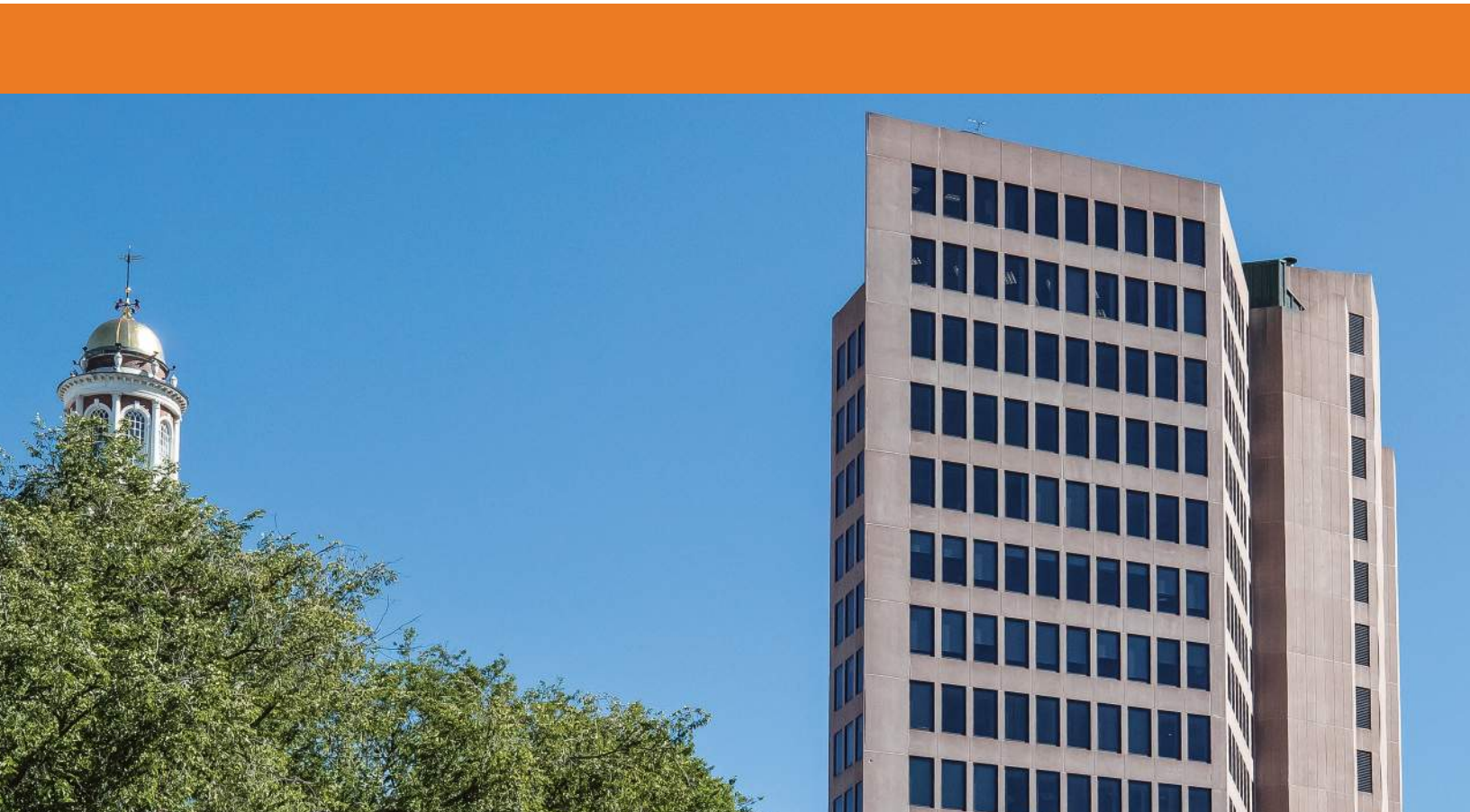


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Energy-Saving Retrofit
with Interior Accessory Windows
195 CHURCH
New Haven, Connecticut

