

**tech overview**

- applicable building types
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- fast facts
  - reduces GHG emissions
  - improves user comfort and satisfaction
  - provides balanced heat distribution
  - increases utility savings

**tech primer**

# Metro Steam Optimization

Simple measures for metro steam systems that enhance efficiency and comfort.

**cost & 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 metro steam systems

Recent developments in multi-sensor controls for metro steam systems have made it possible to enhance resident comfort by improving the quality of heat through measures such as advanced zoning and apartment-level temperature control.

## How do metro steam systems work?

Metro steam systems distribute steam through a building's pipes to radiators that heat occupant spaces. Metro steam heating is similar to traditional two-pipe steam systems and provides a simplified and cost saving method of piping steam through large buildings and campuses. Like two-pipe systems, metro steam can come from a district source or be generated in a boiler. The main difference between the two is how the piping layout is installed within the building.

In metro steam systems, steam travels through express risers to the top of the building, sometimes providing heat in bathrooms or kitchens on the way up, and then is down-fed to heaters in a continuous stack back to the condensate return at the base of the building. This uses far fewer steam traps than a standard two-pipe system, thus reducing steam leaks in return lines and simplifying maintenance. Metro steam systems operate best with variable vacuum control which allows the steam temperature to change with the weather.

An inherent problem with the metro steam layout is the imbalanced distribution of heat, where top floor apartments receive too much heat and first floor apartments receive too little (see Fig 1.). Some occupants open windows or add supplemental heat to compensate for an overheated or underheated space, decreasing efficiency and wasting energy. A

high performance retrofit resolves this problem through the addition of a series of controls and devices outlined in this tech primer. A balanced metro steam system (see Fig 2.) should be efficient and effective, providing controlled and predictable heat to building occupants.

Fig 1. An imbalanced metro steam system, where the top floor receives too much heat and the bottom floor receives too little.

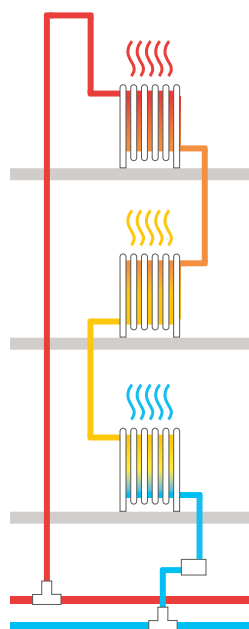
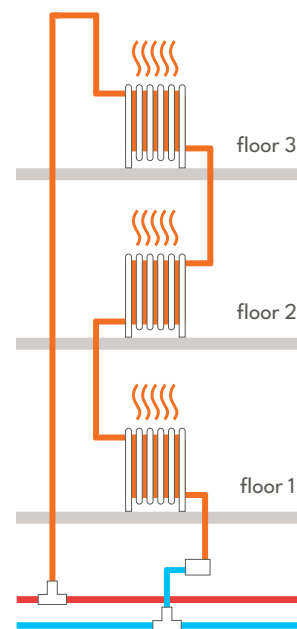


Fig 2. A properly balanced system, where each floor receives the same level of heat, and occupants can adjust temperature to match their personal preference.



### Assess

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

### Coordinate Upgrades for Maximum Savings

Implementing metro steam upgrades in conjunction with building envelope improvements that reduce heat loss and infiltration will improve heating system performance.

*Energy savings will go unrealized without significant steam control optimization after building envelope improvements are completed.*

### Engage End Users

Staff and management should educate residents on optimizing heating in their homes, including how to operate thermostatic controls, why not to block radiators or leave windows open, and how to identify and report any heating issues.

*Resident training and engagement is critical to ensure systems work properly.*

## How to upgrade to two-pipe steam systems

A metro steam retrofit requires not only tuning and upgrading boilers, but comprehensively improving each radiator, enhancing the distribution, and optimizing controls. High performance is only achieved when the system is addressed as a whole.

### Retrofit solutions

A high performance retrofit may start with improving system controls, installing insulation at radiators and pipes, and tuning boilers. Installing new, properly sized boilers once existing boilers fail will complete the system optimization.

**A Upgrade Controls** – Typical boiler controls rely only on outdoor temperature readings to turn the boiler on or off (regardless of how hot or cold apartments are), resulting in uncomfortable overheating. Upgrading to multi-sensor controls that monitor both indoor and outdoor temperatures makes a steam system more responsive to actual heating needs.

