Increasing Property Value with Energy Saving Practices

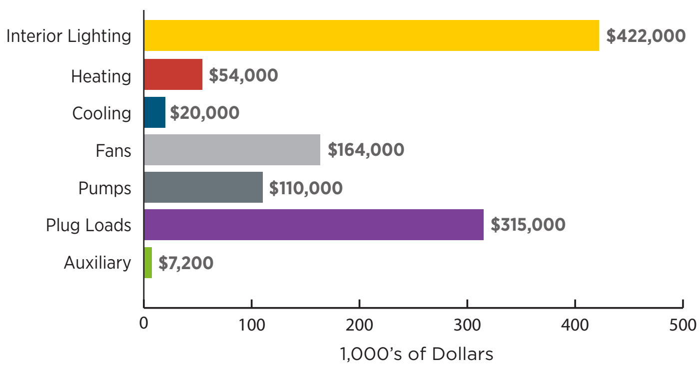
Hines partnered with the Department of Energy (DOE) to develop and implement solutions to retrofit existing buildings to reduce energy consumption by at least 30% versus historic building use or the requirements set by Standard 90.1-2004 of the American Society of Heating, Refrigerating, and Air-Conditioning 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 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.

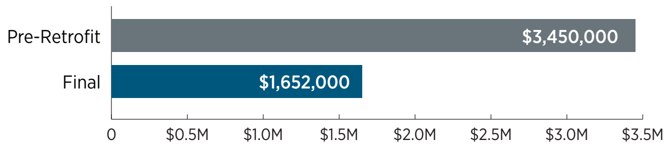
The 522 building has achieved energy savings of 39% in comparison to historic consumption using an ongoing process of continuous improvement to identify, analyze, and implement energy efficiency measures

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 / Actual Energy Savings (versus Historic Operations)	43% based on modeled estimates, 39% based on actual consumption
Expected Energy Savings (versus ASHRAE 90.1-2004)	25% based on modeled estimates
Expected Energy Savings	5,767,000 kilowatt-hour (kWh) of electricity, 1,800 MMBtu of steam/year
Verified Energy Savings	5,032,000 kWh of electricity, 7,700 MMBtu of steam/year
Expected / Actual Cost Reductions (versus Historic Operations)	$1,092,000/year[2] / $1,798,000[2]
Project Simple Payback	Less than 4 years
Estimated Avoided Carbon Dioxide Emissions	Approximately 3,550 metric tons/year[3]
Construction Completion Date	June 2013

Expected Energy Cost Reductions



Actual Energy Costs Before and After Energy Upgrades*



* Actual energy use and costs are influenced by many factors including changes in rates, weather, and building occupancy and uses.

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.

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 high energy costs due to the condition of the building and the high cost of energy in this urban center. 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

Lighting fixture upgrades provided quality lighting and reduced building energy use

staff training and their 522 management staff are Leadership in Energy and Environmental Design Green Associate (LEED GA) accredited.

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

With a building of this size and vintage, efficiency opportunities span all end-use categories. Based on modeling results, the two energy end uses that offered the most 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 eight 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								
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: 29% of Whole Building Savings								
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		
Retrofit/replace fixtures with light-emitting diodes, additional occupancy sensors	Yes	Yes	533,000	$94,000	-49			
Install occupancy sensors in conference rooms and equipment rooms 24, BA, BB	Yes	Yes	153,000	$26,000	-46			
Install lighting occupancy sensors in equipment rooms and schedule 2nd floor	Yes	Yes	79,000	$13,000	-52	$42,000	$0.05	3
Retrofit lobby lighting	Yes	Yes	45,000	$8,100	0	$20,000	$0.04	2
Retrofit the lighting fixtures in equipment rooms	Yes	Yes	44,000	$8,000	0	$30,000	$0.06	4
Upgrade stairwell lighting to light-emitting diodes	Yes	Yes	18,000	$3,200	0	Cost data is not yet available		
Retrofit entrance chandelier	Yes	Yes	9,600	$1,700	0	$10,000	$0.09	6
Upgrade service elevator fixtures to 28-W fixtures	Yes	Yes	8,200	$1,500	0	$5,000	$0.05	3
HVAC: 26% of Whole Building Savings								
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		Steam Savings MMBtu/yr[1]	Expected Improvement Cost $[2]	Expected Cost of Conserved Energy $/kWh[3]	Expected Simple Payback yr
			kWh/yr	$/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	$18,000	$0.01	< 1
Upgrade to premium efficiency motors	Yes	Yes	85,000	$14,000	-45	Cost data is not yet available		
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	$6,000	$0.04	2
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	$9,000	$0.06	4
Add occupancy sensor control to conference room variable air volume boxes	Maybe	Maybe	10,000	$1,800	0	Cost data is not yet available		
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								
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								
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								

