Adam Schultz/ Clinton Foundation

Amory Lovins, New York City Mayor Bloomberg, and President Clinton at the press conference.

President William Jefferson Clinton

Excerpt from the Empire State Building Energy Efficiency Retrofit Announcement

I can't tell you how important this day is for those of us who believe that, in order for the world to heed the call by almost all the climate scientists to reduce greenhouse gas emissions by 80 percent by the year 2050, we have to prove it's good economics, prove we know how to do the work, and prove we can pick the low-hanging fruit by improving efficiency.

Most people are interested in how we can all get around in electric and hydrogen cars, move to solar thermal electric power, or maximize the capacity of wind power in America and around the world. Right here before us, ironically, in this economic time, the biggest job generator is in building retrofits, which will create millions and millions of jobs. We could do this all over the world. Today, people will see the capacity as never before, because every person on Earth who cares about this knows about the Empire State Building.

So, to all of you who are here, I am very grateful. We will never conquer climate change until we prove it is good business to do so. I am very grateful to the leadership New York has shown in this. Seventy-five percent of all the world's greenhouse gas emissions come from cities, which only occupy two or three percent of the world's landmass. This trend will only continue as the megacities of the world continue to expand. Our Foundation is committed to doing what we can to help cities operate more efficiently and effectively, generate more jobs, and take the lead in reducing the threat of climate change.

I was delighted for two reasons that this year's Academy Award for Best Picture went to Slumdog Millionaire. One, I thought it was the best movie, and secondly, in the opening scene, the children run from the police over the Mumbai landfill. It looks like they're running across a Sahara Desert of shredded paper. You see all the scavengers making a living off of the landfill. I hope in my lifetime that we see every major landfill in every city in the world closed. We can turn over the metal and glass to recycling and convert everything else into organic fertilizer, biofuels, or compress it for clean energy generation. These are the kinds of things that cities can do when we have innovative companies that understand it.

Finally, all of the debate about climate change in Washington, and around the world, is focused on what will happen in December at Copenhagen, where many nations will gather to agree on a framework to follow-up on the Kyoto Accords. We hope we can persuade China, India, and, most importantly, the United States to join this time.

There'll be a big debate in Washington about whether an arcane process called reconciliation can be used to jam through a new climate change regime for America by a majority vote that cannot be filibustered in the Senate. I'm for that. But the most important question, which almost nobody's discussing, is what brings us here today: how are we going to do this?

When the Kyoto agreement was finished in 1998, I strongly supported it, and our team, including then-Vice President Gore, helped to write it. The United States Senate voted against it 98-0 before Al Gore got off the airplane coming back from Japan. Why? Because they said, "Nobody knows how to do this. It's crazy, and it will bankrupt the American economy." Now, we know better. We have an operating majority in America to do something, but we haven't given enough thought to "how."

So I hope the integrated system developed here by all these experts will become a model for how to do big buildings. I hope that our Congress and the decision-makers all over the world will focus more on the "how."

