



# Sustainable Boiler Plant Solutions

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# Bettering Boiler Plant Operations and the Environment



We support companies worldwide in achieving their sustainability goals by:

- » Guiding operations through their transition from fossil fuels to renewable energy
- » Strategizing solutions to achieve ultra-low-to-zero NOx and CO emissions
- » Providing optimization recommendations, trend reports and analysis on an ongoing basis




**The power of total integration.**

## Bold sustainability commitments? Count on us.

The **Power of Total Integration** is how Cleaver-Brooks delivers the world's broadest range of integrated, sustainable boiler plant solutions. In addition to our products, this includes our global representative and service network, training resources, and trusted expertise that add significant value to your boiler plant investment.

### EXAMPLES OF CUSTOMER SUSTAINABILITY GOALS



**100%**  
renewable energy by 2025,  
carbon neutral by 2030

*Global Medical Device Co.*



Absolute carbon  
emissions reductions by

**2030**

*Top Semiconductor Co.*



**50%**  
reduction in greenhouse  
gas emissions by 2030

*Multinational Food & Beverage Co.*



Achieve carbon neutrality  
in global operations by

**2040**

*Big Three Automaker*



## Decarbonization

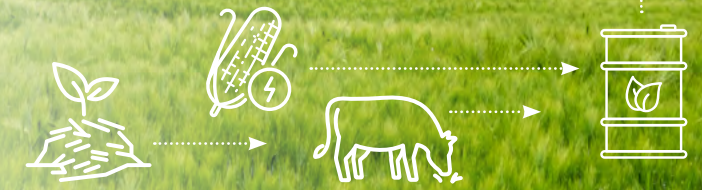
Companies are eliminating CO<sub>2</sub> output by using renewable fuels on their path to achieve zero emissions. Electrification, powered in whole or in part by renewable sources, is increasingly used to replace carbon-intensive combustion technologies.

- » Our electric and electrode boilers are nearly 100 percent efficient, decreasing carbon footprint without sacrificing performance
- » Our Natcom® and packaged burners are engineered for hydrogen and other renewable fuels

## Renewable Fuels

Growing pressure to lower emissions and replace fossil fuels is leading companies to explore a range of biofuels such as ethanol from corn or sugarcane, biodiesel from vegetable oil, and biogas from manure.

- » We offer burner solutions for renewable fuels as well as dual-fuel options
- » We can support your hydrogen needs with the right boiler solution, and can easily retrofit a hydrogen-type burner on any manufacturer's boiler



## Key Sustainability Drivers

Cleaver-Brooks has identified four key strategies for developing environmentally responsible energy solutions toward a low-carbon economy. We partner with leading companies in every industry to reduce their carbon footprint through more sustainable operations in the boiler plant.



**Decarbonization**  
**Renewable Fuels**  
**Energy Efficiency**  
**Emissions Reduction**



## Energy Efficiency

The simplest and most immediate way to reduce greenhouse gas emissions is to use less energy. We offer design recommendations and energy-efficient boiler solutions as well as optimization solutions for your boiler plant.

- » Industry-leading condensing boilers that achieve up to 99 percent efficiency
- » Smart boiler system controls, high-efficiency economizers and other heat-recovery solutions
- » Mobile connectivity and trend reports through our Prometha® solution

## Emissions Reduction

Companies around the globe are working to adapt to, and comply with, a constantly evolving regulatory landscape as policymakers seek to address emissions reduction with increasing urgency.

- » Cleaver-Brooks led in developing ultra-low NO<sub>x</sub> and CO burner technology and engineered the CBEX, the lowest-emissions firetube ever built
- » We offer integrated SCR and CO catalyst equipment for use with fired boilers, HRSGs and waste heat boilers that are well suited for combined heat and power solutions



# Cleaver-Brooks History and Momentum

“We needed to improve the facility and the equipment. Efficiency and emissions were a concern, and we wanted to make sure we were being good stewards of the environment. We knew Cleaver-Brooks manufactured quality equipment, and we specifically liked the Natcom® burner options.”