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

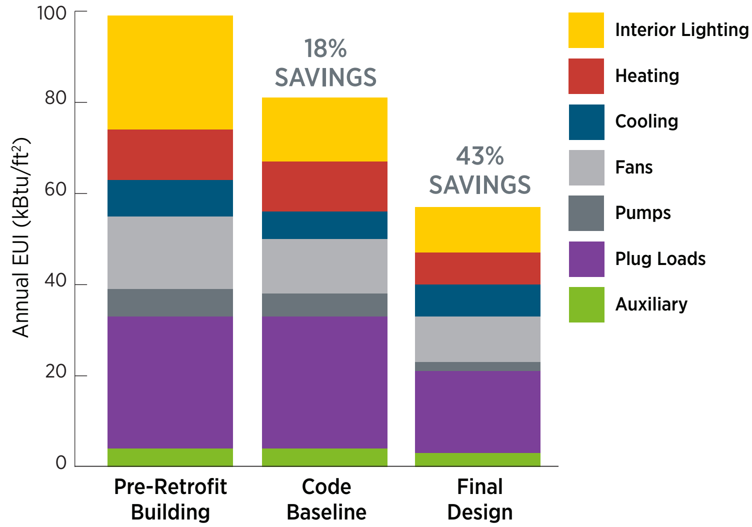
The code baseline model included the prescriptive specifications of ASHRAE 90.1-2004. The code baseline building had an annual EUI of about 81 kBtu/ft^2.

Model 3 - Final Design

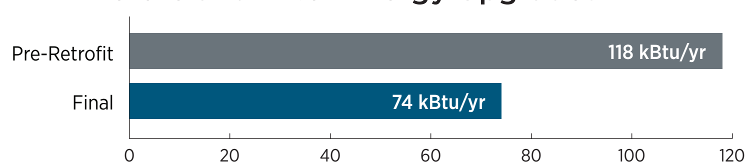
The third version included the EEMs incorporated into the design. This model had an annual EUI of about 56 kBtu/ft^2 and an annual energy savings of 43% over historic operations. Implemented measures to date have resulted in savings estimated at 30%.

Comparing the Proposed Design and the Pre-Retrofit Building model shows an estimated 43% savings if all proposed measures are installed. Actual energy billing data shows a savings of 39% when comparing 2012 with 2008 energy consumption. These numbers seem reasonably close, but they are not directly comparable. The model results allow for a comparison across the models and are useful for identifying measure priorities, potential interactive affects, and an estimation of savings. However, in a building this complex with gaps in recent utility data, the model could not be adequately calibrated to account for all variability with the actual utility data. The actual energy savings should not be directly compared with model results. Even when comparing different years of utility data, analysts need to account for differences in weather data, changes in cost, and changes in building occupancy and operations. To avoid confusion in comparing utility data with model results, two tables show results from the respective approaches.

Comparing Estimated EUI of Pre-Retrofit Building, Code Baseline and Final Design Models



Actual Whole-Building Energy Consumption Before and After Energy Upgrades



Estimated Annual Energy Use and Percentage Savings by End Use Based on Modeling

End Use Category	Pre-Retrofit Building Annual EUI (kBtu/ft^2)	Code Baseline Annual EUI (kBtu/ft^2)	Final Design Annual EUI (kBtu/ft^2)	Final 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**

Lessons Learned

Modeling Vintage Buildings is a Challenge

The 522 Building was built more than 100 year ago, and over its history, has seen several major renovations, additions, and reconfigurations. Engineering drawings produced over the years show only incremental changes for each project and create a challenge to find and extract reliable information. Many of the technologies used in the building are rare and cannot be directly modeled. In addition, the building has changed ownership over time and this limits the ability to obtain utility bills. The overall result is that detailed models can be useful to examine interactive affects across building systems, but their cost and overall accuracy may be questionable in vintage buildings. Modeling requirements and limitations need to be recognized and made a part of project planning.

Alternatives or additions to detailed whole-building models include using simpler models or analyzing specific measures with spreadsheets and other tools. Using simpler models allows for faster, but possibly less sophisticated, studies. Spreadsheet analyses are faster, tend to be directed at specific measures, and may be the only feasible approach for older non-typical systems that are not well covered by models. Spreadsheet analyses tend to be one-off studies and need to be tracked and the actions taken accounted for when incremental improvements are made over time.

Either models or spreadsheet analyses can offer useful information for upgrading buildings. Perhaps the most important step is to decide to take action and to use knowledgeable people to guide and implement those improvements. If the analysis is done all at once with whole-building models, or as systems are prioritized and upgraded using spreadsheets and other tools, the key is to make the commitment to take control of energy costs.

Persistence Pays Off

As a result of measures installed, managers and operators of the 522 Building are achieving 39% savings based on actual energy consumption and LEED certification. Much of this success is the result of an over-achieving staff. The building operators have long experience and use a process of continuous improvement to fine tune controls and settings and to select and implement efficiency measures over time. This approach focuses on individual systems rather than the building as a whole. Although this approach may not account for all system interactions, it does avoid some of the problems posed by building complexity, and has resulted in substantial savings. This persistent and continuous approach is paying off in the 522 Building.

Manage Energy Performance

Controlling energy costs isn't just about installing new equipment. Building managers and operators at the 522 Building tracked and analyzed 15-minute interval data and found that a substantial amount of energy was used on weekend days, similar to what was being used during normal business hours. They determined that HVAC controls were overridden from weekend settings to accommodate a small number of staff. Building management established a policy so that any department requesting changes to reduced settings during non-business hours would be charged a fee for each hour of off-time operation. Consequently, off-hour temperature settings are overridden much less often, resulting in energy savings during low-occupancy periods.

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.
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PNNL-SA-91454 • September 2013

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