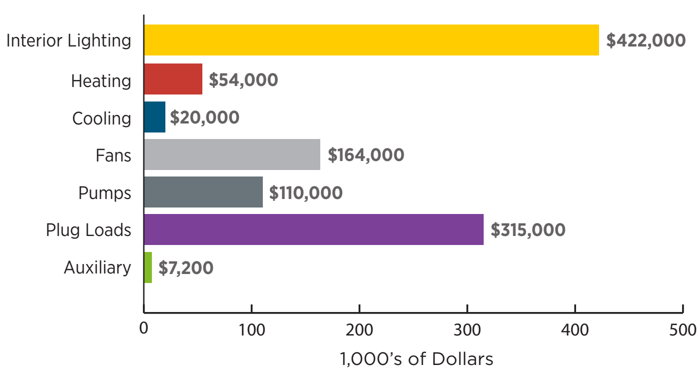
Increasing Property Value with Energy Saving Practices

Hines partnered with the Department of Energy (DOE) to develop and implement solutions to retrofit existing buildings to reduce energy consumption by at least 30% versus requirements set by Standard 90.1-2004 of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), the American National Standards Institute (ANSI), and the Illuminating Engineering Society of North America (IESNA) as part of DOE's Commercial Building Partnerships (CBP) Program.[1] Pacific Northwest National Laboratory provided technical expertise in support of this DOE program.

Hines is a privately owned, international real estate, development, and management firm that manages 135.3 million square feet and $22.9 billion in controlled assets. A pioneer of sustainable building practices, Hines is committed to policies that limit environmental impacts, reduce operating costs, and increase the value of its properties.

To identify a specific project, Hines conducted a survey of its regional managers and selected 20 buildings for initial consideration. From this list, and with the agreement from the owner and occupant Morgan Stanley, the 522 Fifth Avenue building (522 building) in New York City was selected. Even with several upgrades and renovations, the building (originally built over 100 years ago) had energy costs of approximately $5.70 per square foot, offering considerable room for improvement.

Expected Energy Cost Reductions



[1] The Commercial Building Partnerships (CBP) Program is a public/private, cost-shared initiative that demonstrates cost-effective, replicable ways to achieve dramatic energy savings in commercial buildings. Through the program, companies and organizations, selected through a competitive process, team with U.S. Department of Energy (DOE) and national laboratory staff who provide technical expertise to explore energy-saving ideas and strategies that are applied to specific building project(s) and that can be replicated across the market.

[2] Annual savings costs are calculated using assumed utility blended rates of $0.18/kWh for electricity and $30.63/million British thermal units for steam.

[3] Greenhouse Gas Equivalencies Calculator: http://www.epa.gov/cleanenergy/energy-resources/calculator.html.

The 522 building has achieved energy savings of 30% to date in comparison to historic consumption using an ongoing process of continuous improvement to identify, analyze, and implement energy efficiency measures

Project Type	Office, Retrofit
Climate Zone	ASHRAE Zone 4A, Mixed-Humid
Ownership	Owner Occupied
Barriers Addressed	Older buildings are complex to model, expensive to retrofit, and lack baseline documentation
Square Footage of Project	515,000
Expected Energy Savings versus Historic Operations	43%, 30% implemented to date
Expected Energy Savings (versus ASHRAE 90.1-2004)	30%
Expected Energy Savings (to be verified)	5,767,000 kilowatt-hour (kWh) of electricity, 17,679 therms of steam/year
Expected Cost Reductions (versus Historic Operations)	$1,092,000/year[2]
Project Simple Payback	Less than 4 years
Estimated Avoided Carbon Dioxide Emissions	Approximately 4,065 metric tons/year[3]
Construction Completion Date	June 2013 (expected)

The occupied spaces consist of 23 above grade floors and two below grade floors, including four Morgan Stanley divisions within the building's 515,000 square feet of office space.

The CBP team provided technical assistance and suggested many energy efficiency measures (EEMs). Over 40 EEMs and operational improvements were implemented. If the project results in new cost-saving equipment or techniques, the energy reduction strategies will be shared with facility and engineering managers throughout the Hines' worldwide portfolio.