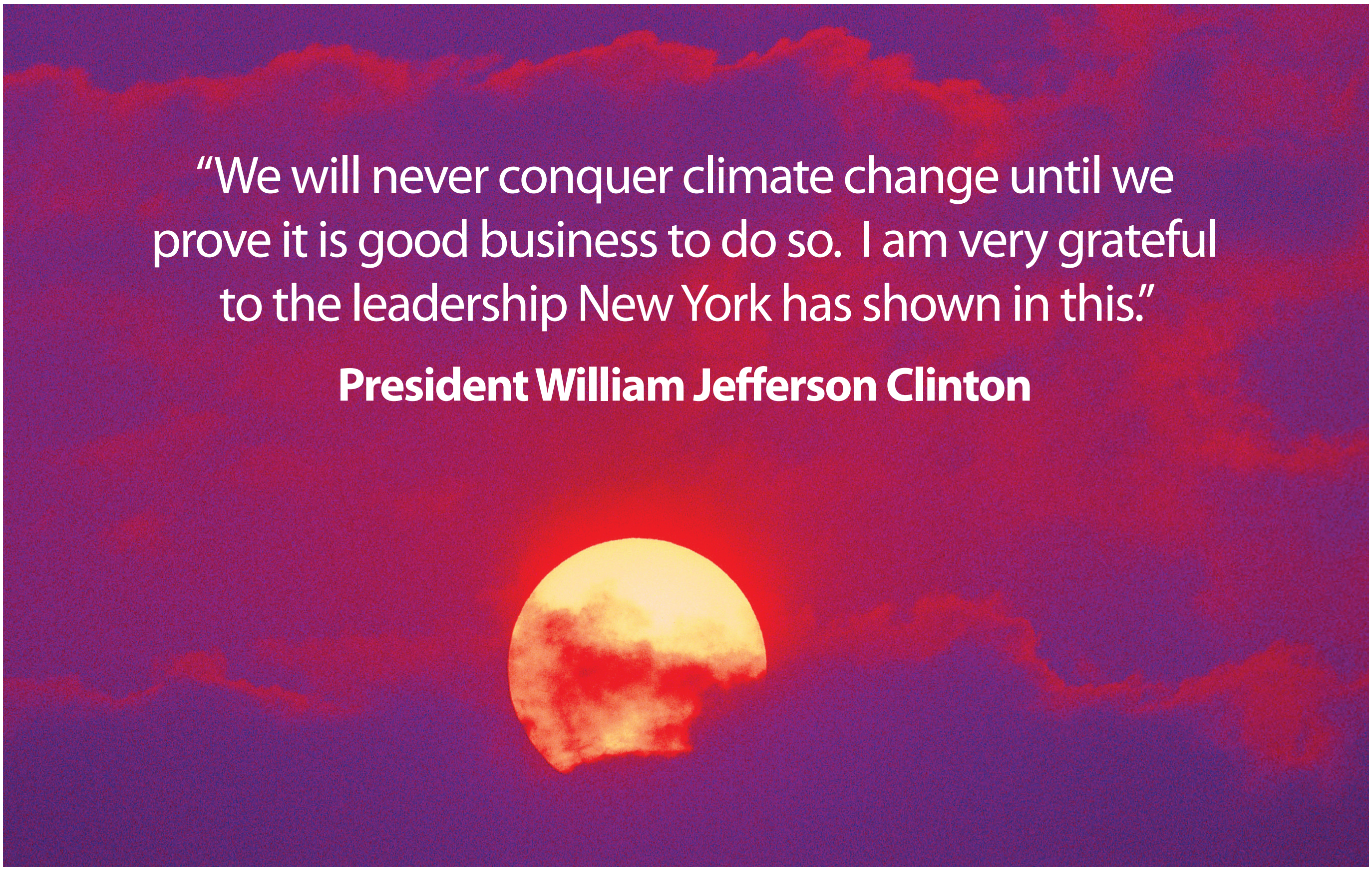
We could use new building codes in every city and state in the country. The federal government could adopt higher appliance standards for the 15 common appliances for which technology already exists to provide massive opportunities for savings. Every state in the country could decouple electricity rates from sales so that utilities would be induced to finance projects like this. It could be financed like power plants so that the economics would be even better, because you could pay for it over 20 years, lower the utility bills, and every one of us could go out and do 10, 20, or 30 times as much.

These are the kinds of things that I ask all of you to think about today. This [success at the Empire State Building] is a great source of celebration and should get every one of our Foundation's 40 partner cities involved, as well as many others. But we still need to focus more on the "how." We have done it very well today, and I am very grateful.

President William Jefferson Clinton *was elected the 42nd President of the United States in 1992 and again in 1996. Under his leadership, the United States enjoyed the strongest economy in a generation and the longest economic expansion in U.S. history. President Clinton's core values of building community, creating opportunity, and demanding responsibility resulted in unprecedented progress for America, including moving the nation from record deficits to record surpluses; the creation of over 22 million jobs—more than any other administration; low levels of unemployment, poverty and crime; and the highest homeownership and college enrollment rates in history.*

After leaving the White House, President Clinton established the William J. Clinton Foundation with the mission to strengthen the capacity of people in the United States and throughout the world to meet the challenges of global interdependence. In 2005, President Clinton hosted the first Clinton Global Initiative (CGI), a non-partisan catalyst for action, bringing current and former heads of state along with hundreds of other leaders from governments, the business community, and NGOs to find ways to address some of the world's most pressing challenges. To date, CGI members have made more than 1,000 "Commitments to Action" valued at more than $30 billion to improve the lives of more than 250 million people in 150 countries.

Among other Foundation initiatives that work domestically and abroad, the Clinton Climate Initiative (CCI) was launched in August 2006 to fight against climate change in practical, measurable and significant ways. CCI works with cities around the world—including the C40 Large Cities Climate Group—to accelerate efforts to reduce greenhouse gas emissions.



Mayor Michael Bloomberg and President Clinton at the press conference.

Mayor Michael R. Bloomberg

Remarks at the Empire State Building Energy Efficiency Retrofit Announcement

First, let me congratulate the Empire State Building Company and the Clinton Climate Initiative on this historic undertaking.

