case study

Steam Innovations for New York City Buildings

Learn how three NYC facilities are saving energy, reducing emissions, and cutting costs with innovative steam technologies.

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Steam Solutions for New York City Buildings

Most buildings in NYC rely on steam systems for heat. These systems are notorious for performing poorly, leading to under-heating, overheating, maintenance challenges, and expensive utility bills. Fortunately, many common steam problems can be resolved using well-proven upgrade measures. Innovative new technologies are also emerging to help tackle some of the more complex challenges.

Begin with the Basics

The following are tried-and-true measures to improve performance in steam-heated buildings:

A) **Boiler Clean & Tune + Burner Modulation –** to improve boiler performance and efficiency.

B) **Master Venting –** to help steam reach all radiators quickly and heat the building evenly.

C) **Multisensor Controls –** to make the system responsive to changing heating needs.

D) **Thermostatic Radiator Valves & Orifice Plates –**to deliver the right amount of heat to each space and provide occupants with more control over ambient temperature.

Most buildings will also benefit from insulating steam system components, right-sizing equipment, and conducting regular maintenance. *(This scope of work is described in BE-Ex's "Better Steam Heat" guide. See page 7 to learn more.)*

Lead with the Cutting Edge

Innovative technology options are now available to push the performance of your steam system even farther and to address stubborn problems often not resolved by a standard scope of work.

To test the viability of some of the promising solutions emerging in the NYC market, the NYC Department of Citywide Administrative Services, Division of Energy Management (DCAS DEM) conducted demonstrations of three steam technologies. Funded by DCAS DEM's Innovative Demonstration for Energy Adaptability (IDEA) program, the demonstrations were carried out in municipal buildings of diverse types and uses. *(See the box below to learn more about DCAS DEM and IDEA.)*

This document provides details on these demonstration projects, highlighting how each technology can help to resolve specific steam problems often encountered in NYC buildings.

Leading By Example: How the City of New York is Advancing Energy Efficiency

NYC DCAS – Division of Energy Management

The Department of Citywide Administrative Services' (DCAS) Division of Energy Management (DEM) serves as the hub for energy management for NYC government operations, serving 80 agencies and more than 4,000 buildings. DEM is leading the City's efforts to reduce greenhouse gas emissions 80% by 2050 from a 2005 baseline, with a near-term goal to reduce emissions from City operations 40% by 2025.

DEM is working to achieve these goals through operational improvements and energy efficiency projects. DEM provides competitive funding opportunities for energy retrofit projects and operations and maintenance measures. Since 2006, DEM has invested more than $900M in energy retrofit projects that advance the City's greenhouse gas reduction goals and deliver energy usage reductions, cost savings, and resiliency benefits. These projects represent investments in over 1,400 properties that together reduce the City's carbon emissions by more than 29% across 27 City agencies.

The IDEA Program

DEM's Innovative Demonstrations for Energy Adaptability (IDEA) Program helps the City meet its emissions reductions goals by engaging vendors to test new or underutilized energy technologies in City buildings. The IDEA Program helps vendors build the use case for their solutions while addressing specific building system or operational needs.

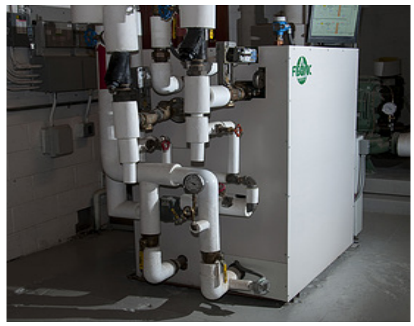
Selected vendors work with DEM to test their technology in a City building for a one-year demonstration period. Findings during and after demonstrations are reviewed to verify savings, greenhouse gas (GHG) reduction potential, and project replicability. These results inform DEM's cleantech strategy and investments and are shared with other NYC agencies and the public. As of 2018, DEM has launched four phases of the IDEA Program, focused on building controls, energy storage, renewable energy storage, and HVAC solutions. Steam system optimization has been a major focus of the HVAC phase.
(See page 7 to learn more.)

Innovative Technology Demonstrations

The following three steam system technologies were tested in City-owned buildings under the IDEA Program. DCAS DEM selected these technologies for their potential to resolve steam issues commonly encountered in NYC buildings, as well as their potential to be replicated and scaled across a wide variety of NYC building types.

