



Quantifying and Demonstrating the Benefits of Outdoor Reset Control

Boilers are designed to maintain a constant water temperature adequate to heat the building during the coldest outdoor temperature conditions (the design temperature). However, by definition, design conditions seldom occur. ORC modulates boiler water temperature in relation to outside temperature. Water temperature is reduced when the outside temperature is higher than the design temperature (i.e., most of the time). Using ORC to adjust the system water temperature has several energy-related and comfort advantages:

- Boiler efficiency is increased as a result of less heat lost up the vent and through the boiler enclosure.
- Distribution system efficiency is improved due to lower standby losses from the distribution system (due to lower temperature of water in the distribution system).
- Occupants are more comfortable because heat emitter temperatures fluctuate less and are closer to room design temperatures (avoiding hot and cold extremes that accompany on/off cycling of the boiler).
- Improved system longevity, durability and performance because of less on/off cycling.

Baseboard heaters, radiators, hydro-air and in-floor radiant heating systems are all candidates for ORC. Estimates of potential annual savings range up to 35 percent of heating fuel use, although this estimate is derived from a few multifamily applications (Lobenstein 1995, Hewett 1984) and manufacturer claims (data from retrofit applications in single family homes is lacking). Based on these estimates, ORC's return on investment is 1 to 2 years (Lobenstein 1995), a truly extraordinary opportunity for a measure with so little market penetration.

Scientific or engineering principles incorporated into the technology.

ORC is an electronic energy management system that effectively adjusts the size (heating capacity) of the boiler to match the desired space heating needs based on outside temperature.¹ The controller doesn't physically change the boiler size but rather adjusts the boiler's output by changing its water temperature to the optimum (lowest) temperature needed to heat the home. Lacking the controller, boilers typically maintain water temperature between 160°F and 180°F. With ORC, boiler water temperature typically can be reduced to 140°F, and for many boilers, even lower.² ORCs continuously measure external temperature using a sensor typically mounted on the north side of the home where it is less likely to be affected by direct sunlight, and boiler water temperature using a second sensor mounted at the boiler. Some systems also use an indoor sensor to provide information on internal heat gains. As the outdoor temperature fluctuates, the controller adjusts the boiler firing rate to maintain boiler water temperature at the lowest level required to meet space heating demands, within specified limits.



What is the current stage of development?

ORC is an off-the-shelf technology. Experience with multifamily buildings suggests that ORC saves energy, is highly cost effective and is easy to retrofit. It has been used in multifamily buildings for at least 30 years and has been a standard multifamily energy management recommendation for about 25 years (Lobenstein 1995).

¹ Reducing boiler capacity is especially beneficial for older homes where insulation and/or air sealing work were done since boiler installation.

Due to reduced envelope heat loss, the boiler may now be significantly oversized. ORC is an inexpensive way to down-size the boiler compared to replacement.

² All gas boilers can be controlled to a minimum temperature with light loads down to 140°F, the point at which significant condensation can

begin. Most gas boilers are “cold start,” and will allow short operating periods below that temperature. Condensing boilers can be controlled to

arbitrarily low temperatures. “Keep-warm” boilers, primarily oil-fired, must be maintained above the condensing temperature or boiler corrosion

rates may accelerate, and condensate may leak from the system. (ACEEE 2006-2)