Decision Criteria

Economic

Hines worked with Morgan Stanley to carefully evaluate the business case for energy improvements. Because this property is a long-term investment, both the return on investment (ROI) and the long-range effects of energy efficient strategies were carefully considered. Morgan Stanley required an ROI under 4 years.

Operational

Hines regularly reviews the energy performance of all its managed properties. Onsite managers evaluate energy use, assess equipment, and develop best practices and operating practices tailored to the individual building. This information, along with recommendations, is compiled into an annual assessment report that identifies all possible improvements. Hines also provides tenants with building manuals to explain heating, cooling, ventilation, and other automated systems. Tenants learn how to balance comfort with efficiency, contributing to good energy management.

An operational strategy that can affect energy savings is Morgan Stanley's requirement to have redundant systems. Given the nature of its financial management services business, Morgan Stanley cannot afford any type of shutdown without suffering severe business consequences.

Hines values knowledge and expertise. When Hines began managing the building in December 2008, instead of hiring only one chief facility engineer for the building, two staff members were selected as co-leads. One had extensive knowledge of the building, having worked at the 522 building for almost 20 years. The other co-lead had expertise regarding the Hines organization, with over 15 years of experience in the Hines' facilities sector. This enabled the co-leads to jointly consider opportunities to keep both the Hines approach and legacy experience of the building at the forefront. Hines also recognizes the importance of continuous staff training and has a goal to get as many staff as possible trained to be Leadership in Energy and Environmental Design (LEED) accredited professionals.

Lighting fixture upgrades provided quality lighting and reduced building energy use

Policy

Hines was an early adopter of the Environmental Protection Agency's ENERGY STAR program, achieving a reduced energy cost of $1.47/square foot ($ft^2$) per year with a total portfolio savings of $102 million. Hines strives to attain the U.S. Green Building Council's LEED certifications for its properties; in 2011, Hines received the highest score ever awarded in the LEED Existing Building category. The company has earned several awards and recognition, including the following:

- The first real estate firm to be recognized with the ENERGY STAR Sustained Excellence Award.
- The Silver Leader in the Light Award for superior and sustained portfolio-wide energy use practices and sustainability initiatives from the National Association of Real Estate Investment Trusts (NAREIT).
- In support of Morgan Stanley properties, the Business Leaders for Energy Efficiency Award by The New York State Energy Research and Development Authority (NYSERDA) for their efforts to implement energy efficiency strategies.

Energy Efficiency Measures

The two energy end uses that offered great potential for energy savings were lighting and plug loads. More efficient lighting not only reduces the amount of electricity used but also generates less heat, thereby reducing the cooling load. In a facility like the 522 building where cooling is the dominant requirement 8 months of the year, lowering the amount of heat produced by lighting can have quite an impact. Miscellaneous equipment loads also have a significant impact on building energy use. By incorporating strategies for the reduction of plug loads, substantial savings are realized from both lower electricity consumption and a reduction of the cooling load.

Energy Efficiency Measures

Building energy improvements at the 522 building include the building envelope; interior lighting; heating, ventilation, and air conditioning (HVAC), and plug loads. Energy savings from the measures follow in the table. The EEM savings are not cumulative but refer to individual measures. The EEMs are presented ranked by expected annual savings. Percentages listed for each category represent measures that have been implemented to date. Benefits from improvements to ongoing building operations are difficult to model, but are suggested from utility billing data.