By taking steps to cut its energy use by up to 38%, this New York icon is sending a strong signal to the rest of the world that going green—even in the current financial crisis—is an economic and environmental imperative.

It's a truly bold statement of intent coming from the greatest city in the world, and it moves us one step closer to our Administration's goal of reducing New York City's production of greenhouse gasses by 30% by 2030.

That's because here in New York, buildings are responsible for about 80% of our carbon footprint.

So we can make the greatest cuts in our greenhouse gas emissions—and also the biggest decreases in energy usage—by improving the efficiency of existing buildings.

To help lead the way in this effort, our Administration has mapped out a 10-year plan to reduce our own energy consumption by City agencies 30% by 2017. It's a central part of PlaNYC—our blueprint for a sustainable future.

We're committing $100 million a year—equal to 10% of our annual energy costs—towards this goal. And building retrofits are a key part of our strategy.

We've already started investing heavily in making our schools, offices, and police and fire stations more energy-efficient.

Within an average of eight years, those investments will have paid for themselves. After that, the savings will keep coming for many decades.

We've also formed partnerships with ten universities and college campuses—including CUNY—who've also accepted the "30 in 10" challenge to reduce their energy use by 30% by 2017.

And at the end of 2007, the New York City Housing Authority (NYCHA) joined the innovative retrofit program that President Clinton and the Climate Initiative have started.

As one of the city's biggest landlords—with more than 2,600 buildings—any improvements NYCHA can make will produce major benefits for us all.

But because the majority of the more than 900,000 buildings in New York City are privately owned, we've long said that we need private landlords to get involved, too.

So we couldn't be more thrilled that the owners of the Empire State Building—in partnership with President Clinton, and others—have answered the call, in a big way.

They are showing the rest of the city that existing buildings—no matter how tall they are…no matter how old they are—can take steps to significantly reduce their energy consumption.

And that's an important point because about 80% of the buildings standing today will still be around for decades to come.

In addition, we're excited that the Empire State Building and its partners on this project have developed a model for retrofitting buildings that can be replicated by landlords around the world.

Before I conclude, let me make one final point: We realize that for some, going green may be something that's slid down the list of priorities during this recession, but that would be a mistake.

Shrinking the world's carbon footprint is a pro-growth strategy —indeed, the only pro-growth strategy for the long-term.

Going green cuts energy costs, improves the bottom line, creates good-paying jobs, and strengthens the future for everyone.

We cannot afford to abandon these efforts—especially now.

And for inspiration, we should remember another moment in time when our nation's future was in doubt, yet New York City refused to stop reaching for new heights: The Empire State Building—maybe the most famous building on the planet—was built during the worst years of the Great Depression.

Today, the Empire State Building is once again reaching for new heights—and reminding the world that even in the toughest of times, New Yorkers are not afraid to be bold, to be ambitious, and to do the right thing.

Thank you, and congratulations again.

***Michael R. Bloomberg** is the 108th Mayor of the City of New York. He attended Johns Hopkins University, where he paid his tuition by taking loans and working as a parking lot attendant during the summer. After college, he went on to receive an MBA from Harvard Business School. In 1966, he was hired by Salomon Brothers to work on Wall Street. He quickly rose through the ranks at Salomon, where he eventually oversaw equity trading and sales and then information systems. These two jobs enabled him to gain a keen understanding of the importance of technological innovation to a successful business. With a vision of an information company that would use emerging technology to bring transparency and efficiency to the buyers and sellers of financial securities, he began a small start-up company called Bloomberg LP in 1981. Today, Bloomberg LP has over 300,000 subscribers to its financial news and information service in 161 countries around the globe. Headquartered in New York City, the company has more than 10,000 employees worldwide. Already deeply involved in civic affairs, he officially entered public life in 2001, when he entered the race for Mayor of the City of New York. His election came just two months after the tragic attacks of 9/11. Under Mayor Bloomberg's forward-looking leadership, and with his determination to build on the spirit of unity that defined the city after the attacks, New York rebounded faster and stronger than anyone expected. In 2005, Mayor Bloomberg was re-elected by a diverse coalition of support that stretched across the political spectrum. In the first half of his second term, while balancing the budget and driving unemployment to a record low, Mayor Bloomberg took on a number of new challenges including a far-reaching campaign CREATE A MORE SUSTAINABLE NEW YORK. On Earth Day 2007, the Mayor put forward PlaNYC, and has been making steady progress ever since to make New York City the cleanest and greenest of any major city in the world.*

Anthony E. Malkin speaking at the press conference.

