boilers are as large as utility boilers (boilers owned and operated by electric generating utilities producing energy for sale), energy generated by industrial boilers is primarily for private consumption.[3] Consequently, industrial boilers are regulated separately from utility boilers. This report solely considers energy efficiency options associated with industrial boiler units.

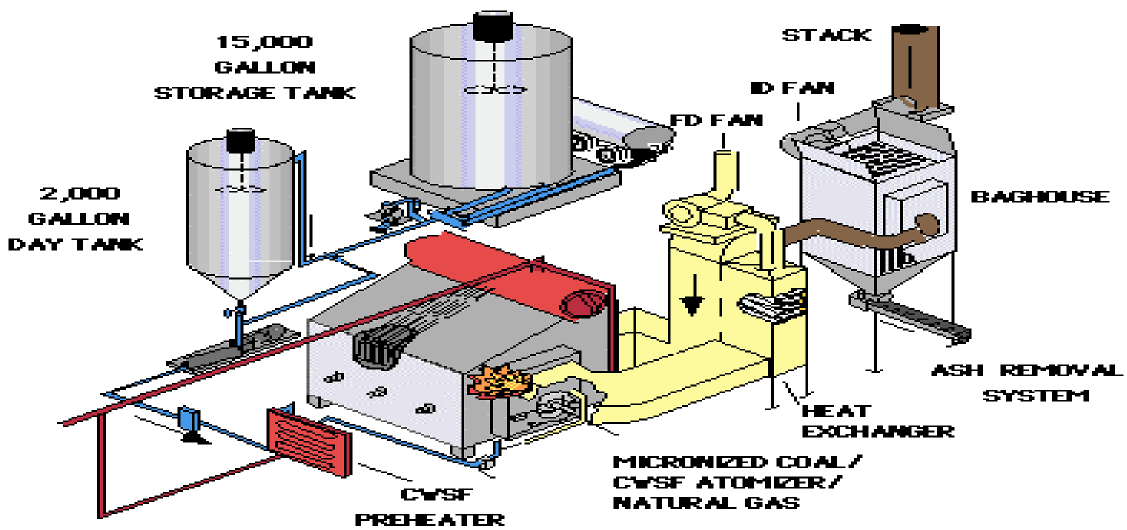
A range of industrial boiler types and sizes were assessed during this project; however, the majority of the units assessed fall into the category of large capacity, water-tube type boilers. The predominate design configurations assessed as part of this project were:

1. *Stoker-fired boilers.* Stoker-fired boilers are typically water-tube boilers with a mechanical system to feed solid fuel into the boiler. Water-tube boilers circulate hot combustion gas around water-filled tubes lining the walls of the boiler unit.
2. *Pulverized Coal (PC) fired boilers.* PC-fired boilers are also water-tube type boilers. Instead of solid fuel, pulverized coal is injected with primary combustion air into the boiler unit from a series of coal injection points. Liquid and gaseous fossil fuels can be supplemented in PC-fired boilers.

[2] A British thermal Unit (Btu) is a standard unit of heat measure approximately equivalent to 0.293 Watts.
[3] An electric utility is defined in Section 112 (a) (8) of the Clean Air Act as "any fossil fuel fired combustion unt of more than 25 megawatts electric (MWe) that serves a generator that produces electricity for sale." A unit that cogenerates steam and electricity and supplies more than one-third of its potential electric output capacity and more than 25 MWe output to any utility power distribution system for sale is also considered an electric utility steam generating unit.

3. *Fluidized bed combustion (FBC) boilers.* Fuel is burned on a bed of hot particles suspended by an upward flow of combustion air. As compared to other water-tube type boilers, FBCs can burn a variety of fuel types and generally achieve greater rates of efficiency.
4. *Cyclone-fired boilers.* Cyclone-fired boilers are water-tube type boilers where high-temperature flames circulate in a cyclonic pattern. Cyclone-fired boilers are almost always coal-fired units.

A more detailed description of these, and other types of industrial boiler units, can be found in the CIBO's *Industrial Boiler Guide.* Figure 2-1 shows a simple schematic of a water-tube boiler.



Schematic from the Coal Utilization Center

For the purposes of this report, the primary distinction between boilers is fuel source. The type of fuel used together with the individual boiler efficiency characteristics defines the air emissions profile (e.g. type and quantity of controlled and uncontrolled emissions) for industrial boiler units. The three fuels most commonly used in industrial boilers are coal, liquid fossil fuel, and natural gas (CIBO 2002). Alternative fuel sources such as wood, tires and other solid waste, and process gases are utilized by less than 1% of industrial boilers in the Great Lakes region.

Coal was the most common fuel used in the industrial boilers evaluated in this project. Fuel oil and natural gas were used in several of the smaller size units evaluated or as supplemental fuel for coal-fired units. Coal is a solid fossil fuel that varies in heat value based on the type of coal and source location. Classes of coal include lignite, sub-bituminous, bituminous, and anthracite. The type and quantity of criteria and toxic emissions depend on the class of coal. Fuel oils are liquid fossil fuels that also vary in heat value based on the type of fuel oil. For the purpose of this report, two types of fuel oil are considered- distillate fuel oil and residual fuel oil. Distillate fuel oils (e.g. Number 2 fuel oil) are more refined than residual fuel oils and are generally considered to have fewer emissions of toxic pollutants as compared to residual fuel oil or coal. Distillate oils are commonly used for residential heating or as supplemental fuels in industrial boilers. Residual fuel oils (e.g. Number 6 fuel oil) are more viscous and have greater emissions of criteria and toxic compounds than the lighter, less viscous distillate oils. Natural gas is considered to be the cleanest burning fuel- lowest overall emissions of criteria and toxic pollutants- of the three fuels considered in this report. Natural gas is used as the primary fuel by some smaller industrial boiler units and as a supplemental fuel source by larger units.

The efficiency of a boiler unit is the capacity of the unit to maximize the conversion of fuel energy to thermal energy with minimal heat losses. It is generally accepted that more efficient boilers utilize less fuel to produce a given quantity of steam or energy (CIBO 2002). Correspondingly, reduced fuel usage results in reduced emissions per a given quantity of energy produced. Two factors that affect operation at optimal efficiency are combustion efficiency and boiler efficiency (CIBO 2002). Combustion efficiency is the ability of the boiler through design and operational parameters to extract the maximum energy from the fuel sources or to achieve complete fuel combustion. Boiler efficiency is a function of non-combustion related losses such as radiant heat loss, blow-down loss, and other unaccounted losses (CIBO 2002). The industrial boiler assessments completed as part of this project identified efficiency improvements to improve both combustion efficiency and boiler efficiency with the overall result being reduced fuel usage.

