tech primer

Hydronic Heating Upgrades

Highly efficient centralized heating upgrades that increase comfort and energy savings.

tech overview

applicable building types
hotels, multifamily, institutional, and commercial

implementation
at equipment replacement, at refinance

fast facts
- improves user comfort and satisfaction
- provides balanced distribution
- extends equipment life

Brendon Harris Hydronics

costs & benefits*

GHG Savings: 3 of 4

Tenant Experience Improvements: 2 of 4

Utility Savings: 3 of 4

Capital Costs: 3 of 4

Maintenance Requirements: 2 of 4

*ratings are based on system end use, see back cover for details.

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getting to know hydronic heating systems

Hydronic heating is a common centralized heating system that uses water to heat buildings. Efficiency and performance can be improved through the appropriate selection and optimization of high-performance equipment and controls.

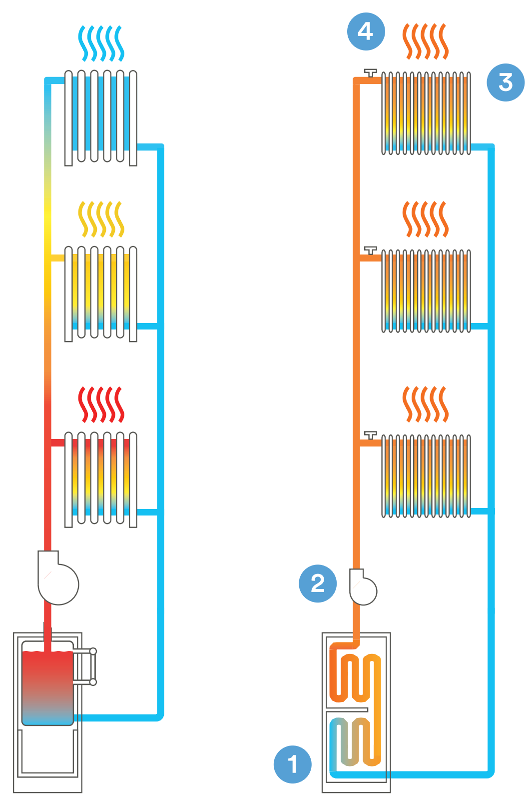
how does hydronic heating work?

Hydronic heating is a centralized system that uses water to heat buildings. Hot water is generated in a boiler and pumped through distribution piping to spaces with fan coils, or other terminal units such as radiators, convectors, baseboards, or packaged terminal air conditioners (PTACs). Cold water returns to the boiler where the cycle is repeated (see Fig. 1).

Compared to steam heat, hydronic heating offers several advantages, such as ease of temperature control, more predictable balancing, and lower distribution temperatures, which translate into energy savings and comfort improvements. Hydronic heating systems are often paired with chilled water plants to provide cooling using the same distribution piping and terminal units. See our *Chilled Water Plant Optimization* tech primer to learn about the cooling side of the system.

This tech primer highlights opportunities to maximize performance when upgrading hydronic heating systems, and identifies additional technologies, such as hybrid water-cooled air conditioners and water source heat pumps, that can be used to create a complete hydronic heating and cooling system.

Fig. 1. Improving efficiency and occupant comfort in buildings with hydronic heating typically requires (1) installing condensing boilers, (2) right-sizing pumps, (3) upgrading terminal units, (4) and adding pressure independent control valves (⊤).



Assess
Always consult a qualified service provider before undertaking any building upgrades.

Coordinate Upgrades for Maximum Savings
Implementing insulation, air sealing, and window improvements at the time of hydronic heating retrofits will lower demand on the heating system by reducing heat loss through the building envelope.

When future building improvements are completed, energy savings may go unrealized without optimizing the hydronic heating system for newly reduced loads.

Training and Maintenance
Building occupants should be educated on the proper operation of terminal units, including how to operate controls and how to identify and report any heating issues. Trained staff can identify and address maintenance items independently or know when to engage qualified contractors.

Energy savings can only be sustained with regular maintenance and end-user engagement.

how to upgrade hydronic heating systems

A high-performance retrofit typically includes updating boiler plants and terminal units, balancing the distribution, correctly sizing pumps, and installing smart controls.

retrofit solutions

Hydronic heating systems are comprised of a number of components that each contribute to the overall performance of the system. Completing a holistic suite of measures to address all of these components will yield the greatest results.

A Upgrade Heating Equipment– Install either high performance, fuel-fired condensing boilers or electric air-to-water heat pumps.