Leadership and American Progress in Sustainability:
Lessons Learned Retrofitting an American Icon

Anthony E. Malkin, Empire State Building Company

The Empire State Building is the world's most famous office building, an icon recognized historically for innovation and a beacon for those who dare to dream of great things. The building was purchased in 1961 by my grandfather Lawrence A. Wien, my father Peter L. Malkin, and my grandfather's close friend and partner, Harry B. Helmsley. The building is 77 years old and has 2.85 million rentable square feet.

In August 2006, after a lengthy litigation, my father and I succeeded in removing the management that had been in place since the building's purchase. At that time, we decided to upgrade the property to "best-in-class" from its then tired condition. The upgrades involved operational changes and investments. In the process, we have garnered international recognition for our decision to become not only "green", but also a model for innovation in energy efficiency retrofits.

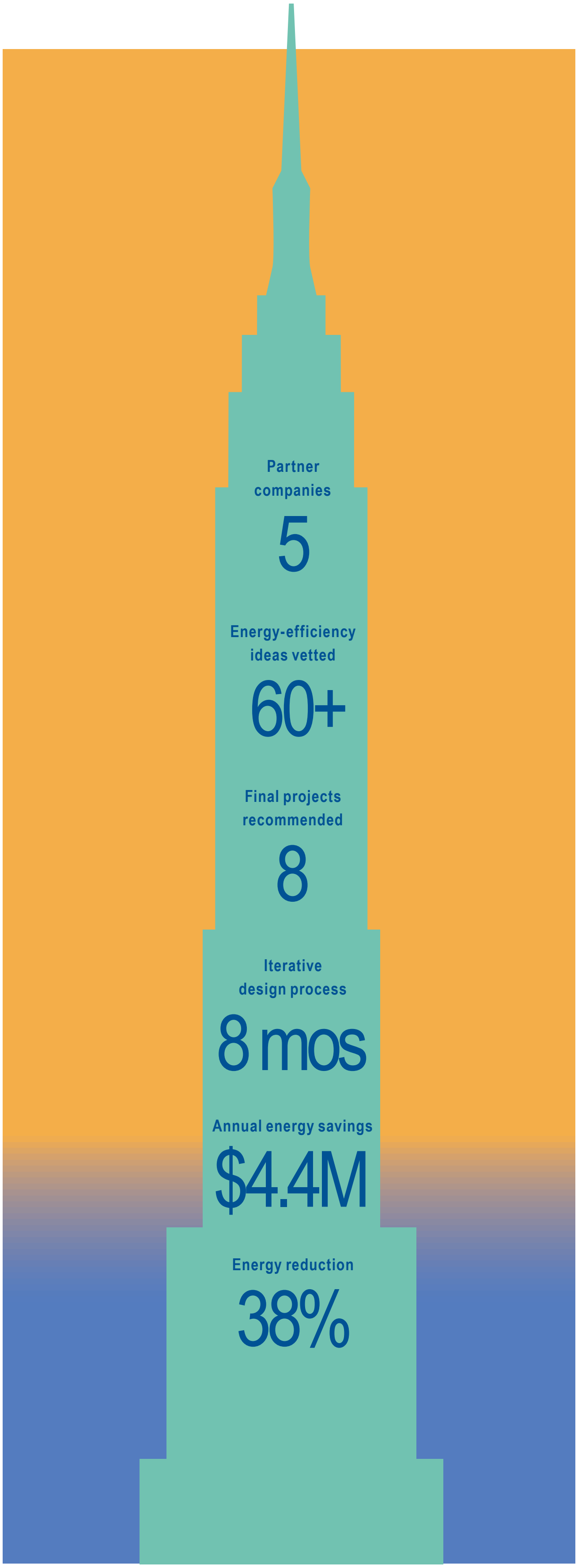
"Green" and energy efficiency are distinct from each other. We define "green" to include: recycling of tenant and construction waste, utilizing recycled materials in construction, using green certified cleaning and pest control products and water conservation measures. Energy efficiency, in our context, is focused specifically on reducing energy consumption without compromising function.

By August 2006, it was clear that our investment program would engage the entire building in a comprehensive upgrade. It was necessarily an intelligent moment to look at how the building consumed energy and what steps could be taken to achieve the same results with less energy usage.

Clearly, there is a strong motivation to conserve energy. China and India are growing economies with new middle classes, each of which will be larger than the entire population of the United States. Should these growing economies and their new middle classes consume comparably to the United States, there will be severe energy shortages. If we do not reduce our energy consumption per capita in the United States and provide a model for others, resource competition will create global conflict.