2.3 Pollutants of concern

Emissions from industrial boilers are a function of the type and quantity of primary fuel burned in the boiler unit, the type of boiler, and emissions controls. Boilers emit a variety of pollutants including those pollutants associated with combustion processes, such as nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter (PM), and carbon monoxide (CO), as well as air toxics. The primary air toxics include: formaldehyde, polynuclear aromatic hydrocarbons (PAHs), lead, hydrogen chloride, cadmium, mercury, and dioxin/furans (US EPA 1998). Several of the air toxics emitted by industrial boiler units, such as mercury, dioxin/furans, cadmium, PAHs, and 1,4-dichlorobenzene are considered to be Level I and II pollutants of concern under the BTS program which are the primary focus of this project.

2.4 Regulatory Framework

Industrial boilers considered to be major sources are regulated for hazardous air pollutants and certain criteria pollutants.[4] Title V of the Clean Air Act contains provisions for issuing operating permits by the federal government or designated state agencies (40 CFR 70 and 71). For some units, the Acid Rain Program may also be applicable (40 CFR 72). Additionally, new boiler units over a certain size are required to comply with National Ambient Air Quality Standards (NAAQS) and New Source Performance Standards that regulate criteria pollutants including NO_x, SO_2, CO, PM, and ozone (O_3). New large sources or modification of existing sources located in attainment

[4] A major source is considered to emit more than 25 tons of total hazardous air pollutants per year or more than 10 tons of any one hazardous air pollutant per year.

areas must comply with the Prevention of Significant Deterioration (PSD) requirements (40 CFR 52.21).[5] Sources located in non-attainment areas must obtain a Non-attainment New Source Review Permit.

A Maximum Achievable Control Technology (MACT) standard for industrial, commercial and institutional boilers and process heaters will be proposed by the U.S. EPA in summer 2002 (Eddinger 2002a). The MACT rules are technology driven requirements that require facilities to meet emissions limits of hazardous air pollutants (HAPs). Industrial/commercial/institutional boilers and process heaters situated at a major source facility will likely be required to comply with the MACT standards. Nationwide it is estimated that 57,000 units (42,000 boilers and 15,000 process heaters) will be required to comply. Fossil fuel-fired electric utility boilers, municipal waste boilers, hazardous waste boilers, medical waste boilers, black liquor recovery boilers, hot water heaters, and waste heat boilers will not be addressed by the upcoming MACT rules (Eddinger 2002a).

The Industrial/Commercial/Institutional Boiler MACT is anticipated to include provisions for controlling the following compounds: metal and particulate matter, acid gases, and mercury. With respect to the BTS compounds, when fully implemented the MACT rules are expected to reduce cadmium by 10.3 tons per year and mercury by 1.9 tons per year. MACT will not likely regulate organic HAPs, although some reductions may be realized based on the final emissions limitations promulgated, therefore projected reductions from MACT implementation for dioxin, PAHs, 1,4-dichlorobenzene are not available (Eddinger 2002a). The MACT emissions limits are based on the concentration of HAPs per unit of fuel input as compared with total HAPs in the fuel. Therefore, energy efficiency measures that depend on decreasing HAPs emissions by reducing fuel usage could not necessarily be used to meet the MACT emissions limits. However, reductions through energy efficiency opportunities will become increasingly important in those states, such as Wisconsin, that are in the process of promulgating state rules to control combustion and industrial sources of certain compounds- specifically mercury.

[5] An attainment area is a geographic area considered to meet the U.S. EPA National Ambient Air Quality Standards for six criteria pollutants: carbon monoxide, nitrogen dioxide, ozone, lead, particulate matter, and sulfur dioxide. Additional information can be found at the U.S. EPA website- www.epa.gov/airs/criteria.html.

SECTION 3- Energy Efficiency Assessments

3.1 Overview

The combustion expert, hired by the Delta Institute, performed boiler energy efficiency assessments at nine facilities with a total of thirty-four operating boilers. Primary operations at the participating facilities included:

- Four pulp and paper producers (designated in this report as PVT-1 through 4);
- One manufacturing facility (designated PVT-5); and,
- Four institutional facilities (designated PUB-1 through 4).

Except for the manufacturing facility, coal was the primary fuel source used in each industrial boiler. The manufacturing facility used natural gas because of the relatively small size of its boilers. Table 3-1, found at the end of this section, summarizes the boiler types, sizes, and fuel sources at each participating facility.

Each assessment included: a one to two day site walkthrough of readily accessible areas of the power plant; a visual inspection of each boiler, control room, and associated equipment; and visual inspections of fuel storage areas. The consultant also interviewed on-site personnel responsible for maintenance and operation of each power plant. When available, each facility provided data for operating parameters (e.g. oxygen, inlet air temperature, flue gas temperature) for each boiler as well as stack emissions measurements. Plant-specific energy efficiency recommendations were developed based on the site visit. In general, the consultant used the following assessment methodology:

1. *Consultation with facility managers*. The consultant interviewed facility managers and power plant operators and collected general background facility information such as: type and configuration of combustion devices and steam systems and fuel use records. The consultant also reviewed pertinent technical documentation including: previous audit or testing reports, stack testing, and permits. In some cases, the facility provided this information prior to the on-site assessment.
2. *Inspection and audit of facility*. The consultant assessed the feasibility and effectiveness of implementing the following specific combustion and steam efficiency measures:
    - Combustion Evaluation and Optimization Methods
    - Combustion Monitoring and System Controls
    - General Operations and Training of Staff
    - Steam Load and Efficiency Measures
    - Combined Heat and Power (CHP) potential.
3. *Facility report*. Recommendations on the feasibility of implementing specific combustion and steam efficiency measures and combined heat and power were provided. This included estimates of costs to implement, fuel and cost savings, and specific emission reductions, including persistent bioaccumulative compounds.

The recommendations were discussed with each facility immediately following the site visit and a follow-up letter report documenting the recommendations and, in some cases, capital costs and estimated payback periods.

The scope of the April 2002 assessment performed at a small manufacturing facility was different from the previous assessments. The manufacturing facility had previously undergone a process side energy efficiency assessment by the Wisconsin Focus on Energy process experts. Based on that assessment, it was determined that greater energy efficiency savings could potentially be realized throughout the plant if the boiler and steam generating systems also operated more efficiently. The Wisconsin Focus on Energy group contacted the Delta Institute to participate in the project. At the time of this report, the Wisconsin Focus on Energy group is continuing to coordinate with the facility to implement the recommendations.