**Sam Merrick**  
Brigham Young University – Idaho  
Supervisor of HVAC Services,  
Facilities Management

## our innovations



### 1920s-50s

- » **1920s** John Cleaver started manufacturing small, portable boilers
- » **1930s** Cleaver joined forces with Raymond Brooks to form Cleaver-Brooks
- » Replaced a coal-fired boiler in a dairy plant with the first packaged firetube boiler
- » **1940s** Purchased a burner company and developed the first integral burner, increasing overall boiler system efficiency and reliability
- » **1950s** Opened highly automated plants in U.S. and Canadian markets

### 1960s-90s

- » **1960s** Began manufacturing industrial and commercial watertube boilers
- » **1970s** Introduced high-efficiency Model 4 watertube boiler
- » **1980s** Introduced heat recovery steam generators (HRSG) and waste heat boilers that increase overall plant efficiencies while reducing carbon footprint
- » Engineered burners to combust renewable fuels such as biofuels (vegetable oil, ethanol, methanol, digester gas) and hydrogen
- » **1990s** Developed low NOx technology with the CBLE low-emissions boiler

### 2000s

- » Engineered Natcom® burners to achieve ultra-low NOx and CO emissions
- » Introduced electric and electrode boilers that reach 99% efficiency with zero site emissions
- » Unveiled ClearFire® condensing boiler that achieves up to 99% efficiency with <20 ppm NOx
- » Engineered ProFire®-V burner that achieves <20 ppm NOx
- » Launched Flextube boilers that achieve 81% efficiency (steam), 85% (hot water) with <9 ppm NOx

### 2010s

- » Engineered CBEX with EX technology that achieves up to 82% efficiency and sub-5 ppm NOx without selective catalytic reduction (SCR)
- » Launched ClearFire®-CE boiler that can reach up to 99% efficiency with <7 ppm NOx (named Most Valuable Product of the Year by consulting engineers in 2019)
- » Introduced Boiler Plant Optimization™ to recommend actions for energy and emissions reductions
- » Achieved <5 ppm NOx with selective catalytic reduction (SCR)

### 2020s

- » Introduced Prometha® Connected Boiler Solutions that help companies increase efficiency by 28% on average
- » Engineered SBR-5 burner that achieves <5 ppm NOx with flue gas recirculation
- » Joined EPA Combined Heat and Power Partnership

# Total Integration for Asset Lifecycle Management



Maximize your investment while optimizing the performance of your boiler equipment over its lifecycle to reduce waste and resource consumption.

## Phase I: Plan and Design

Let us recommend the best boiler solution to meet your sustainability goals.

## Phase II: Procure, Build and Commission

Feel confident at start-up knowing your boiler system is fully integrated and factory tested.

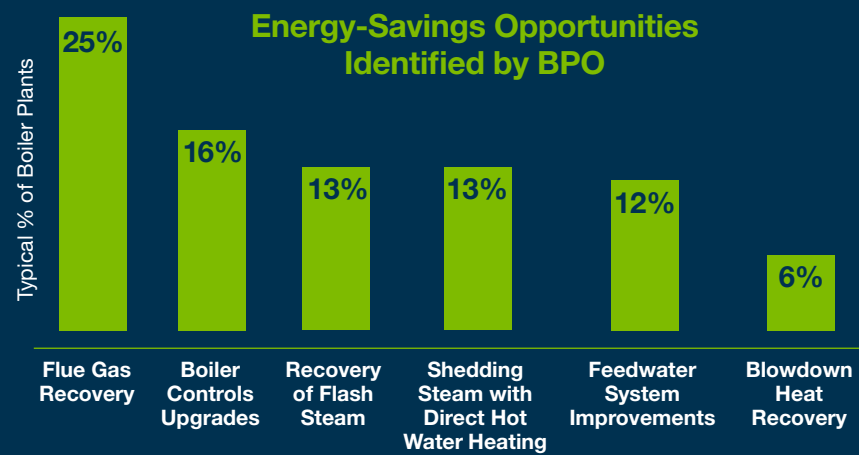
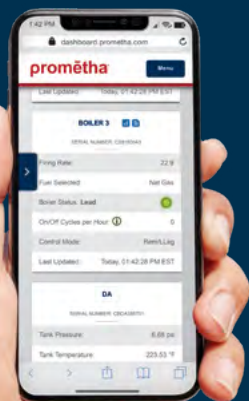
## Phase III: Operate and Maintain

Take advantage of our **Preventive Maintenance** programs to maintain peak performance, extend equipment life, and meet sustainability goals throughout the product lifecycle.

Trust our **Prometha®** intelligent boiler solution for mobile connectivity along with trend graphs and reports to maximize and substantiate sustainability efforts.