EEM	Implementing in This Project	Will Consider for Future Projects	Expected Annual Saving		Steam Savings MMBtu/yr[1]	Expected Improvement Cost $[2]	Expected Cost of Conserved Energy $/kWh[3]	Expected Simple Payback yr
			kWh/yr	$/yr				
Envelope: 0% of Whole Building Savings *(implemented to date)*								
Replace double-pane windows with triple-pane windows*	No	Maybe	44,000	$14,000	193	Cost data is not yet available		
Upgrade R-12 to R-22 in exterior insulation finishing system*	No	Maybe	3,000	$4,700	136			
Lighting: 13% of Whole Building Savings *(implemented to date)*								
Upgrade to energy efficient lighting fixtures throughout active areas (exclude equipment rooms)	Yes	Yes	1,436,000	$258,000	-17	Cost data is not yet available		
Option 1 - Retrofit/replace fixtures with light-emitting diodes, additional occupancy sensors	Maybe	Yes	533,000	$94,000	-49			
Option 2 - Replace lamps with more efficient compact fluorescents, additional occupancy sensors	Maybe	Yes	168,000	$29,000	-26			
Install lighting occupancy sensors in equipment rooms	Yes	Yes	192,000	$34,000	0			
Install occupancy sensors in conference rooms and equipment rooms 24, BA, BB	Yes	Yes	153,000	$26,000	-46			
Retrofit lobby lighting	Yes	Yes	45,000	$8,100	0			
Retrofit the lighting fixtures in equipment rooms	Yes	Yes	38,000	$6,800	0			
Retrofit entrance chandelier	Yes	Yes	9,600	$1,700	0			
Upgrade service elevator fixtures to 28-W fixtures	Yes	Yes	8,200	$1,500	0			
HVAC: 11% of Whole Building Savings *(implemented to date)*								
Convert the constant flow primary chilled water system to a variable flow system	Yes	Yes	506,000	$91,000	2	$50,000	$0.01	<1
Implement optimal start stop for all the major air handling units	Yes	Yes	296.000	$54,000	28	$21,000	$0.01	<1
Close outside air dampers during unoccupied hours when outside air enthalpy is greater than return air enthalpy	Yes	Yes	-23,000	$48,000	1,272	$23,000	$0.00	<1
Implement static pressure reset air handling units	Yes	Yes	217,000	$34,000	-153	$25,000	$0.01	<1

EEM	Implementing in This Project	Will Consider for Future Projects	Expected Annual Saving kWh/yr	Expected Annual Saving $/yr	Steam Savings MMBtu/yr[1]	Expected Improvement Cost $[2]	Expected Cost of Conserved Energy $/kWh[3]	Expected Simple Payback yr
HVAC *(continued from previous page)*								
Integrate control of independent computer room air conditioning units with cold aisle temperature set point	Yes	Yes	139,000	$25,000	0	Cost data is not yet available		
Upgrade to premium efficiency motors	Maybe	Yes	85,000	$14,000	-45			
Optimize cooling tower 1 cell operation	Yes	Yes	52,000	$9,400	0	$22,000	$0.04	2
Recover dry cooler heat for space conditioning	Maybe	Maybe	--	$9,000	290	Cost data is not yet available		
Install variable frequency drives on fans	Yes	Yes	49,000	$7,800	-35	$29,000	$0.06	4
Operate only one condenser water pump during low loads	Yes	Yes	22,000	$4,000	0	$12,000	$0.05	3
Add occupancy control to supplemental air conditioning units	Yes	Yes	14,000	$2,500	1	Cost data is not yet available		
Implement enthalpy economizer mode on air handling units*	Yes	Yes	13,000	$2,400	0	$26,000	$0.18	11
Implement condenser outside air temperature water reset strategy and optimization	Yes	Yes	13,000	$2,400	0	Cost data is not yet available		
Add occupancy sensor control to conference room variable air volume boxes	Maybe	Maybe	10,000	$1,800	0			
Restore/replace steam piping insulation	Yes	Yes	2,400	$1,400	31	$5,000	$0.06	4
Repair torn ductwork	Yes	Yes	--	$0	0	Cost data is not yet available		
Optimize cooling tower 2 control	Yes	Yes	--	$0	0			
Service Hot Water: 0% of Whole Building Savings *(implemented to date)*								
Install variable frequency drive triplex booster pump system (service water)	Yes	Yes	--	$0	0	$75,000	$0.01	<1
Miscellaneous Plug Loads: 0% of Whole Building Savings *(implemented to date)*								
Retrofit plug load night-time turn off[4]	Maybe	Yes	1,304,000	$229,000	-185	Cost data is not yet available		
Retrofit plug load-occupancy controllers during occupied hours[5]	Maybe	Yes	863,000	$148,000	-237			
Replace office equipment with ENERGY STAR or high efficiency[6]	Maybe	Yes	325,000	$59,000	0			
Maintaining Building Operations: 6% of Whole Building Savings *(implemented to date)*								

MMBtu = One million British thermal units.