3.2 Energy Efficiency Recommendation Trends

The energy efficiency opportunities recommended to a participating facility can be divided into nine categories based on industrial boiler operations, as follows:

- Start-up procedures
- Fuel management
- Water treatment
- Combustion air pre-heating
- Controls
- Flue gas treatment
- Associated equipment
- Steam systems
- Heat recovery.

In general, the recommendations have been grouped to correspond to typical power plant operational areas and could, therefore, be implemented at other industrial boiler facilities. Even though boiler systems have many of the same operational components, it should be acknowledged that most large boiler systems are custom designed and installed to meet specific facility power needs. The final category- Facility-specific recommendations- represents those recommendations that are particular to a facility and not likely to be broadly implemented at other facilities. A description of each of the categories follows.

> *Start-up/shut-down procedures*- Boiler start-ups typically require one to six hours to achieve optimal operating temperatures. Until the operating temperature is reached, the start-up fuel is not completely combusted causing increased emissions of toxic compounds. Frequently, boiler owners will use a relatively low emission fuel, such as natural gas, during start-up to alleviate this problem. This, however, is not the case with all boilers. Start-up procedures typically do not improve boiler efficiency; however, managed start-up and fuel choice can minimize regulatory compliance issues as well as significantly reduce toxics. In one instance, shut-down procedures provided energy savings. If the boiler units

are relatively small, shutting the units down in the evening would provide energy savings.

Fuel management- Fuel is typically the most costly item associated with boiler operation; therefore, the maximum BTUs should be extracted from each load of fuel introduced into the boiler. Improving management of fuel storage areas to reduce excess water and debris and enhancing fuel input mechanisms are methods that can easily be implemented to improve the combustion potential of fuels.

Water treatment- Water is the most common medium for boiler heat exchange and steam generation. Proper conditioning of water used in boiler systems, in order to prevent scaling and fouling, is integral to maintaining efficient boiler operations.

Combustion air preheating- Preheating inlet combustion air with otherwise wasted heat is one method to improve combustion and increase the efficiency of the boiler unit.

Controls- Implementing control strategies that take advantage of improved measurement techniques such as computer based distributed control systems for air flow, pressure, and temperature can be utilized by boiler operators to improve overall system efficiency.

Flue gas treatment- Flue gas controls are necessary to minimize criteria and toxic pollutants into the atmosphere. Improved pollution reduction techniques and control measures do not necessarily provide energy efficiency opportunities; however, these measures can improve regulatory compliance.

Associated equipment- Auxiliary equipment includes fans, pumps, motors, turbines, and material handling equipment. Proper control, operation, and maintenance of this equipment, as a whole, will result in significant energy efficiency improvements. Replacing equipment with high efficiency models or installing variable speed drives will more significantly improve energy efficiency.

Steam systems- Operation and maintenance of steam system components such as steam generating equipment, steam traps, and steam lines have been found to be one of the best energy and cost saving techniques.

Heat recovery- Utilizing excess heat from boiler operations to fuel other plant processes or to create energy that can be sold to a local utility is one method of efficiently using all of the BTUs generated from the boiler fuel. Economic gains from combined heat and power systems will vary, however, based on the local utility pricing structure and the power needs of the plant.

Table 3-2, found at the end of this section, summarizes the recommendations presented to each facility. Estimated capital costs were based on typical purchase and installation requirements and yearly cost savings and payback periods were based on yearly fuel usage and estimated yearly primary fuel savings that would result from implementing the recommended energy efficiency improvement.

Taken together, these eight categories represent some of the best opportunities for cost savings from energy efficiency. Table 3-3 presents the average energy efficiency savings, costs, and payback period for each category.

Table 3-3: Average Recommendation Costs and Efficiency Improvements

Category (1)	No. of Recommendations	Average Capital Cost to Implement	Average Yearly Cost Savings	Average Efficiency Improvement
Start-up/Shut-down procedures	4 (2)	$0	$1,500	<1%
Fuel management	9	$77,000	$133,800	0.8
Water treatment	4	$93,200	$24,300	2
Combustion air pre-heating	3 (2)	$12,000 to $75,000	$146.700	2
Controls	8	$53,100	$46,000	1.4
Associated equipment	2	$65,000	$109,800	3
Steam systems	6	$21,350	$313,900	9
Heat Recovery	4	Further assessment required.		

(1) Recommendations pertaining to flue-gas treatment were not included in Table 3-3 because no efficiency improvements would be realized for those recommendations although reductions in toxics would likely occur. Only one start-up/shut-down procedure would provide efficiency improvements. These recommendations, as shown on Table 3-2, generally address permit issues and stack emission controls.
(2) Cost information provided for one recommendation only.

3.3 Discussion

A comparison with other energy efficiency studies shows that the energy efficiency savings developed by this project are less than those projected by CIBO in their Energy Efficiency Handbook or DOE/Industrial Assessment Centers (IAC) database for similar recommendations (CIBO 1997; U.S. EPA 1999). Energy efficiency improvement estimates developed for this project are considered to be conservative (low) due to the small sample size (9 facilities).

Average capital costs and payback periods for the project recommendations are representative for the paper and allied products industry (SIC 26) when compared to the DOE/IAC database of 226 paper and allied product companies summary of energy efficiency measures. (U.S. EPA 1998c). For example, the average implementation cost for the pulp and paper facilities assessed by the Delta Institute is $76,000 while the DOE/IAC database average is $65,000. Alternately, payback costs for recommendations developed as part of this project are generally higher than the DOE/IAC database. The capital costs and payback periods developed for the manufacturing facility were higher than the averages found in the DOE/IAC database of efficiency measures (U.S. EPA 1998c). The primary reason for these differences is that the costs developed for the participating facilities did not fully integrate operation and maintenance costs and used using maximum operating parameters to calculate the fuel load.

SECTION 4- Implementation

4.1 Overview

Several months after the site visits, the Delta Institute requested each participating facility to complete a short survey. The purpose of the survey was threefold. First, each facility was asked to assess progress toward implementation of energy efficiency opportunities. Second, each facility was asked to identify incentives and barriers affecting implementation of the recommendations. Third, feedback regarding incentives that would lead to energy efficiency changes was requested. A sample survey is included in Appendix B. The following presents a summary of the survey feedback from each the participating facilities. The small manufacturing facility had not completed a survey at the time of this report. The section headers correspond with each section of the survey.