Technologies Tested

Read on to learn about three promising new steam technologies successfully implemented at municipal properties under DCAS DEM's IDEA program.[1]



ThermaXX Smart Jackets
Custom jackets to insulate odd- shaped components. *(See p. 4.)*

◆ **FisonicMax System**
Hyper-efficient steam to hot water heat exchanger. *(See p. 5.)*

■ **STEAMGARD System**
Condensate removal devices that outperform standard steam traps. *(See p. 6.)*

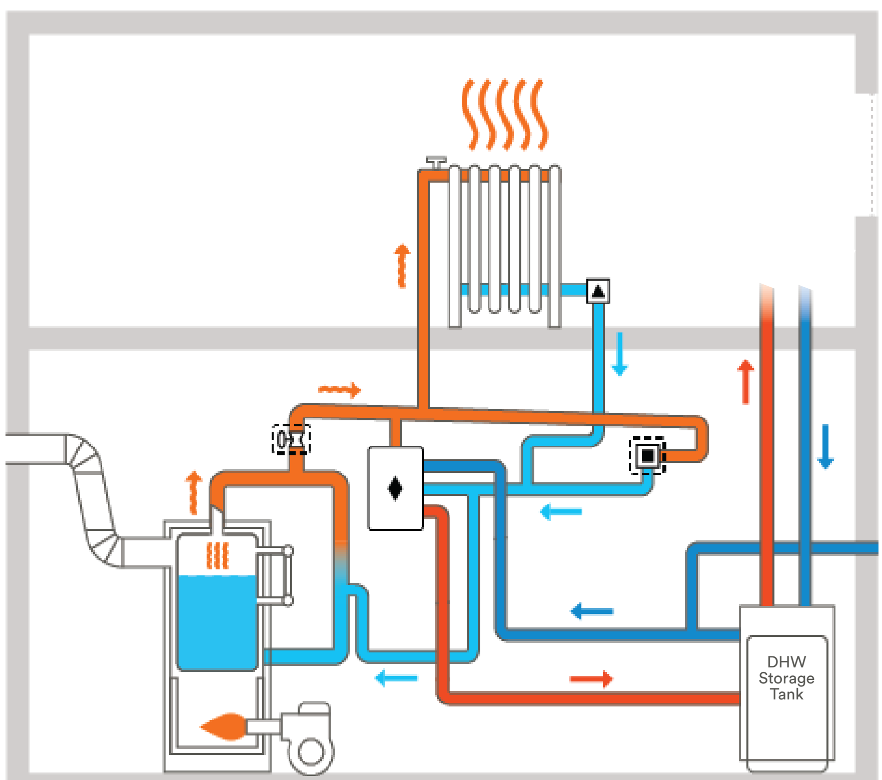
Technologies in Context

This diagram depicts a two-pipe steam system with supply and return lines indicated by color. The icons highlight key areas where the technologies may be applied.

ThermaXX Smart Jackets can insulate fittings like valves ( ), strainers, and large steam traps (■). They may also be effective for odd-shaped piping and boiler components that require periodic access.

◆ **FisonicMax** can be installed in place of, or in parallel to, your existing steam-to-hot-water heat exchanger to heat potable cold water and deliver domestic hot water (DHW).

■ **STEAMGARD** devices can replace large steam traps, such as those on condensate return lines. In some cases, they may also be used to replace smaller radiator traps (▲).



ThermaXX at John Ericsson Middle School (MS 126)

This NYC public school realized significant savings by installing custom insulation jackets for odd-shaped steam components. The installation also gave students an opportunity to learn about energy efficiency and innovative technology right in their school's basement.

Fast Facts

- **Demonstration Period:** Nov. 2016 – Jan. 2017
- **Building Type:** Public School
- **Building Size:** 160,800 gross sq. ft.
- **Location:** Greenpoint, Brooklyn
- **Technology Installed:** 29 ThermaXX Smart Jackets
- **Fuel Savings (natural gas):** 8,675 therms/yr
- **Emissions Reduction:** 46 metric tons CO2e/yr
- **Cost Savings:** $8,068/yr
- **Projected Payback:** 3.1 years (with incentive)
- **Incentive Provider:** National Grid

Image: MS 126 students learn about energy efficiency and innovative technology in their school's boiler room.

Challenge: Uninsulated Steam Fittings

A building's steam distribution system is comprised primarily of straight pipe runs, which can be readily insulated. However, a system may also have non-standard devices such as steam traps, valves, and strainers, which are more difficult to insulate. Building operators may also need regular access to these devices for periodic maintenance – something that conventional insulation systems do not allow. These uninsulated devices are often located in spaces that may already be overheated, such as boiler or mechanical rooms. Insulating these devices can yield energy savings, reductions in space temperature, and comfort improvements.