Building Retrofit Strategy
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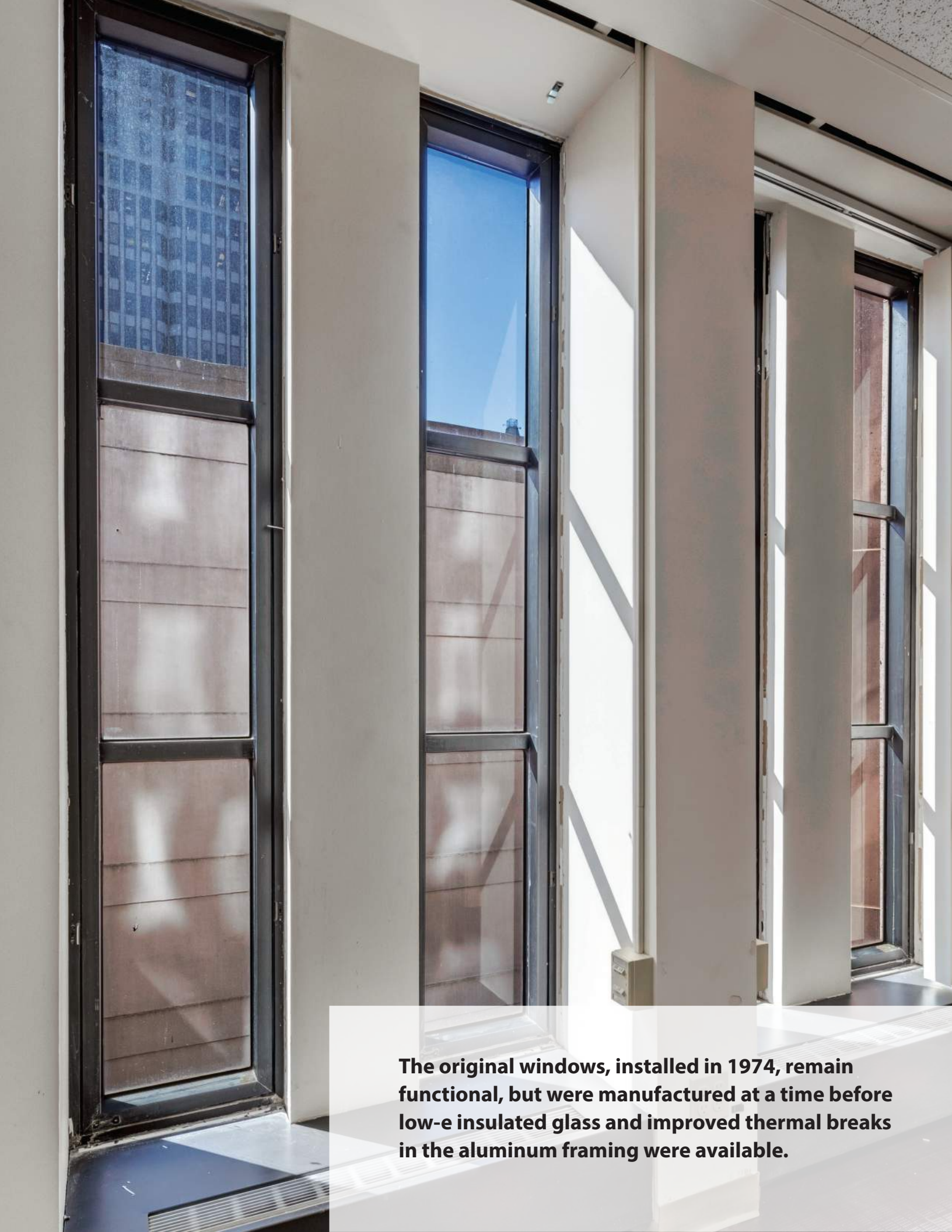
Window Retrofit Project:

More energy-efficient, more comfortable, more savings

Located on the New Haven Green, 195 CHURCH is undergoing a \$6 million energy-efficient window and lighting retrofit. Implementing recommendations from Globelé Energy and Apogee Enterprises, Inc.'s Building Retrofit Strategy Team, the property's tenants already are experiencing more comfortable workspaces. The building owners, 195 Church Street Associates, LLC, are also noticing significant annual energy savings; it is on track to earn an estimated \$589,000 rebate from utility provider United Illuminating through the EnergizeCT initiative.