- A central control can be used to control heat output, collect data, enable remote monitoring and setpoint control, and improve operations and maintenance.
- Because the pressure of steam corresponds to its temperature, controlling the system's heat output is accomplished by adjusting the pressure of steam downstream of the main supply valve. Program the control to adjust the valve position in response to indoor and outdoor temperature feedback.
- Install window sensors to monitor when windows are open and turn off heat from individual units.

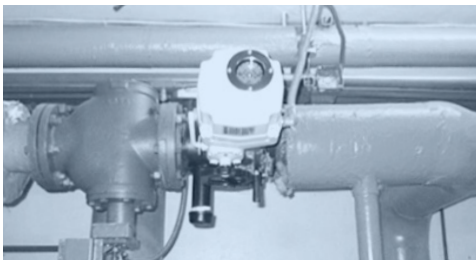


Photo: Steven Winter Associates

An automatic supply valve determines the pressure of steam in response to indoor and outdoor temperature feedback.

**B Insulate Piping and Radiators** – All exposed riser piping must be insulated in order to optimize heat distribution. Insulating radiators can prevent overheating in upper floor apartments.

- The Radiator Cozy is a proprietary device that

includes an insulated radiator cover with a fan that releases hot air stored in the cover when the thermostat calls for heat.

- Integrate the Cozy thermostats with the central controls to improve system operation, and allow for building-wide and room-by-room setbacks as well as temperature limits.

**C Support Staff Training and Maintenance** – Energy savings can only be realized with regular maintenance conducted by trained staff.

- Refer to page 4 for maintenance recommendations.

**D Tune Existing Boilers** – In order for a steam system to run effectively, it is critical that the boiler produce “dry” steam (steam that does not contain water droplets).

- Clean and skim the boiler water to remove oil.
- Tune the burner– the device that controls the boiler's fuel consumption– to reduce short cycling and limit maximum firing rate.

**E Replace Boilers** – When existing boilers have reached the end of useful life, replace with new boilers that are correctly sized for the distribution system.

- Operate the existing boiler at part-fire to determine the correct size of a new boiler. Completing a building-wide radiator survey can also determine how large a new boiler should be.
- To ensure the production of dry steam, install oversized steam outlets, which slows the steam down, and proper header piping, which removes entrained water droplets.
- Improve the burner's modulation to increase the precision of heat output in response to changing heating demands.
- Utilize linkage-less controls, which are more efficient than traditional, linkage-based modulation, on large burners.

# Costs and benefits of metro steam retrofits\*

## Greenhouse Gas (GHG) Savings



A comprehensive metro steam upgrade can moderately reduce heating related GHG emissions, depending on the building's base heating fuel usage.

## Tenant Experience Improvements



A metro steam retrofit greatly improves tenant satisfaction by delivering balanced, even heating throughout the building. Residents can elect to reduce heat in their apartment by adjusting thermostats for each radiator.

## Utility Savings



Moderate utility cost savings can be expected from a metro steam retrofit.

## Capital Costs



Metro steam upgrades require a moderate capital investment. Payback is dependent on a building's fuel type and base heating usage and should be analyzed on a case by case basis.

## Maintenance Requirements



Metro steam systems require a moderate level of maintenance to ensure optimal operating efficiency. A properly working metro steam system must be airtight, but leaks may not be visibly apparent due to the vacuum operation. Methods for identifying leaks include pneumatically pressurizing the system and adding peppermint oil to help identify air leaks. Staff must also regularly check for water leaks by keeping a detailed log of the boiler's makeup water meter. Boiler maintenance includes cleaning the boiler water to reduce oil contamination, and burners must be tuned annually. Steam traps must be tested for leaks to ensure proper operation. Knowledgeable staff can identify and address maintenance items independently or know when to engage qualified contractors.

## Take Action

This document is one of more than a dozen High Performance Technology Primers prepared by the Building Performance Partnership (BPP) to introduce decision-makers to solutions that can help them save energy and improve comfort in their buildings.

For more information, contact Built Environment Plus.

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The Building Performance Partnership (BPP), created by Building Energy Exchange (BE-Ex) and the Institute for Market Transformation (IMT), supports the creation and operation of local high-performance building hubs that accelerate measurable, equitable, and sustainable action to improve the health, comfort, and performance of buildings. With support from both BE-Ex and IMT, partner hubs serve their respective regions with customized resources that cater to the needs of their communities while benefiting from the existing resources and expertise of our network.

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\*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, dark blue 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.