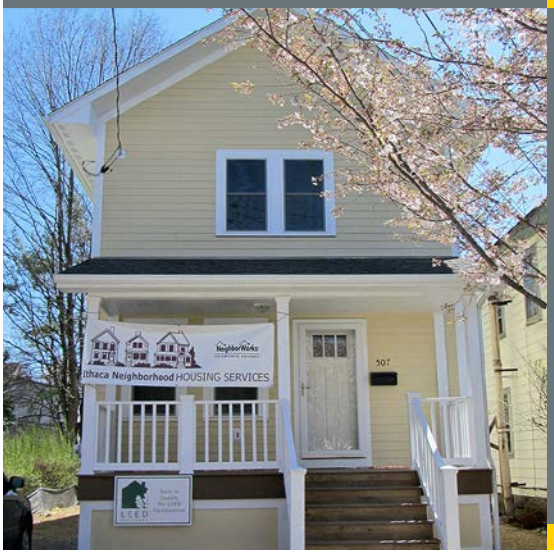

Building America Case Study

Technology Solutions for New and Existing Homes

Hydronic Systems: Designing for Setback Operation

Ithaca, New York

PROJECT INFORMATION

Project Name: Condensing Boilers—Optimizing Efficiency and Response Time During Setback Operation

Location: Ithaca, NY

Partners:
Ithaca Neighborhood Housing Services, *www.ithacanhs.org*
Appropriate Designs, *www.hydronicpros.com*
HTP, *www.htproducts.com*
Peerless, *www.peerlessboilers.com*
Grundfos, *www.grundfos.com*
Bell & Gossett, *www.bell-gossett.com*
Emerson Swan, *www.emersonswan.com*
Consortium for Advanced Residential Buildings, *www.carb-swa.com*

Building Component: Space heating, water heating

Application: New; single and multifamily

Year Tested: 2012–2013

Applicable Climate Zone(s): 4,5,6,7

PERFORMANCE DATA

Cost of energy efficiency measure (including labor): $10/ft of baseboard

Projected energy savings: ≈1% heating savings for every 1°F setback

Projected energy cost savings: ≈$100/year for the homes tested

Building America SM U.S. Department of Energy

For years, conventional wisdom surrounding space heating has consistently recommended two strategies for saving energy and improving efficiency: 1) size the mechanical systems to the heating loads; and 2) set the thermostat back at night for at least 8 hours to save energy. Setback operation has been shown to save energy in numerous field studies and can also lower system cycling, which reduces wear on the boiler. The problem is that these two recommendations oppose each other. A system that is properly sized to the heating load will not have the extra capacity necessary to recover from a thermostat setback, especially at design conditions. The implication of this is that, for setback to be successfully implemented, the heating system must be oversized.

This issue is exacerbated further when an outdoor reset control is used with a condensing boiler, because not only is the system matched to the load at design, the outdoor reset control matches the output to the load under varying outdoor temperatures. Under these circumstances, the home may never recover from setback. In that case, special controls to bypass the outdoor reset sensor are needed.

To address this issue, the U.S. Department of Energy Building America team, Consortium for Advanced Residential Buildings (CARB), identified steps for properly designing a hydronic system for setback operation, which are applicable to new construction and retrofit applications. The team determined that the savings to be achieved and the response times possible depend on the climate, the heat capacity of the home (mass storage), the level of setback desired, and the controls available. The first step is to decide how appropriate setback is for a particular project. This is followed by proper sizing of the boiler and baseboard to ensure the needed capacity can be met. Finally, control settings must be chosen that result in the most efficient and responsive performance.

FACTS ABOUT SETBACK

- For an 8-hour nighttime setback period, every 1°F setback will result in ≈1% savings in energy consumption.
- The colder the weather, the greater the energy savings from thermostat setback.
- Savings are generally greater during periods of nighttime setback than during periods of daytime setback.

WHO SHOULD *NOT* USE SETBACK

For any home with a hydronic heating system, if the answer to any of the following questions is "yes," the project is probably not right for nighttime setback and should be maintained under constant temperature operation.

- Does the home have a boiler that cannot modulate its output?
- Is the home insulated to levels significantly better than the 2009 IECC?
- Is the heat emitter radiant flooring or radiant panels?
- Are the walls or floor of the conditioned space constructed with concrete? If yes, is that concrete uninsulated to the interior?
- Do the occupants expect or desire a recovery time of less than 1 hour?

For more information, see the Building America report, *Measure Guideline: Condensing Boilers—Optimizing Efficiency and Response Time During Setback Operation*, at *www.buildingamerica.gov*

Image credit: All images were created by the CARB team.

Efficiency Level	Heat Capacity (Btu/°F)	Design Load (Btu/h)	Boiler Size (Btu/h)	Recovery Time (hours)
Super insulated	10685	8,540	17,080	6.9
2009 IECC	8131	15,441	30,882	3.4
Old, uninsulated	6600	44,030	88,060	1.0

The recovery times show that similar size buildings with lower heat capacities, or thermal mass, warm up or cool down faster under similar climatic conditions

Read details about these steps in the referenced measure guideline report, which the CARB team developed to help heating contractors and hydronic designers select the proper control settings to maximize system performance and improve response time when using a thermostat setback.

Lessons Learned

- An undersized distribution system will lead to the same problems as an oversized boiler—slow response, increased cycling, and reduced efficiency.
- In addition to using a boost control to more efficiently and quickly recover from setback, the CARB team recommends increased baseboard capacity for the most efficient steady-state operation after the house reaches the desired temperature.
- Setback for super-insulated homes should be avoided. Because the heating loads are so small, the potential savings from operating in setback mode would be miniscule compared to the extra cost of the baseboard needed to recover quickly.
- If installing additional baseboard to aid in recovery without a boost control, consider that baseboard radiators have less effective heat transfer at lower temperatures. Recovery times will actually increase as the outdoor temperatures increase and the boiler supply temperature decreases.

Looking Ahead

To aid hydronic system designers in using setback strategies, it would be beneficial to have more data to support the assumptions for calculating effective capacities for energy-efficient and super-insulated homes. As energy codes require higher levels of efficiency, heat capacities of buildings will increase, resulting in slower recovery times. The cutoff for when constant temperature operation should be used over setback is not clear at this time. Determining the benefits of a properly functioning system using setback controls will warrant further analysis.

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