"There has not been a capital improvement of this magnitude to a building in New Haven in many years," observes Christopher Vigilante, chief operating officer of Northside Development Co., the property management company for 195 CHURCH where Northside Development Company also is a tenant. Currently, the 244,000 square foot, 18-story, Class A office building is 75 percent occupied with 28 tenants and 340 occupants.





The original windows, installed in 1974, remain functional, but were manufactured at a time before low-e insulated glass and improved thermal breaks in the aluminum framing were available.

“The goal was to make this building as efficient as possible thus doing the right thing for the environment and also producing a very good return on our investment.” Gary Pattavina, United Illuminating’s energy engineer

Improving on History for a Better Future

Built in 1974 and largely constructed of concrete, 195 CHURCH reflects the materials and style of the era. The original windows remain functional, but were manufactured at a time before low-e insulated glass and improved thermal breaks in the aluminum framing were available.

In addition to the aging windows, the property’s all-electric baseboard heating and variable-air-volume system with electric reheat contributed to large utility bills. Seeking to improve the building’s energy efficiency, Northside worked with Globelé Energy, LLC, to review the property per the U.S. Department of Energy’s benchmarking program and by performing a Level 1 ASHRAE energy audit.

As a regional electric distribution company, United Illuminating (UI) provides energy efficiency programs through the EnergizeCT initiative. This initiative is designed to advance the efficient use of energy, reduce air pollution and negative environmental impacts, and promote economic development and energy security.

“UI’s energy engineer Gary Pattavina was instrumental in guiding us through the plan and offered very helpful advice and guidance through a very intricate process,” says Vigilante. “The goal was to make this building as efficient as possible thus doing the right thing for the environment and also producing a very good return on our investment.” Pattavina notes, “Electrically heated buildings are a great candidate for energy efficiency measures and these types of projects are exactly what we look for at UI. We recognize new energy-efficient windows are a costly investment and the incentives available to our customers help bring that up front cost down significantly. We were very excited to work with the customer and their design team to help them achieve the energy savings on this window replacement project.”

“Today’s energy-efficient windows can dramatically lower the heating and cooling costs associated with windows, while increasing occupant comfort. Optimizing natural light also can contribute to a building’s energy efficiency and tenants’ wellbeing.”

– Mike Sheppy, Apogee Building Retrofit Strategy Team’s certified energy manager

Modeled for Savings

To achieve the owner’s energy reduction goals, Globelé outlined a multi-phased plan. Phase I recommended replacing the old fluorescent lights with new LEDs and updating the 43-year-old windows. Helping Northside’s team select the optimal window system, Apogee Building Retrofit Strategy Team provided an annual energy savings forecast showing the potential savings offered with Wausau Window and Wall Systems’ 1297 Series S.E.A.L. interior accessory windows.

Interior accessory windows are installed from the building’s interior over the existing windows, which were sealed closed to prevent air infiltration. For 195 CHURCH, Wausau’s S.E.A.L. units feature Viracon’s RoomSide™ low-e glass and aluminum framing members finished by Linetec in Dark Bronze anodize.

Using the eQUEST energy modeling physics-based software tool to simulate the performance of a building on an annual basis, the Apogee Building Retrofit Strategy Team forecasted the level of energy savings that could be achieved by adding an interior accessory window with low-e glass to the existing glazing. From this data, performance predictions were provided on annual energy, peak demand and daylight energy use.

“Today’s energy-efficient windows can dramatically lower the heating and cooling costs associated with windows, while increasing occupant comfort,” says Apogee Building Retrofit Strategy Team’s certified energy manager, Mike Sheppy. “Optimizing natural light also can contribute to a building’s energy efficiency and tenants’ wellbeing.”

