Effective: November 8, 2009

ITC Steam Temperature Control System

Green-Buildings' team of accredited green building professionals performed a benchmark analysis of the ITC Steam Temperature Control System against Green-Buildings' proprietary Green Building Accepted Environment Principles Process™ and determined that the ITC Steam Temperature Control System will:

A. **Conserve Energy and Electricity**
B. **Reduce Greenhouse Gas (GhG) Emissions**
C. **Increase Occupant Comfort and Satisfaction**

Green-Buildings also believes that the use of the ITC Steam Temperature Control System is an effective choice when seeking to achieve certification under green building rating systems, such as LEED.

EXECUTIVE SUMMARY

The ITC Steam Temperature Control System (ITC Steam System) is a patent pending software algorithm that operates in conjunction with various Johnson Controls systems implemented and installed by Independent Temperature Control Services, Inc (ITC).

Green-Buildings.com ("Green-Buildings") worked with ITC to complete a review and evaluation of the ITC Steam System. Green-Buildings believes that the ITC Steam System meets several important accepted green building principles and, as such, the product is applicable to high-performance building implementation.

Green-Buildings' team of accredited professionals performed a benchmark analysis of the ITC Steam System against Green-Buildings' proprietary Green Building Accepted Environment Principles Process™ and determined that use of the ITC Steam System will:

A. **Conserve Energy and Electricity**
B. **Reduce Greenhouse Gas (GhG) Emissions**
C. **Increase Occupant Comfort and Satisfaction**

Additionally, Green-Buildings believes that the characteristics of the ITC Steam System make it an ideal option when seeking to obtain certification through various green building rating systems, such as the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) Green Building Rating System.

While no single product may guarantee a credit or certification in a green building rating system, Green-Buildings believes that the use of the ITC Steam System may be effective in helping earning credits towards LEED certification[i] in at least one of the following categories:

a. **Energy & Atmosphere (EA):** 1-10 Points
b. **Indoor Environmental Quality (EQ):** 1 Point
c. **Innovation in Design (ID):** 1 Point

SYSTEM DESCRIPTION

The patent pending ITC Steam System regulates steam temperature from a boiler or third party utility by providing a well-defined sequence of instructions for the operation of a digital steam pressure controller system. The ITC invention makes mechanical systems even more efficient by further reducing the energy required to produce steam to heat the buildings. The result is that the ITC Steam System is capable of maintaining steam at as little as 160 degrees Fahrenheit, a 52 degree reduction from steam held at 212 degrees.

ITC works with Johnson Controls to install their mechanical systems to make buildings more efficient in their use of resources such as energy, electricity and water. ITC currently utilizes the Johnson Controls FX-16 series controller to power the steam temperature control algorithm; however the ITC Steam System is not limited to this model.

Steam heating systems are used in some types of commercial and multi-unit residential structures. A typical steam heating system includes a boiler from which steam is distributed to multiple steam radiators located throughout a building. Temperature controls for a conventional steam heating system may include only one type of sensor input, such as the temperature of the interior of the building. The ITC steam system includes multiple sensor inputs to facilitate enhanced temperature control of the steam heating system.

A traditional boiler generates steam from heating water. The ITC system includes the addition of a steam outlet conduit and control valve to vary the volume of steam distributed from the boiler to the radiators or other pieces of equipment throughout the building. The control valve is operated by a valve controller that regulates the opening and closing of the valve based on the ITC Steam System software as well as input from multiple input sensors which could include:

- Steam temperature sensor at the steam outlet of the boiler
- Vacuum sensor at the steam outlet of the boiler
- Outdoor air temperature sensor installed on the exterior of the building
- Room air temperature sensor(s) installed within the building envelope

These sensors all report back to the steam system controller to vary system delivery characteristics. A condensation return line connects the vacuum sensor line to the boiler. Condensate is pumped through the line back to the boiler via a return vacuum pump in the condensation return line. Another vacuum pressure sensor in the condensate return line reports back to the controller and allows the vacuum pump to operate and maintain vacuum pressure in the condensation return line to ensure continual removal of condensate from the system. A variable frequency drive (VFD) may be connected to the controller and used to conserve energy on the vacuum pump operation by controlling the speed of the pump motor.

Ultimately the system is a complete variable volume, variable temperature steam system which utilizes input data from the outdoor air sensor, room sensor(s), steam discharge temperature sensor, and vacuum pressure sensor, resulting in a zoned steam delivery system.