Assessment

Each facility reported that previous boiler efficiency studies had been completed at the plant. Generally, the facilities considered the assessment to be helpful although a greater level of detail could have been provided with the recommendations. All of the responding facilities, however, felt that on-site screening of certain operational parameters such as O_2 or CO would have been helpful. Providing the additional screening data as part of the assessment report may have enabled some of the facilities to justify expenditures for additional studies or analysis to follow-up the recommendations. For instance, PVT-3 noted during the site visit that there was some uncertainty with the reliability of existing O_2 control measurements- an operational parameter needed to control the air-heat ratios and maximize fuel combustion. Routine screening as part of the assessment could have been used to confirm the internal controls. One facility noted that a permit and regulatory review would have been helpful.

Assessment Recommendations and Implementation

At each facility, the operators and power plant supervisors were very familiar with the operational issues of each boiler unit. Therefore, energy efficiency opportunities presented to the facilities were, for the most part, already known. In general, the recommendations provided to each facility can be categorized into three areas:

1. New findings
2. Known issues being considered for implementation
3. Known issues not being considered for implementation.

Two recommendations provided by the Delta Institute's consultant had not been considered by the facilities prior to the assessment. PVT-1 noted that the facility-specific recommendation to install activated carbon filters to collect and filter vapors emitted from the steam injections process into the paper rolling/process units had not been considered by the facility even though odors were detected in the facility. This recommendation would not improve boiler efficiency but the carbon filters would likely reduce emissions of certain toxics as well as improving the workplace environment; however, it is unlikely that PVT-1 will implement this recommendation. PUB-1 acknowledged that they were not aware if the high exhaust exit temperatures on the three existing boilers. High exhaust temperatures indicate the presence of waste heat that could be recirculated or reused; however, additional research is needed to assess the energy potential and identify possible uses. The facility plans to investigate the exhaust gas temperatures from the boiler units and assess the potential for waste heat recovery.

Five recommendations by the Delta Institute's consultant were already being considered for implementation based on previous assessments and/or internal reviews. Three recommendations presented to PVT-1 were already under consideration at the time of the Delta Institute's audit including: 1) preheating inlet combustion air; 2) fuel drying; and, 3) installing a protective rain cover for bark fuel storage area. To date, PVT-1 has not implemented these recommendations since the capital costs for each are relatively high ($50,000 to $100,000) with efficiency savings of approximately 2%. PVT-3 noted that they were already addressing excess air to the Boiler Unit 10 through an extensive boiler overfire control testing program underway as part of a regulatory process. Once PVT-3 corrects this problem, efficiency savings of up to 2.5% could be realized. Lastly, PUB-2 noted that they were considering replacement of the coal stokers prior to the Delta Institute's assessment in order to improve opacity and remain within permitted limits. Potential energy efficiency improvements for this recommendation were only 0.25% while capital costs are relatively high (greater than $100,000 per boiler).

The remainder of the recommendations were known to the power plant operators interviewed at each facility but were not being considered for implementation due to high capital costs, long payback periods, and/or other operational considerations. Two opportunities- steam trap maintenance and chemical cleaning- presented to PVT-2 had high efficiency savings and short payback periods yet were not being considered by plant personnel as viable energy efficiency projects even though energy and cost savings potentials were known to the plant operators. According to plant personnel, internal budget constraints prevented even those recommendations with low capital costs, short payback periods, and high efficiency savings from being implemented. However, plant representatives felt that a report from a third-party audit may be helpful to obtain buy-in of upper management for implementation of some efficiency measures.

Factors leading to efficiency improvements
Each facility provided feedback about factors that contribute in making efficiency improvement decisions. According to the facilities surveyed and as shown on Table 4-1, the dominant factors that lead to implementing energy efficiency improvements are payback periods of less than two years and regulatory relief- particularly from New Source Review requirements.

Table 4-1: Factors Leading to Energy Efficiency Improvements

	PVT-1	PVT-2	PVT-3	PVT-4	PUB 1 to 3
Payback period less than two years	✓	✓	✓	✓	✓
Better economy	✓	✓			
Management support	✓	✓			✓

Increasing priority of energy efficiency alternatives in management plan	✓		✓	✓	✓
Proven technology	✓		✓	✓	✓
Streamlined permitting	✓		✓	✓	✓
New source review relief	✓	✓			✓
Relief from certain regulatory requirements	✓	✓	✓	✓	✓
Access to low interest loans	✓				✓
Other					Emission credits

Note: PVT-5 did not complete a survey at the time of this report.

4.2 Discussion

Feedback from the participating facilities identified specific technical assistance and outreach strategies that should be considered to increase the likelihood that industrial boiler owners would implement energy efficiency measures. First, capital expenditures for power plant upgrades are often limited because power plants are traditional cost centers in a manufacturing operation. Rather than focus on traditional payback periods, one consultant advised analyzing the costs of maintaining an old boiler, such down time, maintenance repairs and labor, chemical treatment (water) and energy usage, versus capital and operational costs associated with a newer, more efficient boiler. Also, providing technical implementation assistance and other incentives are necessary to help implement certain recommendations. Second, limited operational parameter testing and data collection, such as hand-held oxygen analyzers, is warranted to justify further consideration of recommendations. Lastly, assistance providers need to avoid "free audit syndrome." Boiler operators are knowledgeable about their units and, more often than not, use free assessments to justify their own ideas or recommendations from prior assessments. Many facilities will say yes to a free assessment, even if they have had independent consultants or government agencies already perform similar audits.

SECTION 5: BTS Compound Emission Aggregation Analysis

5.1 Overview

The objective of the emissions aggregation analysis was to evaluate the potential for Great Lakes region-wide reductions of five BTS compounds that would result from extensive implementation of energy efficiency improvements. The Delta Institute completed an analysis that evaluated the potential emissions from industrial boilers in eight Great Lakes states. The industrial boiler source data used for this analysis was obtained from the U.S. EPA Emissions Test Database, Population Database, and Materials Analysis Database, dated December 14, 1999, developed by the U.S. EPA for the Industrial/Commercial/Institutional Boiler National Emissions Standards for Hazardous Air Pollutants (NESHAP). The NESHAP database was based on state input. As part of the Industrial/Commercial/Institutional Boiler MACT rulemaking, the U.S. EPA developed a range of emission factors for 31 chemical compounds emitted from industrial and commercial boilers based on boiler type, fuel source, and control technology.[6] The U.S. EPA provided the NESHAP database and emission factors to the Delta Institute. This section presents the results of the emissions aggregation as well as an analysis of those results.