High-performance, High Comfort:

Interior accessory windows with low-e glass keep out the cold

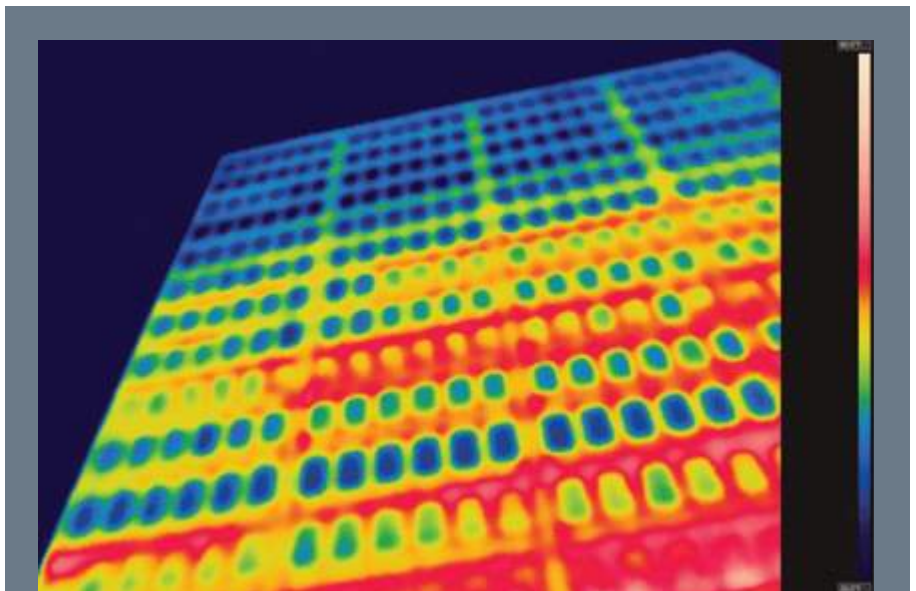
Increased Daylighting and Comfort

Viracon's RoomSide low-e glass also improves light-to-solar gain (LSG) ratio by 21 percent. Sheppy explains, "This improved LSG ratio increases the number of hours in the year that natural daylighting can be used without tenants having to draw their blinds. In addition, electrical lighting can be dimmed or turned off with daylighting controls."

He continues, "Furthermore, according to the World Green Building Council, natural daylighting can save up to \$2,000 per employee in office costs by increasing occupant comfort, leading to higher productivity. Adding an interior accessory window with low-e glass to the existing glazing significantly improves occupant comfort because surface temperatures are much closer to room temperature."

In Connecticut's cold months, Sheppy says, "The new glazing will keep the occupants seated in the perimeter spaces of this building more comfortable by significantly reduced radiant heat transfer. These improvements will allow occupants to sit closer to the windows, increasing the usable floor space of the building."

Comparing the window bays before and after the retrofit, thermal imaging shows window surface temperature differences of nearly 20 degrees Fahrenheit. Sheppy describes, "The new windows (cool blue) stand out in sharp contrast against the old windows (hot red). This indicates that the new windows are keeping out the cold 34 degree Fahrenheit outside conditions, while keeping in the warm 72 degree Fahrenheit inside conditions."



Thermal imaging of the north façade shows the building with a temperature scale of 30 to 50 Fahrenheit. Cooler temperatures are shown in blue, while warmer temperatures are shown in red. From the blue on floors 4, 8, 9

and 14-18, it is apparent that these floors have completed their window retrofit. The new units offer improved thermal performance, which contribute to energy savings and occupants' comfort.