The ITC Steam Temperature Control System improves steam heating efficiency by up to fifty percent (50%) by using ITC's patent pending algorithm to reduce steam holding temperature from

212 degrees to as little as 160 degrees, while simultaneously using individually controlled steam risers and an internet-accessible building management system to implement control strategies like night-setback and trend data. ITC currently utilizes the Johnson Controls FX-20 series supervisory controller to provide internet accessibility.

A. Conserve Energy and Electricity:

According to the U.S. Department of Energy, buildings are responsible for approximately 39% of the energy consumed in the United States. Of the electricity used, building operations result in approximately 74% of total U.S. consumption.

A key green building principle is the conservation of energy and electricity through the use of energy efficient technologies and controls. Heating, Ventilation and Air Conditioning systems typically consume as much as one third of a building's total energy usage, so to reduce any energy associated with those systems may make a significant impact on the building's energy load profile. Taking steps to reduce unnecessary losses from retaining a large quantity of steam on standby and avoiding the generation of larger quantities of steam than are necessary has also been shown to greatly improve the effectiveness and efficiency of green building energy strategies, while simultaneously reducing the demand, and carbon output from, fossil fuel-fired power facilities.

Buildings that incorporate high-performance building components, such as the ITC Steam System, will use less energy and electricity than conventional buildings resulting in a cleaner environment. This is because the underlying technological design of the ITC Steam System produces steam in a far more efficient way than traditional systems, or even retrofitted modern constant volume systems, and is capable of maintaining that steam at a lower overall temperature. The result is that only the quantities needed to heat spaces or run processes that specifically call for steam are generated on an as-needed basis, reducing overall energy consumption.

By incorporating the ITC Steam System into a holistic, energy-saving green building strategy, building owners and operators may not only save money on utility bills, but also realize a positive return on investment over the life of the system while reducing the environmental impacts of greenhouse gas emissions and other harmful pollutants.

B. Reduce GhG Emissions:

The vast majority of electricity consumed in the U.S. is initially generated through the burning of fossil fuels, such as coal, natural gas and oil at conventional power plants. A byproduct of the operation of conventional power plants is the production of a significant amount of greenhouse gases (GhG) and other harmful pollutants.

According to the U.S. Green Building Council and the U.S. Environmental Protection Agency (EPA), for each megawatt of coal generated electricity produced, an average of 2,249 pounds of carbon dioxide, 13 pounds of sulfur dioxide and 6 pounds of nitrogen oxides are released into the atmosphere. Indeed, more than 65% of the sulfur dioxide pollution in the U.S., or approximately 13 million tons per year, is the result of coal fired power generation. The EPA also reports that the average emissions rates in the United States from natural gas-fired generation are 1135 pounds of carbon dioxide, 0.1 pounds of sulfur dioxide and 1.7 pounds of nitrogen oxides per megawatt hour.

Compared to the average air emissions from coal-fired generation, a natural gas fired power plant produces approximately half as much carbon dioxide, less than a third as much nitrogen oxides, and one percent as much sulfur oxides. As use of the ITC Steam System may increase steam storage efficiency, demand for steam production may be reduced by as much as thirty percent (30%) at coal and/or natural gas power plants.

(See attached Case Study for GhG reduction calculations)

The use of the ITC Steam System reduces natural gas and electricity demand and, therefore, reduces the amount GhG emissions released into the atmosphere from fossil fuel-fired power generation.

C. Increase Occupant Comfort and Satisfaction

A key green building principle is to provide a high level of occupant comfort and improve the overall conditions of the building indoor environment. Studies have shown that individuals can spend as much as 90% of their time indoors, and that people who are comfortable are more productive and generally happier. In a work environment, increases in productivity can result in overall cost savings to a company due to higher efficiency worker output. The implementation of systems that contribute to better overall controllability can increase occupant comfort. Furthermore, the implementation of a web interface allows building maintenance staff to conveniently monitor system performance and address potential occupant comfort issues that may arise.

HVAC systems with incorrectly located or too few thermostats or control zones can significantly impair building occupants' comfort. The ITC Steam System addresses this issue with increased zoning and controllability based on input from each space's temperature sensor. Proper zoning based on space usage will result in energy savings, increased occupant comfort, and fewer overall complaints.

The increased controllability capabilities of the ITC Steam System provides real estate owners and operators with the benefit of reduced labor due to thermal comfort complaints and greater occupant satisfaction which in turn can increase employee efficiency. In residential buildings, the use of the ITC Steam System may increase resident comfort and decrease complaints and/or turnover.