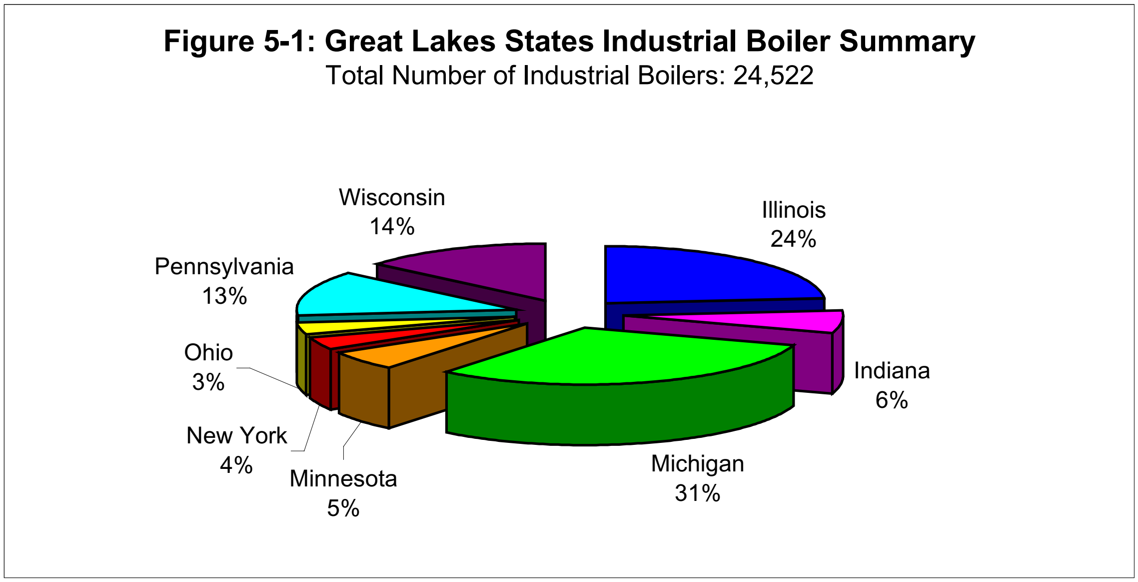
The emissions factors used in the analysis were developed and provided to the Delta Institute by the U.S. EPA. The U.S. EPA developed these emissions factors for the Industrial/Commercial/Institutional MACT rulemaking. Only Level I and II BTS compounds and certain criteria pollutants with calculated emissions factors were included in the aggregation analysis.

The Delta Institute chose to utilize the U.S. EPA NESHAP database and emissions factors, as opposed to the U.S. EPA National Toxics Inventory (NTI) or the Great Lakes Inventory, based on the age of the data- the most current data available from NTI at the time of this report was 1996. The NTI database was used as a comparative measure of the aggregated industrial boiler emissions when more recent data was unavailable.

5.2 Aggregation Analysis

Boilers were segregated by state, fuel type, and fuel input rate in order to complete the aggregation analysis. Figure 5-1 shows the breakdown of industrial boiler units by state.

[6] Emission factors developed by the Industrial/Commercial/Institutional MACT program for the following compounds: 1,4-dichlorobenzene, 16-PAHs, acetaldehyde, acrolein, arsenic, benzene, beryllium, cadmium, chlorine, chromium, dibenzofuran, dibutylphthalate, dioxin, ethylbenzene, formaldehyde, hydrochloric acid, hydrofluoric acid, lead, manganese, mercury, methyl chloroform, methyl ethyl ketone, methylene chloride, nickel, o-xylene, phosphorus, toluene, xylenes, particulate matter, carbon monoxide, and sulfur dioxide.



The following table further segregates the number of boilers in each state by fuel type and size in order to analyze the emissions from each fuel source.

Table 5-1: Percent Total Number of Great Lakes States Industrial Boilers per Primary Fuel Source

State	Total Boilers	Coal (% Total)	Residual Fossil Fuel (% Total)	Distillate Fossil Fuel (% Total)	Natural Gas (% Total)	Other (% Total)
Illinois	5,769	3	5	7	84	~1
Indiana	1,561	11	6	13	68	2
Michigan	7,570	5	2	5	88	<1
Minnesota	1,348	5	6	16	70	3
New York	900	4	27	22	39	8
Ohio	802	36	8	16	37	3
Pennsylvania	3,150	10	13	18	56	3
Wisconsin	3,422	3	4	13	78	2

Based on Figure 5-1 and Table 5-1, the predominate fuel type used in industrial boilers in the Great Lakes region is natural gas which is also the fuel considered to have the lowest emissions of toxic compounds. Natural gas, however, is primarily used in the smaller size boiler units (less than 10 MM Btu fuel input per hour) because of the higher cost of natural gas as compared to coal and oil. Ohio is an anomaly with an equal or greater percentage of coal boilers as compared to other fuels.

The average air emissions of five Level I and II BTS compounds were calculated utilizing the U.S. EPA emissions factors developed for the Industrial/Commercial/Institution Boiler MACT. The average emissions, by fuel type, were then developed for each size category of boiler. Average emissions were used to compensate for the emissions profile differences between boiler types and control technologies. Attachment C presents the total air toxic emissions on a state by state and fuel type basis.

Table 5-2 summarizes the detailed emissions breakdowns in Attachment C. This analysis shows that the majority of emissions to the eight Great Lakes states are from industrial boilers using coal fuel, other fuel (wood, tires, other solid materials), and residual fossil fuel.

Table 5-2: Summary of Aggregated Air Emissions of Specific BTS Compounds from Industrial Boilers in the Great Lakes Region

Compound	Total Emissions (Lbs/Year)	Coal (% Total)	Residual Fossil Fuel (% Total)	Distillate Fossil Fuel (1) (% Total)	Natural Gas (% Total)	Other (% Total)
Hg	9,050	49	43	<1	NA	8
Dioxin	3	57	3	3	5	30
Cd	11,400	72	3	<1	15	9
1,4-Dichlorobenzene	1,220	83	NA	NA	NA	17
16-PAHs	360,970	3	3	7	84	4

(1) Emission factors develop for mercury in residual fossil fuel are considered conservation since the emission factors developed for the Industrial/Commercial/Institutional MACT were based on utility boiler emissions (Eddinger 2002b).