Creating and Calibrating the Baseline Energy Model

The window retrofit for 195 Church St. was modeled using the performance values shown in the table below:

Model Input Parameter/ Energy Efficiency Measure	U-value	Solar Heat Gain Coefficient	Visible Light Transmittance
<i>Baseline:</i> Non-thermally broken frames and clear monolithic glass with no low-e coating	1.08	0.77	76%
<i>Retrofit:</i> Wausau's S.E.A.L. interior accessory window and Viracon's 1/4-inch clear glass with RoomSide low-e	0.48	0.56	70%

To estimate the energy savings of the window retrofit, first a baseline energy model was created using: 12 months of utility bills and 15-minute electrical demand data, information collected from the building engineer, the building's orientation, space type, floor area, glass area by elevation, and Typical Meteorological Year (TMY3) weather data. Since complete building systems information was not available, the energy model assumes ASHRAE 90.1-2004 and eQUEST default values where appropriate. Also, this building is unique because it is primarily heated with electricity. The building uses Variable Air Volume (VAV) boxes with electric resistance reheat, baseboards with electric resistance heating, and an air handler on each floor with hydronic heating coils (with a natural gas heat source).

The baseline building was modeled with the existing, non-thermally broken frames and clear monolithic glass. Also, the air infiltration from the aging pivot gaskets on the windows was modeled at a level equivalent to 1.75 cubic feet per minute per square foot of fenestration area at a pressure of 1.56 pounds per square foot of fenestration area. Next, the window retrofit was modeled and included Wausau interior accessory window with 1/4-inch Viracon clear glass with RoomSide low-e.

Since the pivot gaskets were caulked and sealed during the window retrofit, two levels of air infiltration savings were modeled (no savings and moderate savings). The energy model results were compared to the historical utility data to evaluate the effectiveness of the energy model. The comparison showed that the predicted annual and monthly energy consumption, and peak demand matches well with the historical data. Therefore, the energy model is a good indicator of the energy savings that can be expected in the coming months.

Please note:

- An update on this window retrofit project will be prepared when the entire 12 months of post-retrofit utility bills and electrical demand data are available.
- Air infiltration through the old and new glazing was not measured. Once an entire 12 months of post-retrofit utility data are available, the level of air infiltration savings will be determined more precisely through comparison with the energy modeling results.
- To isolate the energy savings from the window retrofit, the LED lighting retrofit is not included in the eQUEST energy modeling data discussed here.



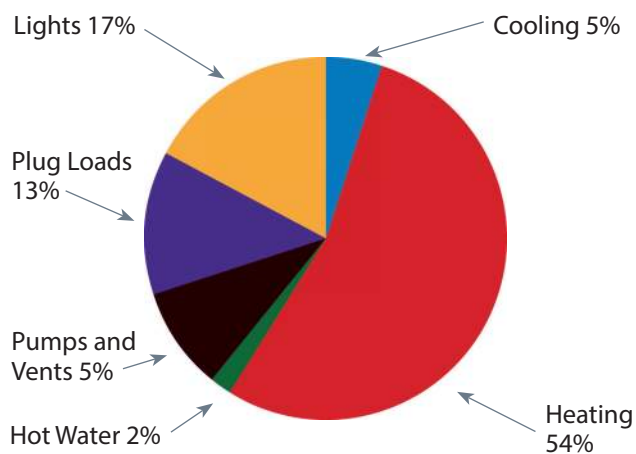
Results of the Baseline Energy Model

The energy modeling results of the window retrofit were compared to the baseline to estimate total annual energy savings. The results are shown in the tables below and are broken out by energy end-use. Savings are expressed in

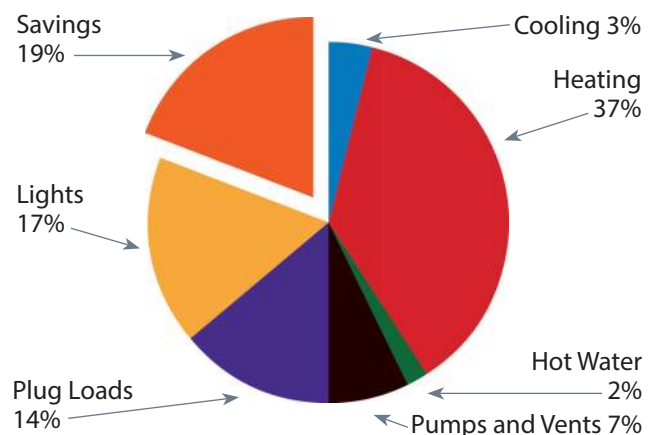
units of megawatt-hours. Please note that electrical and natural gas energy consumption are combined in each energy end-use category.