LEED Scoring and Certification:

Use of variable volume, variable temperature systems, such as the ITC Steam System, may contribute materially to the Leadership in Energy and Environmental Design® ("LEED®") Green Building certification process. Accordingly, use of the ITC Steam System may provide measurable performance in one or more of the following LEED credit categories:

Energy & Atmosphere: EAc1 (1 to 10 Points)

Energy efficiency reduces the negative environmental consequences associated with the production and use of energy. As buildings are commonly powered by fossil fuels, energy savings are critical to green building. The EA credit category represents the primary area where the inherent efficiencies of the ITC Steam System can deliver significant positive impact. And as building HVAC systems

traditionally use up to a third of a building's total energy, reduction of steam production and system electrical usage by 25% - 30% can affect overall HVAC system performance by a factor of up to 10% (1-10 Points).

Indoor Environmental Quality: IEQc7.1 (1 Point)

Systems with proper zoning and enhanced control capabilities provide greater occupant comfort and reduce complaints of inadequate thermal comfort. Designing a mechanical system to meet occupant satisfaction through utilization of ASHRAE Standard 55 requirements meets the intent of this credit. The ITC Steam System will help contribute to overall controllability and occupant comfort.

Innovation in Design: IDc1 (1 Point)

Projects that achieve exceptional performance above the requirements set by the LEED Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System may earn points under Innovation in Design. As the ITC Steam System may be the first of its kind developed to deliberately regulate and actively monitor steam temperature below 212 degrees, following the strategy described in Path 1 of the Innovation in Design of ID credit 1, may meet the requirements of this credit.

CONCLUSION

Green Buildings believes that the ITC Steam System meets three significant criteria used in green building initiatives: **Conserve energy and electricity, reduce GhG emissions** and **increase occupant comfort and satisfaction**. Furthermore, use of the ITC Steam System is an effective choice when seeking to achieve certification under a green building rating system, such as LEED, by potentially earning points in the areas of Energy and Atmosphere and Indoor Environmental Quality. Finally, the use of the ITC Steam System should result in a positive return on investment (ROI) for owners and operators who are considering the benefits of the system in a new building or green building retrofit.

CASE STUDY – PETER COOPER VILLAGE AND STUYVESANT TOWN

Executive Summary

The ITC Steam System has been in use at Peter Cooper Village - Stuyvesant Town, or "Stuy Town" as it is more commonly known, since 2006. Stuy Town is an 87 acre, 110 building New York City apartment complex with over 25,000 residents in 11,000 residential units. The installation of the ITC Steam System has resulted in a significant increase in energy efficiency with a corresponding reduction in GhG production, of approximately fifty percent (50%), to date.

Highlights

- **Project name:** Peter Cooper Village – Stuyvesant Town
- **Location:** Manhattan (New York, NY)
- **Building type(s):** Multi-unit residential
- **Project scope:** 25,000 residents, 11,232 apartment units, 110 buildings.
- **Setting:** Urban setting
- **Built:** 1947
- **Owner:** Tishman-Speyer

Details

Peter Cooper Village - Stuyvesant Town, aka "Stuy Town", is located on the East Side of lower Manhattan in New York City and is comprised of two massive multi-family residential complexes covering over 87 acres of land.

Peter Cooper Village, to the north, is the smaller of the two projects with 21 buildings, while Stuyvesant Town is the much larger southerly development comprised of 89 buildings. The project sits between Manhattan's East River and First Avenue and stretches from a northerly border on 23rd Street to 14th Street to the south. Planning began in 1942 and the project was opened in 1947.

The property is one of the largest apartment complexes in all of New York City. Notably, in 2007, the property was acquired by Tishman-Speyer from MetLife for $5.4 billion. At the time, the acquisition was the largest single asset real estate transaction in U.S. history.

Energy Intensity

The significance of Stuy Town's value as one of the largest multi-family residential developments in all of New York City is well-known to the area's utilities. Stuy Town is Con Edison's largest consumer of steam in all of lower Manhattan. Before September 11th, 2001, this honor was held by the World Trade Center.

The property is served by Con Edison's 14th Street Power Plant. The plant generates steam by burning a range of fossil fuels including natural gas, #6 fuel oil and diesel fuel. Approximately ninety percent (90%) of the steam generated at the 14th Street Plant is produced by burning natural gas.