Comparing the results from Table 5-1 and Table 5-2 shows that approximately 1,500 coal boilers and approximately 1,400 residual fuel boilers are the primary sources of certain toxic air compounds from industrial boilers in the Great Lakes region. As shown on Figures 5-2 and 5-3, 12% (6% coal fired and 6% residual fossil fuel fired) of the boilers are responsible for the majority of toxic air emissions of certain BTS compounds from industrial boilers in the eight state region.

Figure 5-2: Great Lakes States Industrial Boiler Primary Fuel Summary

Total Number of Industrial Boilers: 24,522

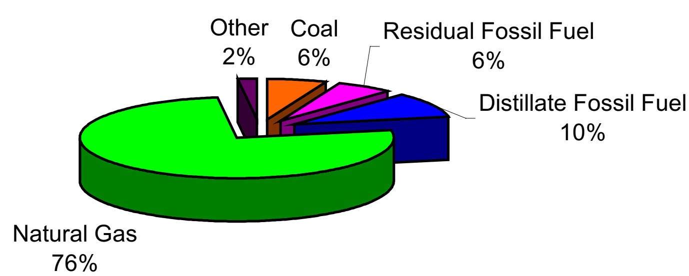
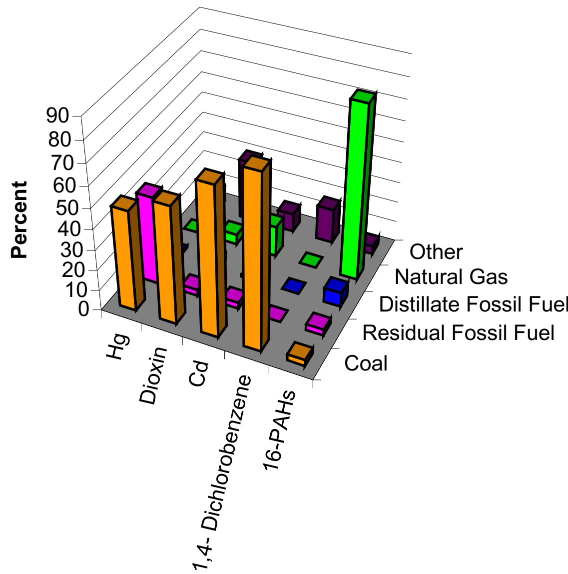


Figure 5-3: Specific Binational Toxic Compound Emissions versus Primary Fuel Type



5.3 Significance of Industrial Boiler Emissions

Industrial boilers are used in many industrial sectors; therefore, obtaining accurate emissions estimates is challenging. For instance, some facilities aggregate boiler emissions with the total plant emissions making it difficult to ascertain the contribution to total emissions from the boiler units. In order to put the emissions profile developed from this aggregation effort into perspective, a comparison between emissions of select compounds from boilers with total nationwide emissions from all sources has been completed. Tables 5-3 and 5-4 compare the industrial boiler emissions of Level I and II BTS compounds aggregated for this project with publicly available emissions databases.

Table 5-3: Comparison of Total Great Lakes States. Industrial Boiler Emissions with Total U.S. Emissions from All Sources

Compound	Binational Toxics Strategy Level	Aggregated Emissions for Eight Great Lakes States (tons/year)	1996 U.S. Emissions from All Sources EPA National Toxics Inventory (tons/year)	U.S. Emissions from All Sources Other Data Source (tons/year)	Percent of National Total
Mercury	Level I	4.5		125 (1)	3.6
Dioxin	Level I	3.0 lbs/year		2.2 to 90 lbs/year (2)	0 to 3.3
Cadmium	Level II	5.7	157		3.6
1,4-Dichlorobenzene	Level II	0.6	10,984		<1
16-PAHs	Level II	180	20,873		<1

(1) Cain 2002.
(2) U.S. EPA 2000.

Industrial boiler emissions for the Great Lakes region comprise up to 3% of the estimated national emissions for mercury, dioxin, and cadmium. Nationwide, emissions of the aforementioned five compounds from industrial boilers are estimated as follows:

Table 5-4: Comparison of Total U.S. Industrial Boiler Emissions with Total U.S. Emissions from All Sources

Compound	U.S. Emissions from All Sources (tons/year)	U.S. Aggregated Industrial Boiler Emissions (tons/year)	Percent Total of U.S. Emissions from All Sources
Mercury	125 (1)	14	10
Dioxin	2.2 to 90 lbs/year (2)	10.7 lbs/year	0 to 12
Cadmium	157 (3)	19.8	13
1,4-Dichlorobenzene	10,984 (3)	3.6	<1
16-PAHs	20,873 (3)	375	2

(1) Cain 2002.
(2) U.S. EPA 2000.
(3) U.S. EPA 2002.

5.4 Efficiency Improvement Potential

The estimated emissions reductions for five BTS compounds shown in Table 5-5 are based on reduced fuel usage associated with implementing energy efficiency recommendations. Since energy improvements result in less fuel usage, it is not surprising that the most significant emissions reductions would result from improvements to coal, residual, and other fuel (e.g. wood, tires, other solid materials) boilers.

Table 5-5: Estimated Emissions Reductions from Great Lake States Industrial Boilers Resulting from a 10% Energy Efficiency Improvement (1)

Compound	Coal (lbs/yr)	Residual Fuel Oil (lbs/yr)	Distillate Fuel Oil (lbs/yr)	Natural Gas (lbs/yr)	Other Fuel (lbs/yr)	Total (lbs/yr)
No. Boilers	1,531	1,436	2,564	18,591	387	24,509
Mercury	443	389	<0.01	NA	73	905
Dioxin	0.17	~0.01	~0.01	~0.02	~0.09	0.3
Cadmium	826	32	6	175	101	1,140
1,4 Dichlorobenzene	101	NA	NA	NA	21	122
16-PAHs	1,043	927	2,353	30,453	1,293	36,069

(1) The potential emissions reductions, according to fuel type, from implementing energy efficiency improvements are shown in Attachment C. Each table in Attachment C presents the aggregated potential reductions associated with a 1%, 2%, 5%, or 10% fuel savings possible from energy efficiency improvements.

For example, 905 pounds of mercury emissions could be avoided if industrial boiler units implemented some form of energy saving measures and reduced fuel use by 10%. This represents approximately 1% of mercury from all emissions sources in the Great Lakes region and 0.4% of mercury of all U.S. emissions sources (U.S. EPA 1998d; Cain 2002). On a national level, industrial boilers emit approximately 14 tons, or 28,000 pounds, of mercury per year (Eddinger 2002a) representing approximately 10% of the total estimated U.S. mercury emissions from all sources. Achieving a 10% energy efficiency reduction for all boilers represents 1% of total U.S. mercury emissions. Table 5-6 presents a similar analysis for the five BTS compounds analyzed above.

