# Efficiency and Cost Benefits of Controls Retrofits

## Strategies for producing measurable results

One-third of a facility's energy bill can be directly attributed to the boiler room. Replacing an older boiler system is one way to achieve energy savings. Retrofitting is another.

When deciding whether to replace or retrofit a boiler, the boiler's overall condition, not its age, should be the determining factor. If a boiler's water-side and fire-side surfaces show minimal signs of heavy scaling, pitting, cracking, and/or stress, the pressure vessel likely is in good shape, making retrofitting the more viable option.

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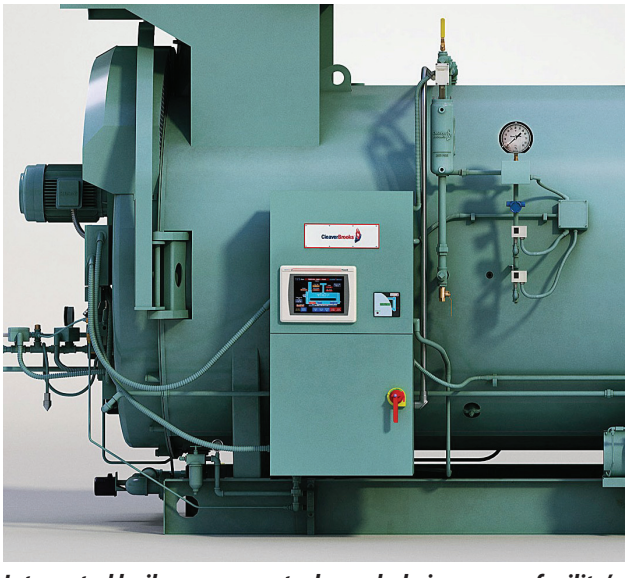
If retrofitting is the course of action, then it is important to identify the areas most likely to yield efficiency gains. The first area to consider is the combustion-controls system. New developments in boiler controls are creating opportunities for substantial efficiency gains. The following options will help an existing boiler system produce measurable efficiency increases and fuel-cost decreases.

**Parallel positioning.** Many boiler burners are controlled with a modulating motor with single jackshaft and corresponding linkages attached to the fuel valve and air damper. This arrangement, set during startup, fixes the air-to-fuel ratio over the firing range. Unfortunately, over time, the linkages wear, stretch, and bend, causing the air-to-fuel ratio to become erratic and non-repeatable as the burner modulates from low to high fire. To solve this problem, the incorporation of parallel positioning is recommended. This involves the use of dedicated actuators for fuel and air valves working through a common master controller. Burners incorporating parallel positioning can be set with somewhat lower excess-air levels because of their consistent repeatability; because of this consistency, energy savings of up to 5 percent can be realized.



***Integrated boiler-room controls can help increase a facility's operating efficiency and reduce its fuel costs.***

**$O_2$ trim.** Another way to ensure peak efficiency is to use an oxygen sensor/transmitter in the exhaust gas. The sensor/transmitter continuously senses oxygen content and provides a signal to the controller that "trims" the air damper and/or fuel valve, maintaining a consistent oxygen concentration. This minimizes excess air while optimizing the air-to-fuel ratio.

**Variable-speed drive.** A variable-speed drive enables a motor to operate only at the speed needed at a given moment, rather than a constant speed, regardless of firing or delivery rate. This speed variance results in the elimination of unnecessary electrical energy consumption. A variable-speed drive can be used on any motor, but is most common on boiler-feed-pump and combustion-air motors above 5 hp. Variable-speed-driven motors operate more quietly than standard motors and cost less to maintain, as stress on motor-drive parts and bearings is reduced.

### Case Study

Troy Jensen, control-systems specialist for Intermountain Healthcare, sought to cut operating costs by optimizing the boiler system at 400,000-sq-ft, 225-bed Logan Regional Hospital in Logan, Utah. In 2010, he received funds to install an advanced integrated

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control system on each of the hospital's three 300-hp boilers. This gave Jensen the ability to continuously monitor and control the boilers' oxygen levels, stack temperatures, lead/lag sequencing, and water levels to increase efficiencies and reduce operating costs while improving the overall operational response of the system.

Because he is not always on site, and an emergency in the middle of the night could necessitate a quick increase in the amount of steam required, Jensen integrated the controls into the hospital's building-automation system (BAS). He then created a schedule to reduce boiler operating pressure in accordance with the hospital's needs. Jensen gave members of the Central Sterile Supply Department access to the controls at their workstations, so when emergencies arise, they can override the system.

Through analysis of 24-hr trend reports generated by the newly automated systems, Jensen learned the boilers were oversized and cycling during low-load conditions, even with a 6:1 turndown capability on their integrated burners.