## Phase IV: Renew or Replace

Count on our **Boiler Plant Optimization™ (BPO)** services to identify areas for improvement throughout your boiler plant.

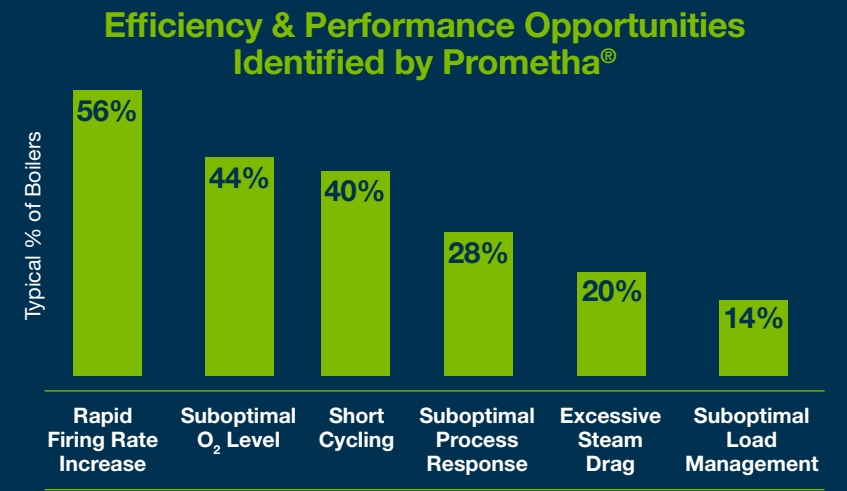


# Prometha® Accelerates Sustainability Efforts

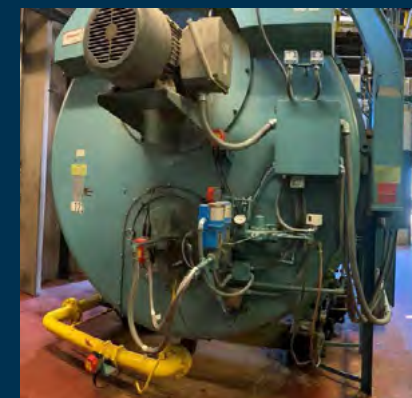
The combined innovation and experience of our engineers, customers and data scientists have resulted in Prometha®, a first-of-its-kind IoT solution that provides actionable intelligence along with our insights and expertise. With Prometha® and our collaboration you can:

- » Receive suboptimal condition alerts and solution recommendations
- » Benchmark your performance against industry peers
- » Ensure your boiler system continues to run safely, reliably, efficiently and sustainably
- » Suboptimal O<sub>2</sub> and load management leads to reduced efficiency, increased fuel usage and higher costs
- » Low feedwater temperature results in higher energy demand, increased fuel usage and shorter equipment life
- » Rapid increase in firing rate and excessive short cycling causes equipment failure, unscheduled downtime and operational disruption

ENERGY EFFICIENCY  
**28%**  
improvement with  
**prometha®**  
Connected Boiler Solutions



## Boiler Intelligence Drives Operational Efficiency



Efficiency upgrades reduced the number of boilers operating from 6 to 4 1/2.

A Boiler Plant Optimization™ (BPO) Overview revealed improvement opportunities at a beef plant running six boilers at full capacity. Prometha trend reports substantiated the BPO findings, and the company fixed the issues. The optimized system now needs only four and a half boilers to run, reducing both natural gas consumption and emissions.

The company is on track to meet its goals of 20% reduction in natural gas use and greenhouse gas emissions.

ON TRACK TO MEET  
**20%**  
reduction in natural gas and emissions

# Cleaver-Brooks Sustainable Products »

- Decarbonization
- Renewable Fuels
- Energy Efficiency
- Emissions Reduction

*These products and services are our most sustainable solutions when paired with the recommended options. We offer expertise and additional sustainable solutions based on customer requirements.*



## CBEX Firetube Boiler



*Higher operating efficiency at same output as competitive boilers*

EX tubes achieve 85% greater heat transfer than plain tubes; larger furnace enables more complete combustion, higher turndown and lowest possible emissions without SCR, <5 ppm NOx emissions, <10 ppm CO emissions



## CBLE Firetube Boiler



*Burns a wide variety of renewable fuels while achieving ultra-low NOx*

Plain tube design and integral head burner enable CBLE to burn more types of renewable fuels than competitors; integral burner technology achieves <7 ppm NOx



## SBR-5 Burners



*Ultra-low NOx combustion without ammonia*

Advanced burner technology with low O<sub>2</sub> levels attains <5 ppm NOx with FGR; 1% efficiency advantage over competition



## CUSTOMER STORY

# Higher Learning, Lower Emissions

Mount Royal University in Calgary, Alberta, Canada, wanted to reduce its carbon footprint and bring its boilers into compliance with the local gas code. The university added new Cleaver-Brooks burners and controls to its existing 800-hp steam boilers.