But "saving the world" is an intangible subject for many. "Green" is mostly a directional and qualitative feel-good initiative. "Climate change" and "carbon" are still questioned by many and do not present clear arguments for investment. I learned a lesson at a dinner with Karl Rove when I realized that even he did not argue against energy efficiency with economic benefits.

Since then, my mission has been to create a business model for energy efficiency with economic returns. We need to win based on economics. Always present in our thinking is that



we are working to improve the environment. The effort to preserve and improve the environment has been identified by most people to maintain scenic lakes in the mountains or pristine beaches by the sea, but the real environment is not some faraway place, rather where we work, live, and conduct the business of our daily lives.

The vast majority of citizens in developed economies live in urban environments. In the urban environment, buildings are the largest consumers of energy, ranging between 40-80% depending upon population density and mass transit availability. And importantly, in the developed economies, 75-95% of the buildings which will be in use 25 years from exist today.

Constructing energy efficient new buildings is good, but they still increase energy consumption, albeit by less than building inefficiently. Demolishing existing buildings wastes the energy already expended in the original structure's construction and materials. Energy efficiency retrofits of existing structures offer the greatest opportunity for energy savings in the built environment, both from the savings themselves and in the reuse of existing buildings.

The great innovation in our work is the focus on quantifying energy savings. Today's best known standard, Leadership in Energy & Environmental Design (LEED®) developed by the US Green Building Council (USGBC), is directionally good but does not quantify energy consumption. Until our work, energy conservation measures in multi-tenanted office buildings focused individually on the main "silos" of energy consumption: lighting; heating, ventilation, and air conditioning; building pumps; and elevators, for example.

At the Empire State Building we proved the value of an integrated approach to energy efficiency with startling results. Working for more than a year in total secrecy with our team of the Clinton Climate Initiative, Johnson Controls, Jones Lang LaSalle, and The Rocky Mountain Institute, we developed new methodology in profiling energy consumption, combining savings measures and building retrofits, and calculating paybacks.

Using the building as a massive, complicated test bench, we developed a multifaceted approach with a transparent and verifiable benchmarking and measurement system. We knew from the start that if limited to the Empire State Building, this effort would be a failure. Our process is replicable and adaptable to any multi-tenanted office building; it is transparent and rigorous enough to allow performance guaranteed contracting.

Additionally, the system offers a cost/benefit curve. The cost/benefit curve helps determine the optimal combination of cost saving measures to produce the greatest result on a payback period; depending upon the payback period desired, the combination of cost saving measures can be customized for different buildings. At the same time, the impact of subsidies and incentives can be factored into the cost/benefit curve.

We reviewed over 60 energy conservation measures and chose eight which afforded energy savings over 38%. Approximately $120 million out of our $550 million upgrade program was impacted, including $20 million of new spending and $7 million of savings for a net additional cost of $13 million. Our savings will be $4.4 million a year, representing a payback period of 3 years. We developed a new performance guarantee contract to ensure that the integrated measures would actually achieve the projected savings.

We learned that incorporating energy conservation measures in a thorough building upgrade can achieve remarkable results with a very short payback period. I credit the Clinton Climate Initiative for pushing me to use the Empire State Building as a test case. If we had achieved the same results somewhere else, people would have paid far less attention. With the Empire State Building, we captured the world's attention.

The market response has been overwhelmingly positive. What we have learned is that major tenants and many, medium-sized businesses have significant interest in energy efficiency in the space where they work. Not only do energy efficient buildings typically offer a healthier and better work environment, but they also provide lower cost of occupancy. Tenants who want to be in an energy efficient building are attracted to the Empire State Building.

New legislation geared towards energy efficiency standards within buildings is being considered around the country. If basic standards are not met, owners will be required to invest to improve their building's performance. There will be requirements to rate the energy efficiency of buildings. Appraisers, lenders, and buyers will consider energy inefficiency a latent defect. The process we have developed at the Empire State Building informs the debate about the opportunities for compliance, the real costs and the real payback.

In order for tenant energy efficiency to be more broadly implemented, attorneys, engineers, and architects have to better understand the benefits to their clients. In the Empire State Building, we have a LEED Platinum-certified full floor tenant consuming 1.5 watts per square foot above air conditioning. While their space was designed to be energy efficient, their mechanical engineers nonetheless provided electricity distribution for 6 watts and the lawyers demanded 6 watts per rentable sq ft of demand load capacity in their lease.

There is a tremendous need for education. There is so much that can be accomplished with readily available technology in all areas of real estate.