1. Condensing Boilers – Condensing boilers are the most efficient fuel-fired heating option.

- A condensing boiler must receive a low return water temperature (at least 130°F) to condense water vapor in exhaust gases and extract waste heat. The lower the return water temperature, the better the efficiency of the boiler. See sections B and C for methods to achieve the correct return water temperature.
- Condensing boilers require a specially lined flue to handle the corrosive exhaust vapor, and condensate will need to be piped through a neutralizer before going to the drain.

2. Air-to-Water Heat Pumps – Air-to-water heat pumps are an electric alternative to condensing boilers and provide efficient heating. Heat pump units located outdoors and sized for the relevant climate pull heat from the ambient air and transfer it to the hydronic system.

- Heat pumps are available with a variety of refrigerant types that each have different effects on the heat pump's applicability, performance, and global warming potential.
- Heat pumps can integrate into existing fuel-heated hydronic systems that operate at lower heating loop temperatures.

B Upgrade Terminal Units– Terminal units that operate with low entering water temperatures help the whole system operate more efficiently.

- Retrofit apartments with terminal units capable of delivering heat at lower entering water temperatures, such as fan coils or PTACs.
- Installing more baseboard heaters, larger radiators, or panel radiators are other options.
- In lieu of fan coils, PTACs, or other terminal units, the following technologies can expand the system to provide hydronic central cooling and heat recovery for preheating domestic hot water:
  - **Water source heat pumps** provide heating at low entering water temperatures.
  - **Hybrid water-cooled air conditioners** provide heating at very low supply and return water temperatures.
  - Heat rejection via a dry cooler or cooling tower is needed for both options.

C Properly Size Water Pumps – Oversized pumps cannot modulate to low enough speeds, operate at poor efficiencies, and have increased maintenance issues.

- Install correctly sized pumps paired with variable frequency drives to maximize energy savings.
- Pumps must be sized based on calculated headloss (the loss of pressure due to friction) and flow rate in the system, which is highly dependent on balancing and terminal unit selection.

D Balance Distribution – Ensuring the correct flow rate at each terminal unit will help maximize savings and resident comfort.

- Install pressure independent control valves at each terminal unit to provide both temperature and flow control.

E Install Smart Controls – Install window sensors and wireless, wall-mounted thermostats connected to a central control.

- Open windows in the winter are usually signs of overheating. Sensors can monitor if windows are open and turn off heat in that area.
- Program the central control to prevent overheating in spaces if the temperatures go above the programmed setpoint.

costs & benefits of hydronic systems*

Greenhouse Gas (GHG) Savings

A large reduction in heating related GHG emissions can be expected from a comprehensive hydronic heating upgrade, depending on existing building conditions.

Tenant Experience Improvements

A properly balanced hydronic heating system provides residents with a consistent level of heat without overheating or underheating portions of the building. New thermostatic controls give residents precise temperature control within the limits established by the central programming.

Utility Savings

A high level of utility savings is expected from a hydronic heating retrofit.

Capital Costs

Implementation of this scope requires a large capital investment and is best implemented at the time of equipment replacement.

Maintenance Requirements

Hydronic heating systems require a moderate level of maintenance. A common issue with hydronic heating systems comes from failed zone valve actuators (that control the flow of individual terminal units), which leads to overheating and reduced efficiency. Building staff should be trained to identify and resolve this problem.

**The Costs & Benefits rating system is based on a qualitative 1 to 4 scale where 1 () is lowest and 4 () is highest. Green correlates to savings and improvements, orange correlates to costs and requirements. Ratings are determined by industry experts and calculated relative to the system end use, not the whole building.*

Note: GHG & utility savings are dependent on existing equipment and fuel type. Assumes existing system is atmospheric combustion with high supply temperature.

Take Action

This document is one of more than a dozen High Performance Technology Primers prepared by Building Energy Exchange and the Retrofit Accelerator to introduce decision-makers to solutions that can help them save energy and improve comfort in their buildings. Access the complete library of Tech Primers here:

be-exchange.org/tech-primers

The **NYC Retrofit Accelerator's** team of Efficiency Advisors offers free, personalized advisory services to help streamline the process of making energy efficiency improvements to your building. The **High Performance Retrofit Track (HPRT)** of the **Retrofit Accelerator** can help you design and implement a 10-15 year capital plan to reduce your building's energy use by 40-60%.

HPRT participants commit to accomplishing deep energy reductions by holistically upgrading all major building systems, including the heating system, cooling system, and the building envelope.

Get in touch with the **NYC Retrofit Accelerator** today!

Call (212) 656-9202
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The **Building Energy Exchange (BE-Ex)** is a center of excellence dedicated to reducing the effects of climate change by improving the built environment. **BE-Ex** accelerates the transition to healthy, comfortable, and energy efficient buildings by serving as a resource and trusted expert to the building industry.

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