	Lighting Energy (MWh)	Heating Energy (MWh)	Cooling Energy (MWh)	Plug Load Energy (MWh)	Hot Water Energy (MWh)	Pumps and Vents Energy (MWh)
Baseline	966.9	3,060.5	273.0	765.3	103.6	492.0
Retrofit + Moderate Air Infiltration Savings	966.9 (-)	2,111.0 (31% ↓)	237.2 (13% ↓)	765.8 (-)	103.5 (-)	420.8 (14% ↓)
Retrofit + No Air Infiltration Savings	966.9 (-)	2,511.7 (18% ↓)	241.4 (12% ↓)	765.5 (-)	103.6 (-)	428.3 (13% ↓)

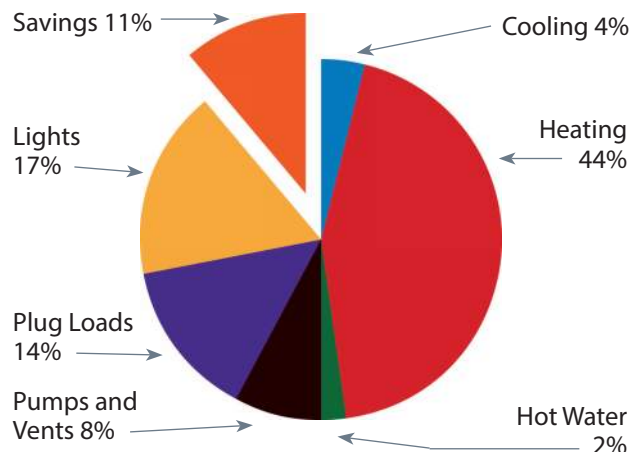
Baseline Annual Energy Consumption



Interior Accessory Windows + Moderate Air Infiltration Savings



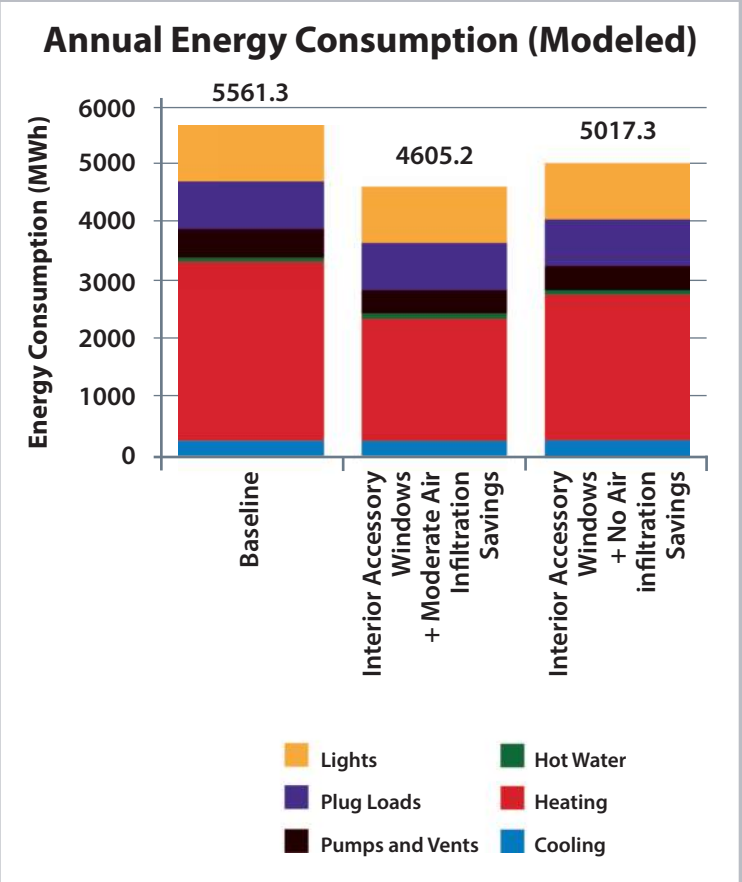
Interior Accessory Windows + No Air Infiltration Savings