And, finally, we drove our process at the Empire State Building without any consideration to LEED or ENERGY STAR ratings. After we set our program, we retroactively graded the building by LEED and ENERGY STAR standards. When the energy efficiency retrofit program is concluded we will qualify for LEED EB Gold and an ENERGY STAR rating of 90, placing the Empire State Building within the top 10% most energy efficient buildings in the United States.

The work we are doing at the Empire State Building is already underway. We will achieve over 50% of the savings by December 31, 2010. 100% of the savings should be in place by December 31, 2013. The lessons we have learned are invaluable to building ownership, lawmakers, lenders, appraisers, and policy makers. We hope that the broad circulation of what we have learned will result in reduced energy consumption throughout cities, with major economic benefits for owners and tenants. Along the way, perhaps we will help with energy independence, climate change, and carbon output.

In 1989, ***Anthony E. Malkin*** *joined Malkin Holdings. He is now president of this firm and of its affiliates, including W&H Properties. Altogether, these firms comprise the real estate acquisition, management, construction and marketing arm of the Malkin family, which has been active in real estate for four generations. Malkin Holdings' history runs from Joseph Wien, to Lawrence A. Wien (who in 1934 created the concept of real estate syndication), to current chairman Peter L. Malkin.*

The businesses are involved with office, residential, and retail real estate in 17 states and have full in-house capabilities, including: acquisitions, financing, equity raising, engineering, construction, marketing, management, accounting, and cleaning. Mr. Malkin has been a leader in existing building energy efficiency retrofits through coordinating the team of Clinton Climate Initiative, Johnson Controls, Jones Lang LaSalle, and Rocky Mountain Institute in the groundbreaking project at the Empire State Building. Mr. Malkin also leads the Malkin family office in alternative investments outside of real estate in the United States and internationally.

Mr. Malkin is a member of the Urban Land Institute and the Real Estate Roundtable, a member of the Board of Governors of the Real Estate Board of New York, board member of forestry management company Greenwood Resources, member of the advisory board of MissionPoint Capital Partners, board member of the Committee to Encourage Corporate Philanthropy, member of the Advisory Council of the Natural Resources Defense Council's Center for Market Innovation, and member of the Committee on University Resources of Harvard University. Mr. Malkin regularly guest lectures on real estate and family businesses at the McIntire School of Commerce at the University of Virginia. He received a B.A. degree cum laude in English from Harvard College in 1985.

Empire State Building Sustainability Program

The Clinton Climate Initiative established a partnership with Jones Lang LaSalle, Johnson Controls Inc., Rocky Mountain Institute and Empire State Building Company. Together, the team developed a replicable model for retrofitting an existing building for energy efficiency, while reducing greenhouse gas emissions and delivering measurable economic returns.

What?

- Economically viable integrated sustainability program for the Empire State Building including:
  - Infrastructure projects
  - Design standards
  - Tenant energy management
  - Property management
  - Leasing and marketing initiatives

Why?

- To create a replicable model for significantly reducing greenhouse gas emissions, and promote sustainable design and operations in existing buildings through a leading example

How?

- Rigorous eight-month iterative design process
- Narrowed 60+ ideas to a package of eight recommended projects
- Identified optimal balance of financial and environmental return on investment
- Addressed increased infrastructure needs, utility costs, future planning, and tenant use of energy
- Included building windows, radiators, automated controls, cooling plant, air quality, tenant space design, and tenant energy use
- Required the active engagement of an ESCO (Johnson Controls Inc.), the building owner, and building tenants

How much?

- Incremental cost of $13.2 million
- Saves a maximum of $4.4 million in annual energy costs
- Equivalent to a 38 percent energy reduction

What are the top three goals of the program?

- Dramatically reduce energy use of the Empire State Building, and be able to demonstrate the savings in a transparent and verifiable way
- Improve tenant comfort and reduce tenant energy use via improved design and energy awareness
- Improve the building's marketability

What are the top five innovative solutions?

- "Right steps in the right order" retrofit for whole-systems optimization
- Utilized both industry sustainability ratings, plus created new tools
- Demonstrated that a building retrofit can cost-effectively achieve upwards of 35 percent energy savings
- Innovative commercial model and measurement and verification model
- Designed a model pre-built office suite as a physical example of an integrated sustainability program that bridges base-building and tenant space improvements

What are the top three expected results?

- Achieve an energy use reduction of 19 percent in the initial phase, and gradually increase the savings to 38 percent as the longer-term projects are completed
- Create a competitive advantage in the marketplace
- Cause an increase in the number of multi-tenant building retrofits that seek more dramatic energy use reductions by tackling tenant as well as base-building systems

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"The goal has been to define intelligent choices which will either save money, spend the same money more efficiently, or spend additional sums for which there is reasonable payback through savings. Addressing these investments correctly will create a competitive advantage for ownership through lower costs and a better work environment for tenants."