Efficiency Measures

In 2005, MetLife was engaged in a series of retrofits to improve the efficiency of its physical plant operations. ITC was contracted to install and measure the performance of a steam temperature control system designed by Lockwood Greene in a single building in Peter Cooper Village. The

objective of this initial engagement was to measure and compare the steam usage of the new steam temperature control equipment to existing steam systems currently in place in other, similar buildings at the property. Soon thereafter, ITC's services were expanded to include the evaluation of the remaining buildings in Peter Cooper Village and, subsequently, all of Stuyvesant Town.

During the system commissioning process, Bud Flynn, President of ITC, devised a new strategy and unique approach to the control programming which enhanced and improved the performance of the system's original configuration. The result is a patent pending software algorithm that has proven to significantly increase efficiency and comfort levels throughout Peter Cooper Village – Stuyvesant Town and/or at any properties where steam heating systems are in use. By regulating Con Edison supplied steam temperature based on outside air temperatures, steam vacuum pressure and inside air temperatures, ITC is able to maintain steam temperature at 160 degrees, resulting in less steam being used and less line loss occuring, resulting in significant savings.

Tests of efficiency were conducted by on-site facility management utilizing Con Edison meters in two five-building clusters with similar exposures. The tests resulted in a 27% reduction in steam consumption from the steam system baseline, resulting in approximately a 5 year payback for the $28,500,000 investment.

Implementation of this system shows immediate overall trending downward in terms of steam usage, indicating that the buildings in which the new system was implemented were generating more steam and at a higher temperature than was needed for their actual heating and process loads when the prior system had been in use.

Estimated GhG Savings

The production of steam in New York City is achieved by the burning of fossil fuels such as natural gas, diesel or other fuel oils.

When accounting for the carbon dioxide emissions associated with the production and distribution of steam in New York City, a coefficient must be established. For our purposes herein, metered supply of steam is used and the coefficient sought is metered steam (in pounds) to Btu.

Fossil Fuels			
Pounds per Billion Btu of Energy Input*			
Pollutant	**Natural Gas**	**Oil**	**Coal**
Carbon Dioxide	117,000	164,000	208,000
Carbon Monoxide	40	33	208
Nitrogen Oxides	92	448	457
Sulfur Dioxide	1	84	2,744
Mercury	0.000	0.007	0.016

According to Con Edison and the City of New York, steam is released from its plants at 125 pounds per square inch (psi). At this pressure, it is at 1193 Btu per pound. Because the steam is reduced in quantity by fourteen percent (14%) on average during delivery, for each pound purchased, 1.16 pounds are produced. Con Edison estimates that its steam boilers operate at 81% efficiency, on average.

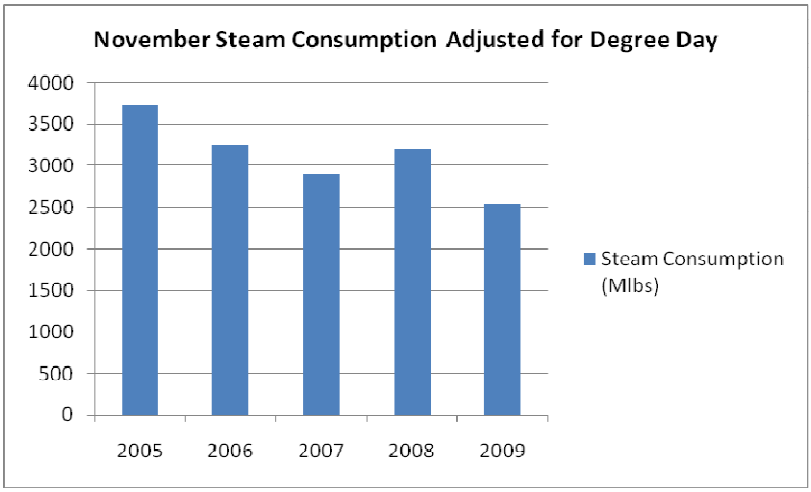
Water used to produce steam, delivered at 50 degrees Fahrenheit, on average, has a Btu content of 18 Btu per pound. Fuel consumption per pound of steam purchased, therefore, is determined through the formula 1193 Btu/pound x 1.16/0.81, resulting in a conversion factor of 1,687 Btu/pound.[ii]