The lower U-value of the proposed glazing significantly reduces winter heat losses. Therefore, between 18 percent (no air infiltration savings) and 31 percent (moderate air infiltration savings) less energy is needed to meet the heating needs of the building. Because approximately 90 percent of the heating in this building is provided by electric resistance, this window retrofit will significantly reduce whole building electricity consumption and peak demand.

The table and graph below highlight the predicted whole building energy savings that this window retrofit could achieve.

	Total Energy Consumption (MWh)	Total Electrical Peak Demand Reduction (kW)
Baseline	5,661.3	1,890
Retrofit + Moderate Air Infiltration Savings	4,605.2 (19% ↓)	1,850 (2% ↓)
Retrofit + No Air Infiltration Savings	5,017.3 (11% ↓)	1,860 (2% ↓)



Along with energy savings, 195 CHURCH’s retrofitted windows provide tenants with daylighting, outdoor views of the nearby New Haven Green, and enhanced thermal and acoustic performance for a more comfortable, quieter interior.



Window of Opportunity

Energy-efficiency upgrades and renovations on 195 CHURCH began in the summer of 2016. Milestone Construction Services, LLC substantially completed the window retrofit by May 2017. To complete the building retrofit on the last two floors, Milestone is waiting for a more convenient time that minimizes disruption to the tenants.

Northside's Vigilante compliments their efforts, "Milestone did an incredible job on the installation. Of course, vacant offices are a piece of cake, but when you get into occupied offices, which need to be completed on nights and weekends, it's a completely different story. The efficiency of their crews were amazing. All offices that had windows in them had to have blinds removed, windows cleaned (existing and new), furniture moved, electronics disabled and reinstalled... oh and then you had to install the

new insert windows and caulk them. Milestone took pictures of every office before anything was touched and they made sure it was put back perfectly. They did an amazing job with no added stress in my life."

He adds, "There were a lot of pieces to this puzzle and Milestone made this the easiest construction job that I have ever been involved with."

When completed, Milestone will have updated 1,400 window units totaling 42,336 square feet. More than 1,200 of these interior accessory windows units were 4 by 8 feet. The rest were narrow 1.5 by 8 feet, installed on the South elevation. Wausau also provided the field measurements to ensure the best possible fit.

"It's a top-notch team at Wausau," praises Vigilante. "From the sales department to the modeling department to the delivery of truckloads of windows – the process was nearly flawless. They build a great product and deserve a lot of recognition for their team's products and processes."

Making the Goal

Vigilante also is quick to recognize Globelé's important role, saying, "Elena Cahill and her staff guided me through the world of energy purchasing, as well as introducing me to the UI's energy incentive programs. We are all proud of the fact that we were the first approved building in the UI territory to be able to receive incentives for the installation of window inserts, something that would not have happened were it not for the team that Globelé brought to the project."

He elaborates, "The year before we bought this building the electric costs were approximately \$1.2 million per year. We believe that through correct energy purchasing and our load reductions from our energy savings programs we will reduce our bill by 50 percent."

Cahill agrees, "This building is poised to meet or exceed their energy savings goals."

As the lead auditor for this building, Globel  Energy’s Alfred Peterson points out that the project’s “success is measured by sustainable reduction in energy for a single Energy Opportunity or as a Comprehensive Initiative of two or more projects as was bundled for 195 CHURCH.”

Based on this measure of analysis, Wausau’s new S.E.A.L. units, in combination with the new LEDs, are anticipated to save 29 percent in annual electrical energy consumption. Estimates show a yearly electrical energy savings of \$0.95 per square foot of floor space, reducing the owner’s roughly \$805,000 annual electricity bill by \$203,000.

