playbook

Better Steam Heat

Save money, enhance comfort

Common steam heating issues can be solved by simple measures that fix hot and cold apartment problems, quiet clanging pipes, and reduce utility bills.

be ex
building energy exchange

NYC Retrofit ACCELERATOR

To get help today: Call (212) 656-9202 or visit nyc.gov/RetrofitAccelerator

JAN 2017

steam heat: keeping new yorkers warm for over a century

The majority of New York City residents rely on steam heating systems to keep them warm, with nearly 80% of all large multi-family buildings[1] heated by steam distribution systems.[2] Many of these systems are decades old and perform unpredictably, causing discomfort for residents and wasting expensive heating fuel. Fortunately, with common upgrades, building owners can significantly improve comfort and reduce annual heating costs by an average of 15%,[3] collectively saving over $145 million each year.[4]

Heating is the single largest use of energy in New York City buildings,[5] yet much of it is wasted through overheating caused by poor heating system design and maintenance. Studies of buildings with steam heating systems find that apartment temperatures often top 80 degrees, with residents opening their windows for relief from excessive heat on even the coldest days.[6]

Many steam heated buildings also suffer from loud, clanging pipes, leaky radiators, and simultaneous under- and overheating of apartments. These common problems not only waste energy and make residents uncomfortable, but also drive up utility bills and maintenance costs.

Some of these issues stem from improper steam system maintenance, while others are legacies of steam heating's past. Many steam boilers and their piping distribution systems were designed in the early 19th century to run on coal, and have not been updated or maintained to perform well using the oil and gas we burn today. In many buildings, this includes operating outdated boilers that are more than twice the size needed to deliver cost-effective and high-quality heat.

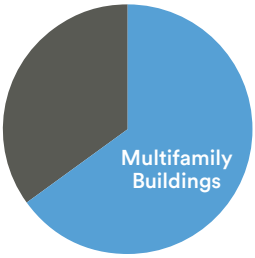
Fortunately, with proper maintenance, simple repairs, and relatively inexpensive upgrades, steam systems can provide efficient, reliable, and balanced heat for years to come.

Optimizing steam system performance also reduces heating and maintenance costs for building owners. Collectively, owners of New York City's large multifamily buildings stand to save over $145 million each year by completing the typical suite of steam heating upgrades.[7] Moreover, these improvements can pay back in as little as four years, depending on heating equipment, building size, and fuel type.[8]

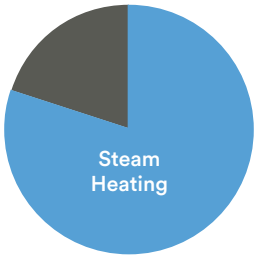
Upgrading steam heating systems is also good for our planet. Completing comprehensive steam upgrades citywide could reduce greenhouse gas emissions from buildings by five percent,[9] helping New York City achieve its ambitious '80×50' climate action goal of reducing carbon emissions by 80 percent below 2005 levels by the year 2050.[10]

Fig. 1. Energy Consumption in Large New York City Buildings[1]

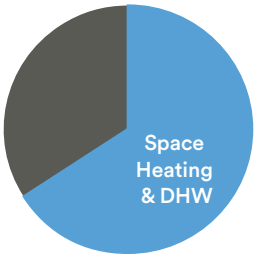
Energy Consumption in Large NYC Buildings, by Building Type



Heating System Type in Large NYC Multifamily Buildings



Energy Consumption in Large NYC Multifamily Buildings, by End Use



NYC's large multifamily buildings consume more energy than any other large building type, and are mostly heated by steam distribution systems. Space heating and domestic hot water (DHW), both of which draw energy from a building's boiler, dominate energy consumption in these buildings. (Source: Mayor's Office of Sustainability, *"One City: Built to Last –Technical Working Group Report"*, 2016).

getting to know your steam heating system

In New York City, most steam used for heat is generated on-site by boilers that burn fuel such as oil or natural gas, while a small portion is sourced from the Con Edison district steam grid. Steam is then distributed through a building's pipes to radiators that heat occupant spaces. Buildings with on-site steam generation can have either a 'one-pipe' or 'two-pipe' steam distribution system.

