tech primer

Hydronic Heat Upgrade

A comprehensive hydronic heat optimization that increases comfort and energy savings.

tech overview

applicable building types
hotels, large multi-family, institutional, and commercial

implementation
at equipment replacement, at mid-cycle or refinance retrofits

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

Brendon Harris Hydronics

costs & benefits*

GHG Savings

Tenant Experience Improvements

Utility Savings

Capital Costs

Maintenance Requirements

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

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getting to know hydronic heat systems

With the implementation of a comprehensive, high-performance system optimization, hydronic heating can reduce greenhouse gas emissions and save energy while providing consistent and comfortable heating.

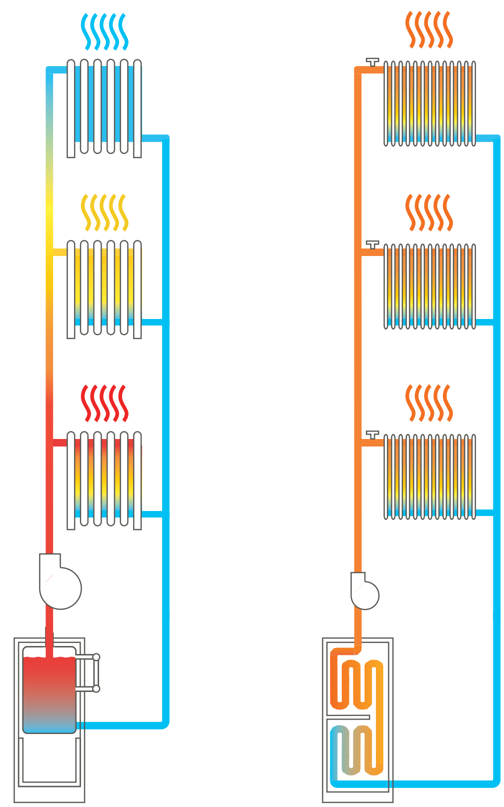
how does hydronic heat work?

Hydronic heat systems use water as a medium to heat large buildings. The system has several components that typically include boilers and pumps, fan coil or other terminal units, and distribution piping. Hydronic heat systems are often paired with chilled water plants to create a complete heating and cooling system. See our Chilled Water Plant tech primer to learn more about how these systems overlap.

A hydronic heat system is a centralized heating system where hot water is generated in a boiler, typically located in the basement, and then pumped throughout the building to occupied spaces where fan coil, or other terminal units such as radiators, convectors, baseboards, or packaged terminal air conditioners (PTACs), heat individual spaces. Return water is pumped back to the boiler where the cycle is repeated.

Hydronic heat systems are a common form of heating found in modern construction and offer several advantages over traditional systems, including precise temperature control, balanced heat distribution (see Fig. 1), and lower distribution temperatures. This tech primer outlines opportunities to maximize efficiency when upgrading hydronic heating equipment and controls. Certain upgrades detailed in the following pages can expand the system to provide hydronic cooling as well efficient heating.

Fig. 1. An unbalanced heat distribution (left), where heat terminals receive different temperatures, vs. a balanced heat distribution (right) where heat terminals receive the same temperature through the addition of PICV valves (see section D, Pg. 3).



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

Coordinate Upgrades for Maximum Savings
Implementing hydronic heat system upgrades in conjunction with building envelope improvements to reduce a building's heat loss will positively impact the heating system performance.

Energy savings may go unrealized without hydronic heat system optimization after building envelope improvements are completed.

Training and Maintenance
Staff should educate residents on optimizing heating in their homes, 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 to a hydronic system

A high-performance retrofit includes updating boiler plants and terminal units, correctly sizing distribution pumps, and designing the system to have a low distribution temperature.

retrofit solutions

There are multiple steps to retrofitting a hydronic heat system:

A Install either fuel-fired or electric hot water heating equipment:

1. Install Condensing Boiler Plant – Install fuel-fired condensing boilers and, where possible, relocate the boiler room to the roof of the building where equipment is much less susceptible to flooding and other damage.

- Condensing boilers are the most efficient option for fuel-fired hot water heating.
- A condensing boiler must have a low return water temperature (130°F or lower) to fully condense water vapor in exhaust gases and extract waste heat. See section 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. The resulting condensate will need to be piped through a neutralizer before going to the drain.

2. Install Air-to-Water Heat Pump Plant – Air-to-water heat pumps (AWHPs) run on electricity and provide efficient hot water heating.

- Heat pump units located outdoors and rated for cold climate operation pull heat from the ambient air and inject it into the hydronic loop.
- Heat pumps are available with a variety of refrigerant types that each have different effects on the 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, typically with return water temperatures below 110°F.

B Install High Temperature-Drop Terminal Units– In order to achieve a large temperature drop and low return water temperature, 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 is another option.
- Equip heating terminals with two-way thermostatic zone valves which cut off heat when the space temperature is satisfied.
- Another alternative is to install hybrid water-cooled air conditioners, which provide heating at very low supply and return water temperatures and have the additional benefit of providing central cooling, as well as heat recovery for preheating domestic hot water. Heat rejection via a dry cooler or cooling tower is needed in the cooling season.

C Properly Size Water Pumps – A large temperature drop will allow for a lower pump flow rate, calling for smaller and more efficient pumps.

- Fit new pumps with variable frequency drives (VFD) and high efficiency, electrically commutating motors (ECM) to automatically adjust flow rate and power consumption.
- Pumps must be sized based on calculated headloss and flow rate in the system, which is highly dependent on plumbing balancing and terminal unit selection. Oversized pumps cannot modulate at low enough speeds, operate at poor efficiencies, and have increased maintenance issues.

D Balance Heat Distribution – The key to balanced heat is making sure each heater gets the correct flow rate of hot water.

- New systems can be designed for balance without special valves and fittings, but retrofits should specify pressure independent control valves (PICVs) or balancing orifices in supply piping for each heater.

E Install Smart Controls – Install window sensors and wireless, internet enabled apartment thermostats (wall-mounted will provide a more acurate reading than unit-mounted) connected to a building management system (BMS).

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

costs & benefits of hydronic systems*

Greenhouse Gas (GHG) Savings

A moderate 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 moderate level of utility savings is expected from a hydronic heating retrofit. Electricity is currently a significantly more expensive form of energy than natural gas or fuel oil, however utility costs may drop dramatically as efficient upgrades to the electric grid take place.

Capital Costs

Implementation of this scope requires a moderate capital investment. Advanced budgeting, proper financing, and utilization of all available local, state, and federal incentives should be pursued.

Maintenance Requirements

A common issue with hydronic systems comes from failed zone valve actuators, which leads to overheating and reduced effectiveness of the heat pumps. Building staff should be trained to identify and resolve this problem, as well as other common or reoccurring issues.

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

NYC Accelerator is a City program that helps New Yorkers implement building energy and water efficiency upgrades to reduce carbon emissions. The NYC Accelerator provides free, individualized support for building decisionmakers to cut operating costs, meet local law compliance, access financing and boost building performance. NYC Accelerator is here to help you navigate the complexities related to local energy laws so your buildings, and our city, are more livable for all.

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This report is financed in part through the NYSERDA Cleaner, Greener Communities Program.