Table 5-6: Comparison of Estimated Emissions Reductions from Great Lakes States Industrial Boilers Compared to Total U.S. Emissions from All Sources

Compound	U.S. Emissions from All Sources (tons/yr)	Estimated U.S. Industrial Boiler Emissions Reductions from a 10% Efficiency Improvement (tons/yr)	% Total of Estimated 10% Reduction Compared to U.S. Emissions from All Sources
Mercury	125 (1)	1.1	~1%
Dioxin	2.2 to 90 lbs/year (2)	1.07 lbs/year	0 to 1%
Cadmium	157 (3)	2	1%
1,4-Dichlorobenzene	10,984 (3)	~0.4	<<1%
16-PAHs	20,873 (3)	37	<1%

(1) Cain 2002.
(2) U.S. EPA 2000.
(3) U.S. EPA 2002.

Furthermore, a 10% energy efficiency with coal and residual fuel boilers would result in important reductions of criteria pollutants.

Table 5-7: Estimated Criteria Pollutant Emissions Reductions from Great Lake States Industrial Boilers Resulting from a 10% Energy Efficiency Improvement

Compound	Coal (tons/yr)	Residual Fuel Oil (tons/yr)	Distillate Fuel Oil (tons/yr)	Natural Gas (tons/yr)	Other Fuel (tons/yr)	Total (tons/yr)
No. Boilers	1,531	1,436	2,564	18,591	387	24,509
Particulate Matter	189,334	24,143	1,795	1,623	64,298	281,193
Carbon Monoxide	11,532	1,663	6,698	6,669,094	98,961	6,787,948
Sulfur Dioxide	1,093,946	(1)	(1)	(1)	194,065	1,288,011
Carbon Dioxide	1,104	635	898	2,988	(1)	5,625
Nitrogen Oxide	(2)	(2)	(2)	(2)	(2)	(2)

(1) Emissions factors were not readily available.
(2) CO_2 and NO_x reductions will occur; however emission factors were not developed as part of the Industrial Boiler MACT program. Where provided, emissions for CO_2 are based on emissions factors provided in the U.S. EPA Climate Wise: Wise Rules for Industrial Efficiency (U.S. EPA 1998c)

5.5 Summary

Industrial boilers represent a significant source of air toxics to the Great Lakes region and the U.S. Comparison of industrial boiler emissions with national emissions estimates for all sources show that emissions from boilers comprise a significant portion of the national inventory- 10% or greater- for certain toxic compounds. Energy efficiency improvements that result in reduced fuel use are one way to achieve nationally significant emissions from industrial boilers. For example, achieving a 10% fuel use improvement for all industrial boilers represents 1% of the total mercury emitted in the U.S. The same 10% reduction achieved by industrial boilers using coal as the primary fuel, representing 5.7% of the total U.S. industrial boilers, would result in a reduction of 1,320 pounds of mercury or 0.5% of total emissions from all U.S. sources of mercury. Similarly, a 10% efficiency reduction in the Great Lakes region would result in approximately 1% reductions of total cadmium emitted in the U.S.

Comparatively, the Industrial/Commercial/Institution Boiler MACT rules are expected to achieve reductions of certain BTS compounds- mercury and cadmium- through emissions limits (Eddinger 2002b). Reductions of other toxic compounds, such as organic hazardous air pollutions, are likely but have not been calculated by the U.S. EPA. While the total reductions of these compounds from MACT implementation are greater than for energy efficiency measures, the benefits from implementing energy efficiency measures- such as reduced fuel usage and cost savings- will not necessarily be realized through MACT implementation.

SECTION 6- Conclusions and Recommendations

6.1 Conclusions

This section summarizes the results of the Delta Institute's outreach to industrial boiler owners and emissions aggregation analysis.

Overall, based on our work at nine Wisconsin facilities, with a total of 34 industrial boilers, we found that optimizing energy needs (e.g., reducing the amount of fuel input) can result in reductions of toxics, in addition to lowering greenhouse gas emissions because of reduced fuel use. Our aggregation analysis showed that industrial boilers are a substantial source of toxic compounds. Even though emissions of toxic compounds from industrial boilers are significant, they are not well inventoried since industrial boiler emissions are often grouped together with the total facility emissions.

The aggregation analysis showed that over 20,000 industrial boilers are located at facilities in Great Lakes. Twelve percent, or 2,900, of industrial boilers that use coal and residual fuel oil as the primary fuel, emit the majority of toxic emissions. For example, almost all of the 4.5 tons per year of mercury emitted by industrial boilers are from coal and residual fuel fired units. Our analysis of industrial boiler emissions shows that a conservative 10% efficiency improvement by coal and residual fuel fired boilers alone would result in reduced mercury emissions of over 900 pounds to the Great Lakes Basin. Furthermore, a 10% energy efficiency with coal and residual fuel boilers would result in important reductions of criteria pollutants.

6.2 Recommendations

Because of the significance of industrial boilers as a source of air toxics and the potential for reductions through energy efficiency measures, we recommend that resources be dedicated to designing a large-scale pollution prevention outreach initiative that links toxic reduction and energy efficiency. By doing so, the "natural" cost savings incentive of energy efficiency can be used to achieve quantifiable reductions of toxics as well as criteria pollutants such as carbon monoxide, sulfur dioxide, nitrogen oxides, particulate matter, and carbon dioxide.

Such an effort would focus on coal and residual oil fired boilers in energy intensive industries in order to take advantage of the reduction potential from this "sector." Focusing on coal and residual-fired units would reduce the target pool of industrial boilers from over 20,000 to 2,900 located in approximately 1,100 facilities in the Great Lakes region. The greatest potential to achieve significant reductions through energy efficiency lies with the following sectors:

- Federal facilities
- Health service facilities
- Institutions (e.g. schools and universities)
- Primary metals
- Petroleum refining
- Paper
- Chemicals
- Transportation equipment

Given the relatively large number of facilities and ubiquitous nature of industrial boilers. In order to achieve meaningful reductions from this "sector" new approaches to outreach and implementation incentives need to be considered. This would require appropriately linking public and private technical assistance and financing tools in such a way so to encourage adoption of energy efficiency measures. For example, closer alliances between local pollution prevention and energy technical assistance resources and state and federal agencies, as well as industry representatives and trade associations need to be established. Simultaneously, access to capital and other financial incentives, a necessary component of any energy efficiency or pollution prevention program, need to be more fully developed to promote diffusion of energy efficiency opportunities.