Common Problems in Steam Heating Systems

Clanging Pipes & Hissing Radiators: Noisy pipes and radiators may indicate that steam contains trapped water droplets. This 'wet steam' can also lead to leaky vents, cold radiators, and equipment damage like steam trap failure that in turn causes additional water build-up. Wet steam can be caused by improper boiler water treatment or by poor boiler and piping design.

Overheating: Uncomfortably overheated apartments are often indicators of an imbalanced heating system, in which steam is reaching some apartments (typically those closest to the boiler) sooner than others (typically those farthest from the boiler). Overheating and uneven heating can be caused by oversized boilers, improper system venting, or ineffective boiler controls that do not respond to indoor air temperature.

Underheating: Radiators that fail to heat up may be symptoms of wet steam or improper air venting. These problems can cause water or air to become trapped in pipes and radiators, blocking steam from reaching and heating all apartments.

Fig. 2. How One-Pipe Steam Systems Work

One-pipe steam systems have one large pipe that connects to each radiator. This single pipe serves as both the supply line that carries steam to the radiator and the return line that drains away water that forms as steam cools and condenses. Steam and water flow in opposite directions in the same pipe at the same time. Vents (▲) on the steam main and radiators release trapped air from the distribution system, allowing steam to travel unimpeded from the boiler to the radiators. One-pipe systems are typically found in buildings built before 1980 and with fewer than six stories.

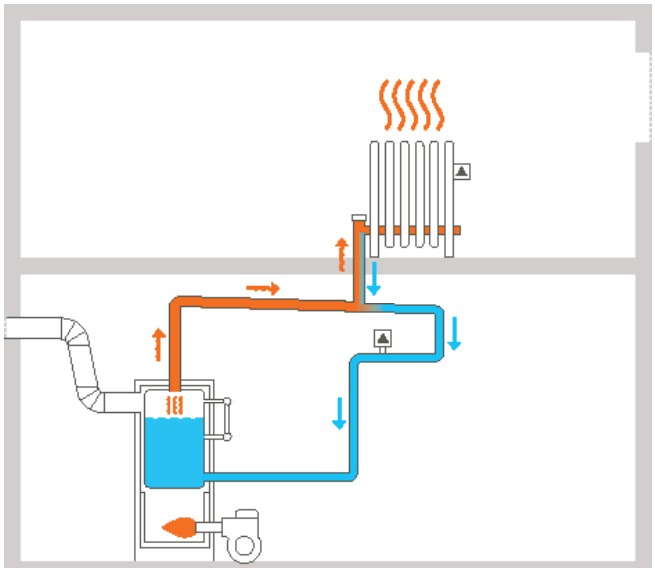
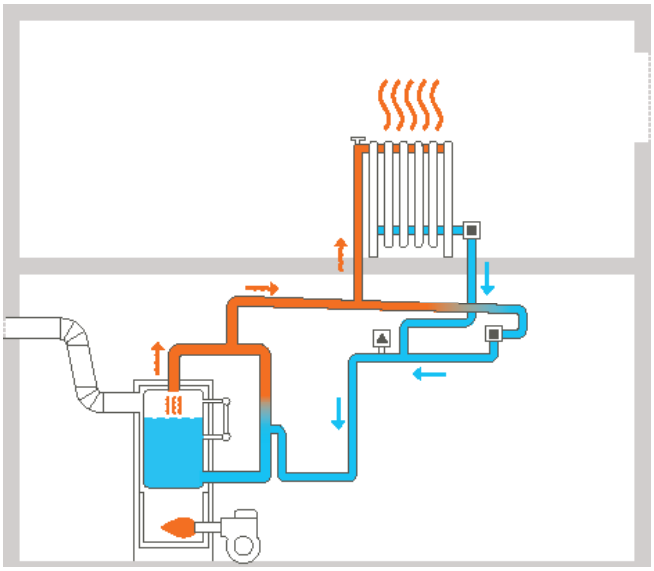


Fig. 3. How Two-Pipe Steam Systems Work

Two-pipe systems have two pipes connected to each radiator: a supply line that carries steam to the radiator, and a return line that drains away condensate (water). A small device called a steam-trap (■) sits between the radiator and the return pipe. In many systems, a larger steam trap is also located on the return main. When properly maintained, steam traps ensure that only water, not steam, enters return pipes. Air is also vented through steam traps, as well as through vents on the steam main (▲). Two-pipe systems are typically found in buildings with six stories or more.[11]



solutions for better steam system performance

There are a number tried-and-true solutions for improving performance in both one- and two-pipe steam systems. It is important to note, however, that no single measure is likely to maximize a steam system's efficiency – performance is typically only optimized when the system is addressed as a whole.