Efficient, Attractive and Vibrant

Throughout the energy-efficiency updates, Northside collaborated with Kenneth Boroson Architects, LLC. “KBA is our architectural firm for the entire building,” notes Vigilante “They designed the office fit-ups, lobby renovations, conference suite design, upcoming fitness center and lounge additions, etc. They are involved in almost every aspect of design for this building.”

Demonstrating the owner’s commitment to design, performance and comfort, Vigilante summarizes, “From purchase in December of 2015, we have replaced the exterior side-walks, remodeled the lobby, added a state-of-the-art 4th Floor Conference Suite, installed 9,000 LED lightbulbs, installed 1,400 new energy-efficient window inserts and have re-positioned the building in the market adding new tech companies as tenants. A new gym is expected in 2018. We have added life and vibrancy to a landmark building in New Haven.”




195 Church St.: New Haven, CT 06510

- Owner: 195 Church St. Associates, LLC; New Haven, Connecticut
- Property management: Northside Development Co.; New Haven, Connecticut; <http://northsidedct.com>
- Architect – lobby and conference room renovations: Kenneth Boroson Architects, LLC; New Haven, Connecticut; <http://www.kbarch.com>
- Utility company: United Illuminating Company; New Haven, Connecticut; EnergizeCT initiative, <https://www.energizect.com>
- Energy consultant: Globel  Energy, LLC; New Haven, Connecticut; <http://globeleenergy.com>
- Window contractor: Milestone Construction Services, Inc.; East Haven, Connecticut; <http://milestonecsllc.com>
- Window renovation strategists: Apogee Enterprises, Inc., Building Retrofit Strategy Team; Minneapolis; <http://www.apogee.com>
- Window systems – manufacturer: Wausau Window and Wall Systems, an Apogee Enterprises Company; Wausau, Wisconsin; <http://www.wausauwindow.com>
- Window systems – glass fabricator: Viracon, Inc., an Apogee Enterprises Company; Owatonna, Minnesota; <http://www.viracon.com>
- Window systems – finisher: Linetec, an Apogee Enterprises Company; Wausau, Wisconsin; <http://www.linetec.com>
- Photos by: Woodruff/Brown Architectural Photography

Data

- Employees/occupants: 340
- Occupancy: 75%
- Square Footage: 244,000
- Floors: 18
- Construction year: 1974



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GLASS

Viracon

World leader in architectural glass fabrication

ALUMINUM WINDOW, CURTAIN WALL, STOREFRONT, ENTRANCE SYSTEMS

Wausau Window and Wall Systems

U.S. manufacturer of windows, curtain wall

Tubelite Inc.

U.S. manufacturer of storefront, curtain wall, entrances

EFCO Corporation

U.S. manufacturer of window, curtainwall, storefront, entrances

Sotawall

North American manufacturer of unitized curtainwall

Alumicor

Canadian manufacturer of storefront, windows, curtain wall, entrances

Linetec

North American finisher of aluminum architectural products

apogee **services**

BUILDING SURVEY

Determine conditions; recommend upgrades

APOGEE ENERGY MODELING TOOL

COMFEN – Lawrence Berkeley, University of Minnesota

SPECIFICATION ASSISTANCE

Review performance requirements

DETAIL ASSISTANCE

Architectural drawings of window and curtain wall products

BUDGETING

Provide installed options

NETWORK OF INSTALLERS

Recommend quality, authorized installers across North America

READY TO LEARN MORE? Apogee Enterprises, Inc.'s Building Retrofit Strategy Team, in conjunction with its businesses, assists building owners and property managers evaluate the benefits of window renovation and upgrades, such as improving the appearance of the building, saving energy, downsizing HVAC loading, reducing maintenance, lowering vacancy rates, increasing rental rates and enhancing the value of the building. The team offers free energy modeling, product selection and design assistance, and a network of installers covering North America.

To learn more, please contact:

John Bendt | jbendt@apog.com | 612-790-3137 or Kevin Robbins | krobbins@apog.com | 715-409-0821