Current regulations will only go so far to attain the necessary reduction in air emissions. Even if all of the needed reductions from regulations could be achieved, the implementation timeframe would be too long. With respect to greenhouse gases, states are only just beginning to formulate policies and programs that reduce greenhouse gases. Pollution reduction opportunities that go beyond existing programs need to be sought out and implemented if permanent, ecosystem improvements in the Great Lakes region are ever to be realized.

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Attachment A
Facility Agreement Letter

Letter of Agreement
Between the Delta Institute
And
Facility

Background

In July of 1999, the Delta Institute launched a partnership with the Council of Industrial Boiler Owners to achieve emission reductions of Bi-National Strategy (BNS) Level I and Level II pollutants from industrial and public sector boilers through the implementation of selected energy efficiency technologies and methods. All BNS pollutants are also considered to be persistent bioaccumulative toxics (PBTs). Non-utility boilers and other energy generating devices constitute a significant percentage of the emission inventories for several BNS pollutants. Boilers, internal combustion engines and gas-fired turbines producing thermal and/or electric energy are the second largest source of mercury (EPA, 1997), second largest source of cadmium, fifth largest source of PCBs, and seventh largest source of dioxins and furans (NTI). These facilities are also significant sources of PAHs. They are important to the Great Lakes industrial economy and are expected to play a greater role in meeting the demands of a deregulated energy marketplace. Although the quantity of emissions of air toxics from electric utility boilers is greater, the local contribution of toxics deposited to the Great Lakes may be disproportionately higher from smaller facilities. These facilities are also significant sources of ozone precursors, acid aerosols, particulate matter and fine particulate precursors, as well as greenhouse gases.

The project is being implemented in two phases. Phase I focused on assessing options for achieving reductions, barriers to achieving widespread reductions and developing strategies for overcoming any identified barriers. In summary, Phase I resulted in agreement on which efficiency measures were most practical, estimations of likely emission reductions and identification of several barriers to widespread implementation of emission reduction strategies.

Phase II began in November 2000 and will continue through October 2001. Based upon the findings of Phase I, the Delta Institute has agreed to offer free combustion/steam system audits to interested public sector and industrial facilities. Participants will review – and as appropriate – implement recommended energy efficiency methods and technologies. Further, the Delta Institute and participants will develop a method for reporting the results of the implemented energy efficiency strategies, including actual and potential PBT emission reductions.

Services Offered by the Delta Institute

The Delta Institute (Delta) will retain an independent combustion/steam system consultant, Ted Guth, PhD, to inspect participating facilities. **The consultant will interview facility staff, conduct a on-site inspection, and issue both a draft and final report recommending options for improving combustion and steam system operations**.

4. Delta will pay all professional fees and travel expenses incurred by the consultant.
5. Delta will provide all participating facilities with a draft final report. Delta will accept editorial suggestions before issuing a final project report.

6. Delta will treat all as confidential facility information that the participant wants treated as confidential. Facility specific findings of the project will be aggregated within final project reports.

Responsibilities of the Participating Facilities

By accepting these services, the participating facility agrees to:

1. Agree to work with undersigned consultant.
2. Provide consultant with access to key facility staff and technical data prior to an on-site inspection. This could include interviews and review of reports from combustion system analyses, stack testing and/or energy audits. Any technical information will be treated by the consultant as confidential.
3. Assist the consultant with the on-site inspection. This will include allowing reasonable access to areas of the facility for both the consultant and Delta staff over an agreed upon period.
4. Review and comment on consultant's draft facility report. The participating facility is expected to provide feedback on the draft report within three weeks of receiving the draft report.
5. Accept and review final facility report. Although under no obligation to implement any of the recommendations in the final facility report, the participating facility agrees to discuss with the Delta Institute staff any changes in facility operations and reductions in emissions resulting from acting upon the report.
6. Review and comment upon the draft project report. The Delta Institute will provide each participating facility with a draft project report that summarizes the generic findings of the project based on the results of audits of all participating facilities. The Delta Institute will incorporate comments received prior to releasing a final project report.
7. Within six months to a year after receiving the final report, will report on which recommendations the facility implemented and the results as well as on what was not implemented and why.

Signed:

____
Facility Manager
Participating Facility

____
Delta Institute

Attachment B
Sample Facility Survey

Attachment B- Sample Facility Survey

Facility Information

We have the following industrial boiler information for your facility. Please update and or note any corrections to this information.

Boiler Unit	Installation Date	Boiler Type	Manufacturer	Fuel Input	Fuel	Start-up Fuel

Boiler Unit	Installation Date	Boiler Type	Manufacturer	Fuel Input	Fuel	Start-up Fuel

Assessment

Was this the first boiler energy efficiency assessment performed at your facility? Yes/No
If no, were recommendations from other, recent assessments implemented?

If no, how did this assessment compare to previous assessments? Please explain.

Would the assessment have been more valuable to you if the assessment included:

__ emission or operational parameter testing

__ permit/regulatory review

__ more involvement by plant personnel

__ less involvement by plant personnel

__ other____

Assessment Recommendations

Please refer to the recommendation numbers on the attached report.

Did the consultant identify any issues that you were not aware of? Yes/No
If yes, please indicate the recommendation number from the attached report.

Was the level of detail provided for each recommendation sufficient? Yes/No
If no, please explain.

What additional information would have made the recommendation more useful?

Implementation

Was the information provided in the assessment report satisfactory (i.e. could the information be used to justify additional follow-up activities and expenses)? Yes/No

If no, please explain.

Is your facility considering follow-up activities associated with any of the recommendations presented in the assessment report? Yes/No

If yes, please indicate which recommendation, anticipated follow-up actions, timeframe, and why.

If no, please explain why.

Was your facility considering actions associated with any of the issues identified as a recommendation prior to the Delta Institute assessment? Yes/No

If yes, please indicate which recommendation, anticipated action, and status

What factors would lead your facility to make efficiency improvements?

__ payback period less than 2 years

__ better economy

__ management support

__ increasing priority of energy efficiency alternatives in management plan

__ proven technology

__ streamlined permitting

__ no New Source Review (NSR)

__ relief from certain regulatory requirements

__ access to low interest loans

__ other____

Please use the space below to provide any additional comments on the project.

Attachment C
Detailed Emissions Aggregation Tables