



Energy Efficiency and Renewable Energy
Federal Energy Management Program

For More Information:

- DOE's Federal Energy Management Program (FEMP) Help Desk and World Wide Web site have up-to-date information on energy-efficient federal procurement, including the latest versions of these recommendations.
Phone: (800) 363-3732
www.eren.doe.gov/femp/procurement
- DOE's Office of Industrial Technologies' information clearinghouse provides publications on steam systems and helpful tips on improving boiler efficiencies.
Phone: (800) 862-2086
www.oit.doe.gov/steam
- American Council for an Energy-Efficient Economy (ACEEE) publishes the *Guide to Energy-Efficient Commercial Equipment*, which includes a chapter on HVAC systems.
Phone: (202) 429-0063
aceee.org
- GAMA's Hydronics Institute publishes the *I=B=R Ratings for Boilers, Baseboard Radiation, and Finned Tube (Commercial) Radiation*, a directory of commercial boilers with certified performance ratings.
Phone: (908) 464-8200
www.gamanet.org
- ASHRAE publishes the *Cooling and Heating Load Calculation Manual*.
Phone: (800) 527-4723
www.ashrae.org
- American Boiler Manufacturers Association (ABMA) publishes a directory of commercial and industrial boiler manufacturers that offer equipment and services for boilers.
Phone: (703) 522-7350
www.abma.com
- Boiler Efficiency Institute publishes maintenance and operating manuals on commercial and industrial boilers.
Phone: (800) 669-6948
www.boilerinstitute.com
- Lawrence Berkeley National Laboratory provided supporting analysis for this recommendation.
Phone: (202) 646-7950

How to Buy an Energy-Efficient Commercial Boiler

Why Agencies Should Buy Efficient Products

- Executive Order 13123 and FAR section 23.704 direct agencies to purchase products in the upper 25% of energy efficiency, including all models that qualify for the EPA/DOE ENERGY STAR[®] product labeling program.
- Agencies that use these guidelines to buy efficient products can realize substantial operating cost savings and help prevent pollution.
- As the world's largest consumer, the federal government can help "pull" the entire U.S. market towards greater energy efficiency, while saving taxpayer dollars.

Efficiency Recommendation^a

Product Type (Fuel / Heat Medium)	Rated Capacity (Btu/h)	Recommended Thermal Efficiency	Best Available Thermal Efficiency ^b
Natural Gas / Water	300,000 - 2,500,000	80% E _t	86.7% E _t
	2,500,001 - 10,000,000	80% E _t	83.2% E _t
Natural Gas / Steam	300,000 - 2,500,000	79% E _t	81.9% E _t
	2,500,001 - 10,000,000	80% E _t	81.2% E _t
#2 Oil / Water	300,000 - 2,500,000	83% E _t	87.7% E _t
	2,500,001 - 10,000,000	83% E _t	85.5% E _t
#2 Oil / Steam	300,000 - 2,500,000	83% E _t	83.9% E _t
	2,500,001 - 10,000,000	83% E _t	84.2% E _t

- a) This Recommendation covers low- and medium-pressure boilers used primarily in commercial space heating applications. It does not apply to high-pressure boilers used in industrial processing and cogeneration applications.
- b) These "Best Available" efficiencies do not consider condensing boilers, which are generally more efficient, but are not readily ratable with ANSI Z21.13.

Specify boilers with efficiency levels that meet this Recommendation. Select only boilers rated under the certification program run by The Hydronics Institute (see "For More Information") of the Gas Appliances Manufacturers Association (GAMA). Although the HI directory reports only combustion efficiencies, thermal efficiencies can be calculated for model series listed **without** a pound sign by dividing gross output by input (using 140,000 Btu/gal. for #2 oil models).