The following are proven solutions for enhancing steam heating system performance:

A Boiler Tune-Up and Burner Modulation – to improve boiler operation and efficiency

B Master Venting – to help heat reach all apartment units quickly and evenly

C Multi-Sensor Controls – to make the system more responsive to changing heating needs

D Thermostatic Radiator Valves (and Orifice Plates) – to provide the right amount of heat to all apartments and give residents greater control over their temperature settings

These four measures yield the greatest results when completed together as a comprehensive suite of work. The first step of any upgrade should be to work with a qualified service provider to develop a scope of work appropriate for your building. The NYC Retrofit Accelerator, a free program provided by the City of New York, can help you find a qualified contractor and determine the right measures for your building. *(See the Resources section to learn more).*

A Boiler Tune-Up & Burner Modulation

Going beyond the typical annual boiler cleaning and tune-up by fine-tuning a burner's modulation can significantly improve boiler efficiency and reduce fuel costs.

Performing an annual boiler cleaning and tune-up is essential for steam heating system maintenance, but alone is not enough to optimize performance. Completing additional work on the burner – the device that controls the boiler's fuel consumption – can yield some of the greatest improvements to steam system performance.

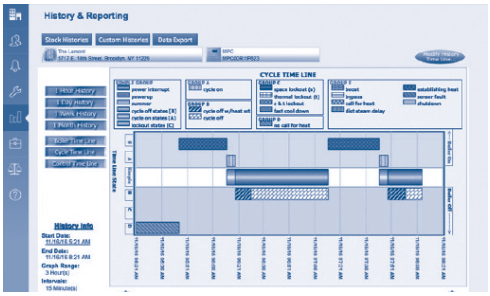
Improving a burner's modulation – its ability to adjust the boiler's firing rate as heating system needs change – can significantly improve steam system efficiency and minimize expensive fuel waste. Fine-tuning boiler and burner performance will also help to get the most out of existing equipment and will enhance the effectiveness of other system upgrades, further improving efficiency, comfort, and savings.

B Master Venting

Master-venting with high-capacity vents, as seen above, helps to speed up and balance the flow of heat to all apartments.

When a steam system cycles off, air rushes in to fill the pipes and radiators. Before steam can fill the radiators again, air must be vented out of the system. The farther an apartment is from the boiler, however, the longer it takes for air to be vented and for steam to reach the radiators. This can lead to cold apartments on the top floors and overheated apartments near the boiler. To flush trapped air quickly and ensure that steam reaches all apartments evenly, a heating service firm can install high-capacity air vents at the ends of steam mains and on the tops of riser lines, a practice known as 'master venting.'

C Multi-Sensor Controls

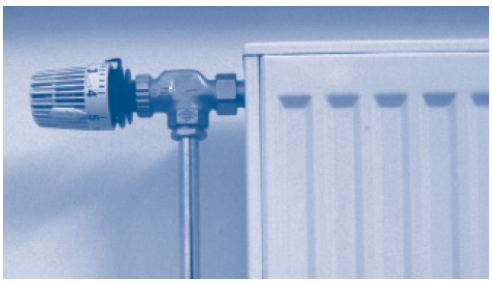


Multi-sensor controls with online dashboards enable better system monitoring and management.

Typical boiler controls rely on outdoor temperature readings to turn the boiler on or off, regardless of how hot or cold apartments are. As a result, the boiler runs longer on colder days, leading to uncomfortable and wasteful overheating.

Upgrading to multi-sensor controls that monitor both indoor and outdoor temperatures makes a steam system more responsive to actual heating needs. The boiler runs only as often as needed to maintain comfort, saving fuel and money.