Technology Solution: Smart Jackets

ThermaXX Smart Jackets are custom-fabricated, removable insulation covers designed for odd-shaped steam fittings and devices that are typically left uninsulated. Smart Jackets help to keep heat in the steam distribution network for more efficient delivery to the desired spaces in the building. Wireless temperature sensors can be added to each jacket to record energy savings (relative to bare fittings) or to provide additional monitoring and diagnostic services. Each jacket features a smart tag that provides easy access to detailed information about the insulated component (via any mobile device) and allows authorized users to add notes and track maintenance activity.

Demonstration Details

John Ericsson Middle School (MS 126), a magnet school for environmental engineering in Greenpoint, Brooklyn, was one of four sites selected by DEM for a 14-month ThermaXX demonstration project. ThermaXX engineers began by conducting a heat loss survey to find poorly insulated steam system components, identify priorities, and estimate costs and savings. Based on this survey, the school installed 29 Smart Jackets with temperature sensors to monitor energy savings and performance. Final measurement and verification, based on data collected by the sensors, confirmed that the jackets not only reduced fuel use, costs, and carbon emissions, but also kept ambient air temperature in the boiler room at a safe and comfortable 79°F. In contrast to previous temperatures that could reach upwards of 90°F, this was a welcome change for staff. Perhaps one of the greatest benefits of the demonstration was that it provided MS 126 students an opportunity to learn about energy efficiency and innovative sustainability solutions right in their school's basement.

Implement it in Your Building

Smart Jackets may be an effective solution for facilities with high steam consumption, year-round steam system operation, uninsulated components with non-standard shapes, and devices that require periodic inspection and maintenance activities.

Vendor engineering surveys should ideally take place while the steam system is operating, and may take one or two days to complete. Better estimates of savings can be generated when building operators provide general reports of daily, weekly and seasonal steam system operations, and how (or if) steam pressure is modulated. During the survey, engineers will inventory uninsulated devices, take spot temperature measurements, and work with building operators to identify devices that require periodic access. Fabrication can take two to four weeks, and installation usually less than one week. Once installed, the vendor should provide training for building operators on jacket removal and re-installation. Be aware that building operators may need to implement limited asbestos abatement or encapsulation if jackets will be in direct contact with existing asbestos insulation.

Hudson Fisonic at NYC Public Health Lab

The NYC Public Health Lab installed Hudson Fisonic Corporation's (HFC's) high-efficiency, two-phase flow heat exchanger for domestic hot water service. The upgrade significantly reduced energy and water use without compromising performance.

Fast Facts

- **Demonstration Period:** Dec. 2016 - Nov. 2017
- **Building Type:** Public Health Lab
- **Building Size:** 358,122 sq. ft.
- **Location:** Midtown Manhattan
- **Technology Installed:** FisonicMax Hot Water System
- **Fuel Savings (District Steam):** 21%/yr
- **Emissions Reduction:** 12 metric tons CO2e/yr
- **Quench Water Use Reduction:** 100%

Image: The NYC Public Health Lab provides a wide variety of clincial and environmental laboratory services, performing testing on more than 2,000 specimens each year.

Challenge: District Steam-to-Water Heat Exchangers

Con Edison manages one of the largest district steam networks in the world, with an estimated 1,650 customers in Manhattan. District steam allows a building operator to focus on maintenance and upkeep of the facility's steam distribution system while effectively outsourcing ownership and operation of the boiler plant to Con Edison. The downside of district steam is that hot condensate is rejected to the city sewer, wasting thermal energy. NYC regulations also require that condensate discharge be below 150°F, which is usually accomplished by mixing the hot condensate with cold potable water, known as “quench” water.

Technology Description: FisonicMax

HFC's FisonicMax Hot Water System is a hyper-efficient hot water-generating system that provides maximum heat transfer with precise control, thereby reducing energy losses. The system uses a nozzle with patented internal geometry to mix steam and water, creating a two-phase flow[2] that efficiently converts steam energy to hot water. Water circulated for space heating is heated by direct contact with steam, reducing or eliminating the need for conventional heat exchangers with electric pumps. The FisonicMax system can bring condensate temperature to below 100°F, which saves energy, reduces steam consumption, and eliminates the need for quench water. The FisonicMax system includes real-time monitoring and controls with predictive analytics that adapt the system to a building's needs. Controls can be easily integrated with existing building automation system. HFC also offers remote monitoring and technical support services.