- » Boiler upgrades were less costly than replacement, with similar end result
- » Upgrades completed without displacing any staff, students or programs

### ENERGY EFFICIENCY

# 30%

increased efficiency overall, with central steam plant upgrades

### DECARBONIZATION

# 1,895<sup>tons</sup>

reduced emissions of carbon dioxide equivalents



Hawk control maintains optimum system performance

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## Boiler Plant Optimization

Boiler plant evaluation provides quantifiable solutions to meet goals

Identifies areas for improvement throughout the boiler plant/steam facility; opportunities typically found in flue gas recovery (25% of facilities), boiler control upgrades (16% of facilities) and recovery of flash steam (13% of facilities), among others

## Prometha® Connected Boiler Solutions

Mobile connectivity and trend reports help optimize a boiler system, reduce emissions

Real-time data and historical reports can increase efficiency by 2-3%, reduce greenhouse gases by 2-3%, and reduce fossil fuel use by 2-3%

## Electric & Electro Boilers

Uses electricity as a fuel source for zero carbon footprint

Nearly 100% efficient at all operating points; we offer higher-capacity electrode boilers compared to competitors so fewer boilers are required for the same load

## ClearFire®-CE Condensing Boiler

Up to 99% product efficiency with <20 ppm NOx emissions standard

Dual-temperature returns increase efficiency by 6%+ compared to competitors; able to achieve ultra-low NOx emissions; AHRI certified, Energy Star\* and SCAQMD\* certified, cULus

\*2000 MBH and smaller

## Flextube® Packaged Watertube Boiler

Performance burner fires renewable fuels with high efficiency

Burns renewable fuels with fully modulating burner, offering optimum efficiency from minimum-to-maximum firing; available to <9 ppm NOx with low CO

## ClearFire®-H Steam Boiler

Horizontal steam boiler with best-in-class operating efficiency and low emissions

Modulating low-NOx burner assembly for maximum operating efficiency, guaranteed up to 85% with standard sub-20 ppm NOx and <10 ppm CO; burner design lends itself to low emissions; SCAQMD certified, cULus



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## Heat Recovery Steam Generators

Captures and uses waste heat otherwise lost

Achieves greater than 80% efficiency compared to 56% for traditional technologies; reduces fuel usage up to 7.0 MMBtu/hr in conventional boilers and eliminates 2,870 tons of CO<sub>2</sub> emissions annually per 1 MWe GT output; EPA Combined Heat & Power Partnership

## Natcom® Engineered Burners

Leading emissions-reduction technology, high efficiency with design flexibility

Burner technology offers flexibility for multi-fuel firing; conventional fuel savings up to 90%; emissions reduction of 50% compared to flaring; achieves <9 ppm NOx

## IWT Boilers

Large watertube boilers custom designed to meet sustainability goals

Optional equipment to increase boiler efficiency by 5% on average; fires renewable natural gas, biogas and hydrogen (1 - 100%); can achieve <2 ppm NOx with ultra-low NOx burner and SCR equipment

## Waste Heat Boilers

Uses waste heat for steam or power while eliminating CO<sub>2</sub> emissions

Capturing waste heat from steam generation replaces the need for additional auxiliary-fired boilers; every 1 MMBtu/hr recovered reduces 410 tons of CO<sub>2</sub> and 280 lbs. each of NOx and CO annually

## Selective Catalytic Reduction

One of the most effective ways to reduce NOx in a flue gas stream

Decreases NOx emissions by as much as 95% down to 2 ppm without retrofitting the burner

## C2X-HE Economizer

First two-stage condensing economizer to achieve up to 94% efficiency

Exclusive technology enables economizer to achieve up to 94% efficiency; ASME U-stamp certified



## The power of total integration.

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