Even if a boiler performs well during an efficiency analysis, incremental savings may be attainable because of the boiler's original sizing relative to its load. Inefficiency often occurs during summer, when an oversized boiler remains mostly in low fire, cycling several times an hour. This drives up radiation and convection losses as a percent of input while increasing excess-air levels and reducing combustion efficiency. Excessive cycling and poor combustion efficiency can reduce a boiler's efficiency from a normal full-capacity rating of 83 percent to a percentage in the low 70s.

Knowing excessive cycling was substantially increasing fuel costs because of repeated pre- and post-purge losses, Jensen decided to explore his options. Instead of starting with 300-hp boilers that turn down to 60 hp, he wanted to start with boilers of about 60 hp and go down from there.

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Jensen contacted Servco Industrial Equipment representative Jason Hansen in Salt Lake City to discuss the best options. In June 2011, Jensen had a compact, high-efficiency vertical steam boiler with low-NOx technology installed at the hospital. The boiler can modulate from 60 hp to 12 hp. The flexibility of pairing the smaller boiler with the existing boilers eliminated the issue of the boilers cycling off and on at night. The boilers share the majority of summer load conditions.


***Logan Regional Hospital paired a 60-hp boiler with its existing 300-hp boilers. The new system has helped the hospital reduce operating costs by 30 to 40 percent.***

Taking into account the hourly per-unit cost of plant downtime, purchasing a small "summer boiler" properly sized for reduced-load conditions can lead to substantial savings, especially during times of fuel-price volatility. This solution can be applied to any efficient boiler with "shoulder" operating months, even new boilers.

With the controls and new boiler integrated into the BAS, "I run on 56 percent of the gas that I used to run on," Jensen said. "That's a 44-percent reduction in natural gas."

Jensen said he recouped his expenses in less than a year. He added that the strategy easily can be replicated in other facilities, resulting in a 30-percent-to-40-percent decrease in operating costs, which, in his facility, amounts to an annual savings of $700,000 to $1.3 million.

Additionally, the new system has environmental benefits. Jensen compared carbon-monoxide samples from July 2009 and July 2011.

"The savings was equivalent to taking 2,000 cars off the road," Jensen said. "When you hit numbers like this—talk about environmental impact. Natural gas isn't always going to be around. It's a finite resource. Wouldn't it be responsible for us to use less if we can?"

Jensen said he is eager to share his knowledge with industry colleagues.

"The health-care industry is unique because we always have to be prepared for the worst-case scenario, which would be a major emergency in the middle of a blizzard," Jensen said. "Many facilities purchase equipment based on this kind of scenario, and the boilers are left at the same set point all the time, even during the summer. This is inefficient and is wasting our natural resources."

## Other Options

Many facility managers are looking for ways to cut costs.

Jensen said reducing pressure on an oversized boiler to save energy can trigger other problems, such as feed-pump cavitation, increased steam-nozzle velocities leading to erratic boiler-water levels and nuisance boiler shutdowns, and water hammer. Other options to increase boiler efficiency while reducing total operating costs include:

**Economizers.** Economizers transfer energy from boiler exhaust gas to boiler feedwater in the form of "sensible heat." This reduces boiler exhaust temperature while preheating boiler feedwater, increasing overall efficiency. Economizers typically increase energy savings by 2.5 percent to 4 percent.

**Two-stage condensing economizers.** This type of economizer combines the functions of both a standard non-condensing economizer and a condensing economizer. The first section of the economizer recovers energy by preheating boiler feedwater. The second section recovers energy by preheating a cool liquid stream, such as makeup water. Sensible and latent energy are captured from the flue gases that leave the boiler. Condensing economizers can increase energy savings by up to 10 percent, depending on design and operating conditions.

**High-turndown burner.** Increasing burner turndown rate increases energy savings and reduces maintenance. Energy savings are realized because of a reduction in on/off cycles. Each on/off cycle is followed by a purge cycle. During a purge cycle, large volumes of ambient room air pass through the boiler, resulting in heat being blown out of the stack.

**Blowdown heat recovery.** Dissolved solids must be removed from a boiler to maintain water purity and ensure long boiler life. Often, blowdown is routed to an enclosed tank allowing safe discharge of saturated water through a reduction in steam pressure. Low-pressure steam is vented from the tank, and condensate is discharged to the drain. In many cases, these tanks are not insulated and do not allow recovery of lost heat. A blowdown heat-recovery system transfers blowdown latent energy to boiler feedwater, recuperating about 90 percent of this energy.

## Maintenance

Installing proper equipment is the first step to long-term fuel savings. To continue operating at peak performance, a boiler must be maintained and tuned regularly. Technicians should keep logs of operating parameters and evaluate the findings regularly. On a semiannual basis, a technician should test all controls for proper operation and calibration, as well as inspect, clean, and lubricate mechanical linkages according to manufacturer instructions.

Regular boiler tune-ups are required under the U.S. Environmental Protection Agency's new Area Source Rule. To learn more, visit *www.cleaverbrooks.com/epa*.

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