Demonstration Details

The IDEA Program selected the New York City Department of Health and Mental Hygiene (DOHMH) Public Health Lab in midtown Manhattan to pilot the FisonicMax system. As a medical lab with over 500 employees, hot water service is critical for the facility. At the outset of the demonstration process, HFC conducted an assessment of the building to determine optimal steam/hot water system configuration and connection points. Based on this analysis, engineers installed a FisonicMax system and new condensate tank in DOHMH's central heating plant on the 14th floor. The compact system was installed in a control valve bypass arrangement, leaving the existing instantaneous steam/hot water exchanger in place. This arrangement avoided system downtime and enabled comparative testing of the new and old systems.

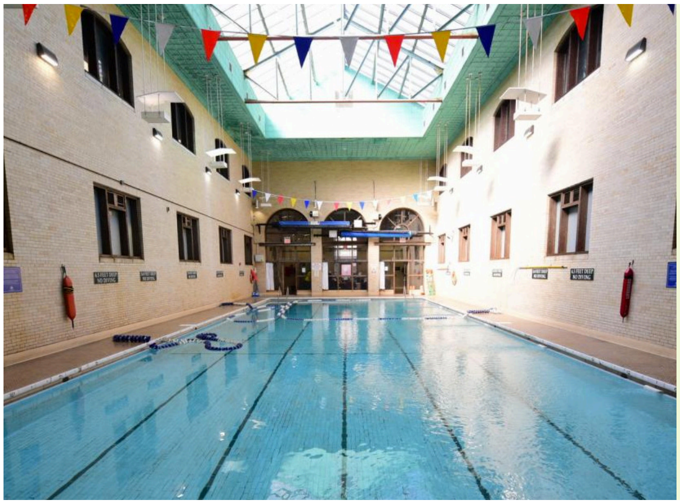
To conduct testing, HFC installed identical flow meters and temperature sensors on the two parallel systems. Steam input was quantified by measuring the flow of condensate discharged from the system, and total energy (BTUs) used by each system was determined using temperature plus flow readings. Ten months of comparative M&V data and an independent final study revealed that FisonicMax dramatically reduced steam trap losses, cutting steam consumption for hot water by 21% and entirely eliminating the use of quench water. Additionally, the transition to the new system was relatively seamless and easy for facility staff.

Implement It in Your Building

The FisonicMax system is appropriate in buildings that use district steam for space heating by circulating hot water and/or have a relatively high potable hot water load. FisonicMax can also be used as a heat exchanger using hot condensate to generate potable hot water. The system requires approximately 100 sq. ft. of floor area, preferably in close proximity to the existing steam and potable hot water lines. Depending on configuration of valves, the system may be installed in parallel to the existing system, minimizing potable hot water downtime. FisonicMax is designed as a skid-mounted device that fits through a typical egress door. A 15-amp electric circuit is needed to power the monitoring and control system.

STEAMGARD at the Metropolitan Pavilion

Replacing failed, conventional steam traps with STEAMGARD's Condensate Removal Devices will reduce maintenance needs and energy use at this recreation center while keeping temperatures comfortable and consistent for staff and visitors.



Fast Facts[3]

- **Demonstration Period:** Feb. 2017- Nov. 2018
- **Building Type:** Recreation Center & Indoor Pool
- **Building Size:** 18,200 sq. ft.
- **Location:** Williamsburg, Brooklyn
- **Technology Installed:** 58 STEAMGARD devices
- **Est. Fuel Savings (natural gas):** avg. 6,100 therms/yr
- **Est. Emissions Reduction:** 32 metric tons CO2e/yr
- **Estimated Cost Savings:** avg. $6,400/yr
- **Projected Payback:** 2-3 years

Image: Post- reftrofit, the pool at the Metropolitan Pavilion maintains a more consistent and comfortable temperature.

Challenge: Steam Traps

Two-pipe steam systems typically rely on steam traps to keep pressure in the heating side of the system and allow water to drain back to the boiler after steam has condensed. If a steam trap fails open, it can cause backpressure on the return system and cause water hammer. If a trap fails in the closed position, the radiator or coil associated with that trap will not receive steam flow. According to the U.S. Department of Energy, if a steam system has not been maintained for 3-5 years, 15-30% of traps are likely to have already failed.[4] In some cases, failed traps can be rebuilt, but doing so often requires manufacturer-specific replacement parts. Failure or functionality of a steam trap may be evaluated using an infared camera or ultrasound leak detector.