A boiler system should be capable of meeting the building's peak heating demand while also operating efficiently at the more common part-load conditions. Sizing and selecting a boiler system properly, therefore, requires a knowledge of the peak heating load, as well as an understanding of the

Definitions

Thermal efficiency (E_t), also known as "boiler efficiency" or "overall efficiency," is the boiler's energy output divided by energy input, as defined by ANSI Z21.13. In contrast to combustion efficiency (E_c), E_t accounts for radiation and convection losses through the boiler's shell.

The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) is working, in conjunction with other groups, to develop a seasonal efficiency rating for boilers. This measure will account for varying efficiency at part-load operation. FEMP expects to adopt this rating method in the future once it is developed and sufficient product ratings are available.

How to Select Energy-Efficient Boilers

Sizing and Part Load Performance

load profile. If building loads are highly variable, as is common in commercial buildings, designers should consider installing multiple, smaller (modular) boilers. Modular systems are more efficient because they allow each boiler to operate at or close to full rated load most of the time, with reduced standby losses. Other efficient options for handling variable loads are modulating boilers, which can run at partial capacity (instead of cycling on and off), and condensing boilers.

While both water and steam models are covered in this Recommendation, water boilers and distribution systems tend to have lower maintenance requirements.

Buyer Tips

There is a broad array of options in boiler equipment and controls that can enhance energy performance: stack gas heat recovery equipment, such as air preheaters and economizers; condensing heat exchangers, which also utilize stack gas waste heat; turbulators (fin enhancers) to improve heat transfer and balance of gas flows between tube banks; water recovery equipment, to re-use heat from blowdown and water return condensate; outdoor temperature controls, which control the system loop temperature in accordance with outside temperatures; electronic ignition devices; increased boiler and piping insulation; and high performance (including “power”) burners.

Several diagnostic and preventive procedures are important to maintaining efficient operation. Flue gas temperature monitoring is useful in detecting efficiency and operation problems. Maintaining steady excess air levels (with an oxygen “trim” system) ensures that burners will mix air and fuel efficiently. The Boiler Efficiency Institute provides maintenance and operation manuals for boilers and boiler controls (see “For More Information”). Low water levels can damage boiler vessels, so water levels must be checked frequently. Water treatment prolongs the life of boilers, while increasing efficiency. Waterside and fireside surfaces should be cleaned annually. Steam boilers should be blowdown daily to remove sludge and sediment.

Maintenance and Operations Tips

Boiler Cost-Effectiveness Example (5,000,000 Btu/h Gas-fired Water Boiler)

Performance	Base Model	Recommended Level	Best Available
Thermal Efficiency (Et)	78.0%	80.0%	83.2%
Annual Energy Use (therms)	96,200	93,700	90,100
Annual Energy Cost	\$38,500	\$37,500	\$36,100
Lifetime Energy Cost	\$654,000	\$638,000	\$613,000
Lifetime Energy Cost Savings	-	\$16,000	\$41,000

Definition

Lifetime Energy Cost is the sum of the discounted value of annual energy costs, based on average usage and an assumed boiler life of 25 years. Future gas price trends and a discount rate of 3.4% are based on federal guidelines (effective from April, 2000 to March, 2001).

Cost-Effectiveness Assumptions

Annual energy use in this example is based on 1,500 equivalent full-load hours per year. The assumed gas price is 40¢/therm, the federal average gas price in the U.S.

Conversions

1 Btu/h = 0.293 watts
 1 therm = 100,000 Btu
 = 100 MBtu
 = 0.1 MMBtu

Understanding the Cost-Effectiveness Table

In the example shown above, a 5,000,000 Btu/h gas-fired water boiler with a thermal efficiency of 80.0% is cost-effective if its purchase price is no more than \$16,000 above the price of the Base Model. The Best Available model, with an efficiency of 83.2%, is cost-effective if its price is no more than \$41,000 above the price of the Base Model.

How Do I Perform a Life-Cycle Cost Analysis for My Situation?

FEMP provides a Web-based boiler “cost calculator.” Go to www.eren.doe.gov/femp/procurement/boiler.html, and click on the “Cost-Effectiveness Example.”