* EEM is dependent on climate.

[1] Steam usage and savings data is based on EnergyPlus model results assuming 100% efficient conversion of steam to heat.

[2] Improvement costs have been estimated by the design team and may not reflect actual costs observed by Hines/Morgan Stanley.

[3] Meier 1984.

[4] Energy modeling assumed office equipment plug loads were reduced 20% during unoccupied periods.

[5] Energy modeling assumed office equipment plug loads were reduced 10% during occupied periods.

[6] Energy modeling assumed office equipment plug loads were reduced 10% by replacement of ENERGY STAR or high efficiency equipment.

Energy Use Intensities by End Use

A key CBP goal is to reduce the energy use of existing buildings by 30%. To establish a baseline that reflects the building's current energy use, the team developed a building energy model using DOE's simulation program EnergyPlus—a powerful and versatile tool that uses data on heating, cooling, ventilation, lighting and other energy use systems to predict how EEMs will perform.

Three models were created to assess whole building savings. Model 1 simulated the pre-retrofit building calibrated using the building's utility data. Model 2 was the ASHRAE 90.1-2004 model. Model 3 represented the final proposed design incorporating the EEM recommendations.

Model 1 - Pre-Retrofit Building

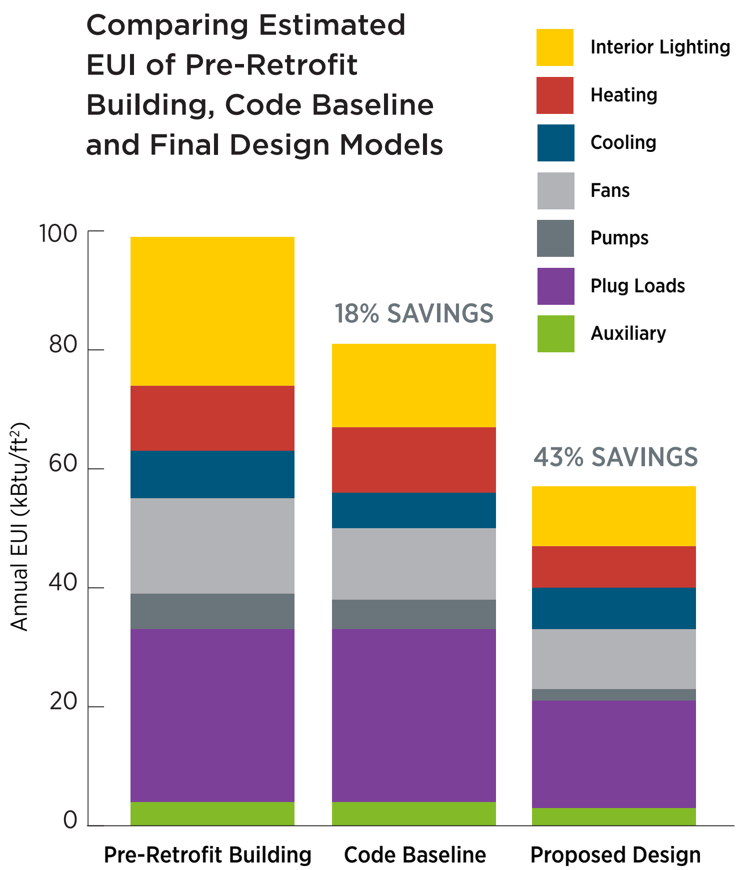
The first model represented the pre-retrofit building prior to any retrofits. The baseline building model had an annual energy use intensity (EUI) of about 99 kilo British thermal units (kBtu)/square foot (ft^2).

Model 2 - Code Baseline

The code baseline model included the prescriptive specifications of ASHRAE 90.1-2004. The code baseline building had an annual EUI of about 81 $kBtu/ft^2$.

Model 3 - Final Design

The third version included the EEMs incorporated into the design. This model had an annual EUI of about 56 $kBtu/ft^2$ and an annual energy savings of 43% over historic operations. Implemented measures to date have resulted in savings estimated at 30%.