– Anthony E. Malkin,
Empire State Building Company

A Case Study: Retrofitting America's Favorite Skyscraper

A Leading Example for Energy Efficiency

Empire State Building Sustainability Team

When you gaze out over the vast canyons of Manhattan from the 86th or 102nd floor observatories of the Empire State Building (ESB), you are looking at one of the greenest cities in the United States. New York City's per capita emissions are a third of the national average because of public transit use, density, and smaller residences. In addition, New York City has vowed to reduce current carbon emissions by 30 percent by 2030.

The Empire State Building, a102-story Art Deco skyscraper at the intersection of Fifth Avenue and West 34th Street, has been named by the American Society of Civil Engineers as one of the Seven Wonders of the Modern World. The building and its ground floor interior are designated landmarks of the New York City Landmarks Preservation Commission, and it was designated as a National Historic Landmark in 1986. It has been called, persuasively, the world's most famous office building.

If the Empire State Building—built the highest in the world, in just over one year during the Great Depression—embodies the ambition of New York, then it only makes sense for it to be going green now with a trailblazing energy retrofit, separate from, but integrated with, its top-to-bottom $500 million renovation. The ReBuilding effort was well under way when discussions by owner Tony Malkin and executives at the Clinton Climate Initiative brought a new dimension to the capital improvement program. A team of experts was convened (including Johnson Controls, Jones Lang LaSalle, and Rocky Mountain Institute) to recommend energy efficiency measures that could be incorporated into the larger renovation but would stand on their own merit from a return-on-investment standpoint.

The renovations will let building ownership offer state-of-the-art office amenities in an historic building while greatly reducing both energy use and carbon emissions. Retrofits typically reduce energy consumption by 10–20 percent; however, by taking an integrated approach the team was able to realize savings of almost 40 percent.

To date, few if any examples of green retrofits exist for our great pre-war multi-tenant buildings. The ESB project is providing its model and practical tools for other building owners to use and replicate on its website at ESBsustainability.com. This precedent is especially important now, as nearly 75 percent of the U.S. commercial building stock is at least 20 years old.

This sustainability effort was undertaken in large part due to the Clinton Climate Initiative (CCI) and the launch of their Energy Efficiency Building Retrofit Program in 2007. "Historically, improvements in existing buildings are made on an ad hoc basis," says Kathy Baczko, New York City director of CCI. "Much more energy efficiency and savings can be obtained by taking a whole-building approach where integrated solutions and blended savings bring long-term benefits. Building owners and operators everywhere will hopefully be inspired by this American icon's example of innovation in building management."

Prior to 2008, the Empire State Building's energy performance was average compared to most U.S. office buildings:

Annual utility costs:
- $11 million ($4/sq. ft.)

Annual CO_2 emissions:
- 25,000 metric tons (22 lbs/sq. ft.)

Annual energy use:
- 88 kBtu/sq. ft.

Peak electric demand:
- 9.5 MW (3.8 W/sq. ft. inc. HVAC)

"This building is a great example of the right kind of building to retrofit," says Caroline Fluhrer, a consultant with RMI's Built Environment Team. "The fact that it is an iconic building that is going to be around for a long time means it makes sense to invest in it. And, the fact that it could be coordinated with a major capital improvement project made it really cost-effective. The capital improvement plan, for example, called for resealing all the windows so they open and close properly. If you are going to pay to reseal windows anyway, it makes sense to analyze the additional costs and benefits of retrofitting the windows at the same time. Coordinating energy efficiency projects with planned capital projects is what made many of the ESB projects cost-effective."

Dana Schneider, a senior project manager with Jones Lang LaSalle, who worked with RMI and the rest of the team on the ESB recommendations, explains the process for refurbishing the Empire State Building's 6,514 operable windows for energy efficiency: "We analyzed the cost and benefit of re-using the existing windows versus replacing them and discovered that we could save on the upfront cost, greatly increase the energy savings and avoid material waste by removing the sashes and the existing double-pane glass, adding a third pane with a low emissivity (low-E) film, and reinstalling the refurbished windows. We will also eliminate the environmental impact of transporting the windows by upgrading them on site."