Btu	.000117 Pounds of Co2
Btu/Pound of Purchased Steam	1,687
Pounds of Co2/Pound of Steam	.197
Lbs Co2/Metric Ton	2,205
Pounds of Steam Saved (November):	1,190,000
Pounds of Steam Saved (March)	1,550,000
Pounds of Co2 Saved (November)	234,400
Pounds of Co2 Saved (March)	305,350
Metric Tons of Co2 Saved (November)	106 (.0000106 MMT)
Metric Tons of Co2 Saved (March)	138.4 (.0000138 MMT)

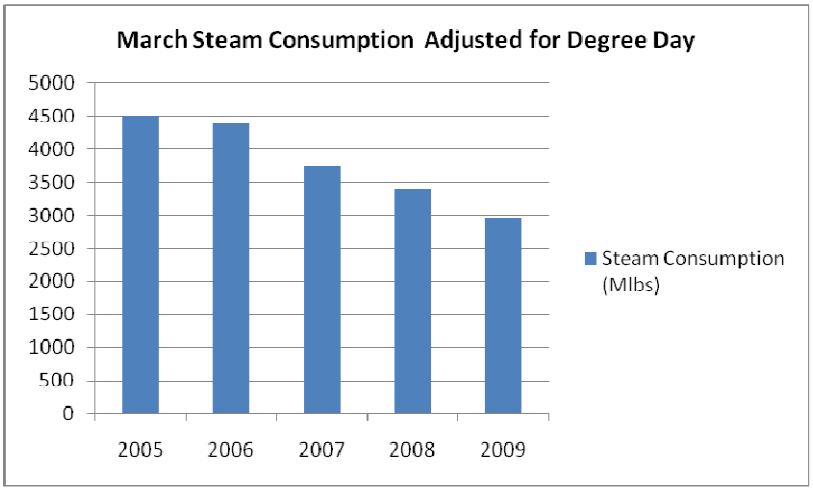
As the Con Edison 14th Street Power Plant uses approximately 90% natural gas, it is our assumption that the conversion factor is 1 Btu (.000117 Pounds of Co2) x 1,687 Btus/Pound of purchased steam = .197 Pounds of Co2 per Pound of purchased steam.

ITC measured steam consumption in Mlbs of steam consumed at Peter Cooper Village - Stuyvesant Town from 2005 through 2009.

The charts to the right and below indicate the steam consumption (per month) in thousands of pounds of steam (Mlbs) at Stuy-Town over that period.



During the months of November and March when comparing against the baseline of 2005, steam savings in consumption of Mlbs of steam was as much as 34% in March and 32% in November, when adjusted for Degree Day.



During the month of November, savings achieved in Mlbs of steam is as high as 1,190 resulting in 234,400 pounds of Carbon Dioxide saved (or 106 metric tons). During the month of March, savings achieved in Mlbs of steam is as high as 1,550 resulting in 305,350 pounds of Carbon Dioxide saved (or 138.4 metric tons).

CONCLUSION

The introduction of the ITC Steam System in other buildings throughout North America's conventional steam fired boiler building stock, could cause a significant reduction in what is estimated to be an annual release of more than 2,200 megatons of CO2 into the atmosphere, about 35 percent of our continent's total, from buildings. When incorporated into a holistic green building design plan, the ITC Steam System may deliver a significant positive impact to a building owner or operator's bottom line, while also reducing GhG. It is common now for more advanced green buildings to reduce energy usage by 30, 40, or even 50 percent over conventional buildings, with the most efficient buildings now performing more than 70 percent better than conventional properties[iii].

Currently existing and emerging advanced energy saving technologies, such as the ITC Steam System, could result in more than 1,700 fewer megatons of CO2 emissions in 2030, compared to projected emissions that year following a business-as-usual approach.

Product Reviewed by: Rob Freeman Jr., LEED AP and Sarah Gudeman, LEED AP

[i] Green-Buildings.com has evaluated and reviewed this product using its own methodology. While Green-Buildings.com believes that certain products have characteristics that may allow users of the products to earn points in a LEED certification, only the Green Building Certification Institute (GBCI) may award points and grant certification. Accordingly, Green-Buildings.com does not make any assurances, guarantees, representations, or warranties, express or implied, and specifically disclaims all warranties or representations, that products will earn LEED points, or any project that utilizes such products, will receive LEED® certification.

[ii] Inventory of New York City Greenhouse Gas Emissions, Mayor's Office of Long-Term Planning and Sustainability

[iii] Design Intelligence; Greenway Communications 2009