Technology Solution: STEAMGARD

STEAMGARD Condensate Removal Devices are designed to dramatically reduce the possibility of steam traps failing "open," which wastes large amounts of steam and energy. They have no moving parts and use custom-modified venturi nozzles with two-phase flow technology to reliably condense steam. Compared to conventional steam traps that may need to be replaced or refurbished every 3-5 years, these traps can perform without degradation for up to 25 years. Further, they require minimal maintenance with blowdown service 1-2 times per year, provided that steam produced by the boiler is relatively clean. STEAMGARD devices reduce thermal inefficiencies, thereby saving fuel, minimizing emissions, and ensuring consistent delivery of heat and hot water.

Demonstration Details

The Metropolitan Recreation Center in Williamsburg, Brooklyn was selected as a demonstration site by the IDEA Program. The recreation center – which features an indoor pool, fitness spaces, and classrooms – had long experienced issues related to steam trap failure, including uneven and non-existent heating in parts of the building. At the outset of the project, STEAMGARD surveyed the steam system. Engineers replaced 58 steam traps with STEAMGARD's Condensate Removal Devices and completed needed repairs to distribution piping. The project resulted in immediate improvements, with even heating restored across the building. Staff and patrons also reported much greater comfort and satisfaction with both ambient and pool temperatures.

Implement It in Your Building

STEAMGARD devices' low maintenance requirements make them a good fit for facilities with minimal or seasonal only on-site staff. They are also better suited for replacing F&T traps than radiator thermostatic traps, due to cost and maintenance issues.

Implementation strategies include periodic replacement as steam traps fail or facility-wide replacement. The latter option may be more cost-effective, as it eliminates year-on-year surveys and repeated mobilization of crews. Vendor engineering surveys can take one or more days, depending on the size of the facility; if only replacing failed traps, the survey must take place with the steam system operating. All steam traps to be replaced should have functioning isolation valves, otherwise it may be necessary to partially shutdown sections of the steam system. According to the manufacturer, installation takes around 30 minutes per trap location. It is recommended that steam system controls be made fully operational as part of the retrofit. For example, thermostatic radiator valve functionality should be evaluated and repaired, if necessary, at each radiator where steam traps are replaced. Post-retrofit, it is best to inspect devices regularly at areas where debris accumulates, such as boiler headers, main line and end of line drips, bottoms of steam risers, at pressure reducing stations, and at key equipment such as AHU coils or heat exchangers.

Note that pre/post-retrofit savings may be hard to calculate accurately if previously under-heated or non-functioning areas of the building are put back into use as a result of the retrofit.

Learn More

Explore the resources below to learn more about steam heating upgrades and assistance available through the City of New York for energy efficiency projects.

Additional Resources

Building Energy Exchange (BE-Ex)
Begin with the Basics: Better Steam Heat
In addition to the innovative approaches described here, be sure to complete a comprehensive scope of work to clean, tune, and optimize your steam system. BE-Ex's "Better Steam Heat Playbook" provides information on measures proven effective for most steam-heated buildings and resources to learn more.

Access the Better Steam Heat playbook, additional case studies on steam heating upgrades, and information on upcoming energy efficiency trainings and events at be-exchange.org.

Endnotes

1. While DCAS DEM found the three technologies featured in this case study to be effective, DCAS DEM does not endorse specific brands or products. Note that in some cases, products may still need to be refined for different building typologies and scales.

2. Two-phase flow is a flow of gas and liquid that displays unusual properties of fluid mechanics. For instance, all dynamic problems in two-phase flow are nonlinear and materials undergoing phase change experience compressible effects that can alter orders of magnitude. Pressure-drops (such as across valves) can also cause exit velocities to increase rather than decrease (source: Wikipedia).

3. STEAMGARD savings data for the Metropolitan Pavilion was estimated rather than measured. Fuel, emissions, and cost savings were estimated by an independent study conducted by Edison Energy. The analysis assumed that existing steam traps will fail in a fully open position, resulting in steam loss if not repaired or replaced. Edison Energy calculated steam loss at failed traps using conservative capacity factors to account for partially open traps and other mitigating factors. The analysis also assumed that inoperative radiator controls would be put into working order post-retrofit.(*To learn more about the methodology used or to access the full report, please contact Saverio Grosso at saverio.grosso@edisonenergy.com)*

4. Citation: "Energy Tips: STEAM - Steam Tip Sheet #1," US Department of Energy, Advanced Manufacturing Office, Jan. 2012.e4. Citation: "Energy Tips: STEAM - Steam Tip Sheet #1," US Department of Energy, Advanced Manufacturing Office, Jan. 2012.

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