Estimated Annual Energy Use and Percentage Savings by End Use

End Use Category	Pre-Retrofit Building Annual EUI ($kBtu/ft^2$)	Code Baseline Annual EUI ($kBtu/ft^2$)	Proposed Design Annual EUI ($kBtu/ft^2$)	Proposed Design Percent Savings Over Pre-Retrofit
Interior Lighting	25	14	9	64
Heating	11	11	7	32
Cooling	8	6	7	13
Fans	16	12	9	44
Pumps	6	5	2	67
Plug Loads	29	29	19	35
Auxiliary	4	4	3	8
Total	**99**	**81**	**56**	**43**

Expected Building Energy Savings from Implemented EEMs by End Use versus Pre-Retrofit

Electricity End Use Category	
Interior Lighting	2,345,000 kWh
Heating	-300 kWh
Cooling	111,000 kWh
Fans	909,000 kWh
Pumps	611,000 kWh
Plug Loads	1,751,000 kWh
Auxiliary	40,000 kWh
Electricity Total	**5,767,000 kWh**

Steam End Use Category	
Heating	18,000 therms
Steam Total	**18,000 therms**

Lessons Learned

Modeling Old Buildings is a Challenge

The 522 building was constructed more than 100 years ago, and during its history, several major renovations, additions, and reconfigurations have been made. The engineering drawings constructed over the years only show incremental changes, so it was a challenge to extract reliable information from the drawings for use in modeling.

This large building has multiple complex HVAC systems posing significant modeling challenges. Many simplifications, assumptions and workarounds were needed. In some cases, hand-calculations had to be performed to approximate energy use estimates.

Hines does continuous commissioning and upgrades to the building and its systems, which makes it difficult to define a stable building operation with yearly utility bills. This process resulted in quite a challenge in calibrating the model.

Monitor Energy Performance

When energy consumption was tracked and analyzed using 15-minute interval data, certain trends were observed. One finding showed a significant amount of energy used during weekend days between 10 a.m. and 4 p.m.; a similar load profile was charted during normal business hours. It was determined the HVAC system was overridden from weekend setbacks to occupied settings to accommodate a small number of staff.

Hines created a policy so that any department requesting changes to heating or cooling set points outside normal business hours from the unoccupied setback values to the weekday set point would be charged for each hour. Consequently, temperature setbacks are overridden less often resulting in improved energy savings during low occupancy periods.

Maintaining Building Operations

In addition to implementing measures, the Hines staff at the 522 building continue to improve systems and optimize operations. Savings that result from these ongoing activities are difficult to estimate by modeling or other calculation techniques. Even though the estimated savings from EEMs currently implemented is less than 25%, the 522 building is realizing a savings of 30%, most likely as a result of Hines' continuous and persistent approach to sustaining and improving building operations.

References and Additional Information

1. ASHRAE. 2011. "50% Advanced Energy Design Guide for Small to Medium Office Buildings." American Society of Heating, Refrigerating and Air Conditioning Engineers, Atlanta, Georgia. Available at http://appsl.eere.energy.gov/buildings/commercial/resource_database/detail_cfm?p=349.
2. Meier A.K. 1984. "The Cost of Conserved Energy as an Investment Statistic." ESL-IE-84-04-109, Lawrence Berkeley Laboratory. Available at http://repository.tamu.edu/bitstream/handle/1969.1/94751/ESL-IE-84-04-109.pdf?sequence=1.
3. Pacific Northwest National Laboratory. 2011. "Advanced Energy Retrofit Guide - Practical Ways to Improve Energy Performance, Office Buildings." PNNL-20761, Pacific Northwest National Laboratory, Richland, Washington. Available at http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20761.pdf.
4. U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. "Large Office Building 50% Energy Savings Technical Support Document." U.S. Department of Energy, Washington, D.C. Available at http://apps1.eere.energy.gov/buildings/commercial/resource_database/detail.cfm?p=199.

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

eere.energy.gov

PNNL-SA-91454 • March 2013

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% post consumer waste.