D Thermostatic Radiator Valves (TRVs)



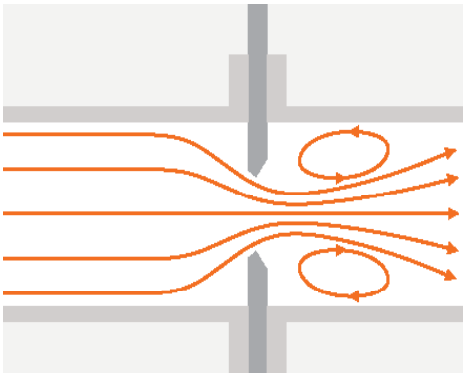
TRVs give residents greater control over their apartment temperature and help to reduce boiler run-times. (Photo: Wikimedia Commons.)

Once the above measures have been completed, residents can be given greater control over apartment temperature settings by installing in-unit thermostatic radiator valves (TRVs). TRVs respond to changes in room temperature, regulating the flow of steam into radiators to maintain a resident's desired heating level. TRVs help to reduce overheating and, when paired with multi-sensor controls, shorten boiler run-times and save fuel.

Two-Pipe Solutions: TRVs & Orifice Plates

TRVs tend to work best in two-pipe steam systems, particularly when installed in conjunction with orifice plates – small metal plates that fit inside the steam supply pipe and restrict the flow of steam into each radiator.

Orifice plates render steam traps unnecessary in most steam heated buildings, eliminating expensive and intrusive in-unit trap maintenance. (Regular steam trap maintenance is an essential measure for any building where they are still in use). Orifice plates also help balance the flow of steam across a building, saving fuel and improving resident comfort.



Orifice plates regulate the flow of steam (depicted here as orange lines) into radiators, and are a simple, low-cost solution for improving performance in two-pipe systems.

Additional Measures

Insulating boiler components, steam pipes, and radiators is a simple, low-cost measure that should be included in any suite of steam system work. Educating building staff and residents on heating system upgrades is also key to the long-term success of any steam improvement project.

In cases where a boiler needs to be replaced, it often makes sense to exchange the old model for a smaller, more efficient one. Most existing boilers are oversized, contributing to costly fuel waste and uncomfortable heating imbalances.

For building owners interested in doing even more, air sealing and other building envelope improvements that reduce heat loss can significantly improve a building's energy efficiency, helping to get the most out of steam system upgrades and further reduce heating costs.

Emerging Approaches: The Radiator Cozy

Designed by Radiator Labs, the Radiator Cozy is an insulating enclosure that is placed over existing radiators in steam-heated buildings. The Cozy's built-in wireless temperature sensor allows residents or managers to control room-level temperatures via web and mobile apps. Retrofitting a whole building with Cozy units can help make building temperatures more even, improve comfort, and may also reduce heating costs.

To learn more, visit: radiatorlabs.com

resources to help you complete steam heating upgrades

Assistance is available to help guide you through the entire process of upgrading your building's steam heating system. You may also qualify for financing and incentives to help reduce the cost of improvements. The NYC Retrofit Accelerator's team of Efficiency Advisors can help you find the right resources for your building.

The NYC Retrofit Accelerator

The NYC Retrofit Accelerator offers free, personalized advisory services that streamline the process of making energy efficiency improvements to buildings. The Retrofit Accelerator's team of Efficiency Advisors are building and energy experts who can help you improve your steam heating system. They will:

- Explain your options to fix your building's steam heating system
- Connect you with contractors trained by the City to make improvements
- Find incentives to help pay for the cost of work
- Help you every step of the way through project completion

To get help today, call (212) 656-9202, email info@nycretrofit.org, or visit nyc.gov/retrofitaccelerator.

Education & Training

The following organizations provide steam heating system education and training for building owners, mangers, operators and staff in New York City:

32BJ Training Fund

The 32BJ Training Fund is a joint labor-management partnership that offers training to eligible participants at no cost. 32BJ provides building O&M training that covers steam heating topics.

- training.32bjfunds.com

Association for Energy Affordability (AEA)

AEA is dedicated to achieving energy efficiency in new and existing buildings in order to foster and maintain affordable and healthy housing and communities, especially those of low-income. AEA offers building O&M training that covers steam heating topics.

- aea.us.org/education

CUNY Building Performance Lab (BPL)

CUNY BPL promotes high-performance building operations for existing commercial and public real estate. BPL offers energy efficiency and building O&M training that includes steam heating topics.

- cunybpl.org/training

NYC Retrofit Accelerator Hands-On Training

The NYC Retrofit Accelerator offers a series of low-cost, hands-on training for building operators on a range of topics including how to test, repair, install, and troubleshoot steam heating equipment.

- NYCRetrofitTraining.eventbrite.com

Solar One

Solar One, New York City's Green Energy Education Center, offers trainings through its Green Workforce Training Program.

- solar1.org

Other Resources

Steam system training may also be available through: Plumbers Local 1 Training Center; the Building Performance Institute (BPI); Urban Green Council's GPRO program; and CUNY City Tech.

Financing and Incentives

Financing and incentives may be available to help cover the costs of steam system improvements.

NYC Energy Efficiency Corporation (NYCEEC)

NYCEEC is a non-profit specialty finance company that develops financing solutions to enable projects that save energy or reduce greenhouse gases. NYCEEC's custom-tailored solutions close financing gaps for buildings and clean energy project developers. NYCEEC can help you explore options for financing steam heating upgrades.

- nyceec.com

Incentive Providers

Customers of Con Edison and National Grid may qualify for incentives for many steam heating system improvements. The New York State Research and Development Authority (NYSERDA) also offers incentives for many steam system measures.

- coned.com/energyefficiency
- nationalgridus.com/services-rebates
- nyserda.ny.gov

Further Reading

To learn more about the topics covered in this brief, please see the following publications, available on the BEEx website:

- *Clanging Pipes and Open Windows: Upgrading NYC Steam Systems for the 21st Century*. Energy Efficiency for All/Steven Winter Associates, Inc. 2015. (Available here.)
- *How to Get the Best from One-Pipe Steam*. Frank R. Gerety, New York City Department of Housing Preservation and Development, 1987. (Available here.)

endnotes

1 "Large buildings" refer to buildings over 50,000 square feet. These buildings are subject to NYC local laws for energy benchmarking and disclosure (LL84) and energy audit and retro-commissioning (LL87).

2 NYC Mayor's Office of Sustainability (MOS), “One City: Built to Last, Technical Working Group Report,” 2016. pp. 36-37

3 NYC Retrofit Accelerator, 2016

4 Energy Efficiency for All (EEFA) & Steven Winter Associates (SWA), “Clanging Pipes and Open Windows,” 2015. p. 4

5 MOS (2016), p. 33

6 EEFA & SWA (2015), p. 4

7 *ibid*, p. 4

8 *ibid*, p. 13

9 MOS (2016), p. 64

10 The New York City Mayor’s Office of Sustainability outlined its 80×50 climate goals in the 2014 report, “One City: Built to Last. ”

11 One-pipe and two-pipe steam system descriptions adapted from: EEFA & SWA (2015), pp. 8-9

about this report

Contributors

Helen Chananie
Building Energy Exchange

Richard Yancey
Building Energy Exchange

Acknowledgments

The authors gratefully acknowledge the very helpful contributions of: Marc Zuluaga, Jonathan Flothow, Jonathan Benezry and Steven Winter Associates; Ali Levine, Jenna Tatum and the Mayor’s Office of Sustainability.

The 2015 report, "Clanging Pipes and Open Windows: Upgrading NYC Steam Systems for the 21st Century," by Energy Efficiency for All and Steven Winter Associates, was also an important resource for the authors.

Disclaimer

The NYC Retrofit Accelerator offers free, personalized advisory services that streamline the process of making energy efficiency improvements to your building that will reduce operating costs, enhance tenant comfort, and improve our environment.

phone: (212) 656-9202
web: nyc.gov/retrofitaccelerator
email: info@nycretrofit.org

The **Building Energy Exchange** connects the New York real estate communities to **energy** and lighting **efficiency** solutions through exhibitions, **education**, technology demonstrations, and research. We identify opportunities, navigate barriers to adoption, broker relationships, and showcase best practices at our resource center in the Surrogate's Courthouse.

phone: 212-349-3900
web: be-exchange.org
email: info@be-exchange.org