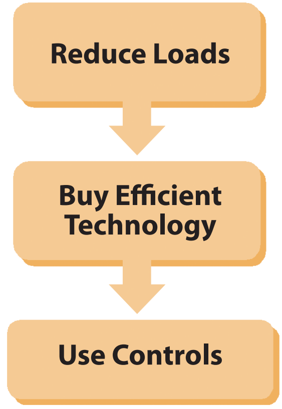
The air-handling units are another example of how the recommendations capitalized on the pre-existing capital improvement plan. The team suggested that instead of replacing old constant volume units with the same models, ESB should replace them with variable speed fan units when they reach the end of their life cycle. While the cost would be marginally higher, the energy efficiency that was achieved by regulating fan speed by temperature would be much greater and ESB would only need two units per floor instead of four.

Key Findings and Recommendations

Collaborative team activities took place over an eight-month period between April and November of 2008. At the end of the process, the team determined that at current energy costs, ESB could cost-effectively reduce energy use by 38 percent and save 105,000 metric tons of carbon dioxide over the next 15 years. Achieving an energy reduction greater than 38 percent appeared to be cost-prohibitive under current economic conditions.

To achieve these results, the ESB team needed to implement eight key projects or measures. The recommendations will reduce cooling load requirements by 33 percent (1,600 tons) and peak electrical demand by 3.5 megawatts, benefitting both the building and the utility.

Using both financial and design analysis tools, the team whittled down over 60 original project ideas to the eight below. For more information on the process and the tools used, please refer to the next article, The Model, a Work in Progress: Optimizing the Empire State Building Retrofit Process.



Taking the right steps in the right order was critical. First, the team reduced cooling and heating loads through measures like the radiative barrier and window upgrades. Next they chose efficient technology like variable speed drives on chillers and variable air volume air handlers to reduce the remaining need, and lastly, they used controls so that the equipment is used only when absolutely necessary.

If the team had started only by looking at efficient technology, they would have missed a huge opportunity. Not needing kilowatt-hours or therms is far cheaper than paying for infrastructure to use them, plus a lifetime of operations and maintenance.

REDUCE LOADS

Building Windows

This project involves upgrading the existing insulated glass (IG) within the Empire State Building's approximately 6,500 double-hung windows to include suspended coated film and gas fill. This "re-manufacturing" of the IG units will take place within the Empire State Building. IG units will be removed, delivered to a production area, and picked up for reinstallation. TC88 or SC75 will be used as the suspended film according to the orientation. A mix of krypton/argon gas will be used between the glass and suspended film. This project will improve the thermal resistance of the glass from R-2 to R-7 and cut the solar heat gain by more than half, in addition to allowing for the recycling of all existing glass and frames.

Radiative Barrier

This project will involve the installation of more than six-thousand insulated reflective barriers behind radiator units located on the perimeter of the building. In addition, the radiators will be cleaned and the thermostats will be repositioned to the front side of the radiator.

Tenant Daylighting, Lighting, and Plugs

This measure involves reducing lighting power density and energy use in tenant spaces using ambient, direct/indirect, and task lighting, installing dimmable ballasts and photosensors for perimeter spaces that can operate with electric lights off or dimmed depending on daylight availability, and providing occupants with a plug load occupancy sensor for their personal workstations.

The Empire State Building encourages tenants to implement these measures by providing tenants with the examples (via a LEED

Platinum pre-built space in the building, which implements the Tenant Design and Energy Management Guidelines developed by the team), the data (the team analysis and methodology), and the tools (the eQUEST model and LEED CI strategies) to help them understand the cost-effectiveness of these measures over the term of their lease. ESB will benefit from tenant compliance with these recommendations as it will result in lower overall cooling and electric demand and higher sustainability ratings for the building. Tenants will benefit from reduced utility costs and higher quality, more productive spaces.

BUY EFFICIENT TECHNOLOGY

Chiller Plant Retrofit

Because of the cooling load reduction projects mentioned above, the team was able to reduce chiller capacity instead of increasing it. This meant the team could recommend a far cheaper chiller retrofit project as opposed to bringing in new chillers. The chiller plant project will include the retrofit of four industrial electric chillers (one low zone unit, two mid zone units, and one high zone unit) in addition to upgrades to controls, variable speed drives, and primary loop bypasses.

All existing pumps and chillers will remain. For the low zone chiller, the retrofit will involve the installation of: a new chiller mounted variable speed drive, a new VSD-rated compressor motor, a new IEEE Filter in VFD to reduce harmonic distortion, and a new Optiview Graphic Control Panel with the latest software revision. For all other chillers, the retrofit will involve the installation of: new drivelines, new evaporator and condenser water tubes, new Optiview Graphic Control Panels again with the latest software, chiller water bypasses with two-way disk type valves, new piping in place of backwash reversing valves, new automatic isolation valves on the CHW supplies to each electric chillers, and temperature and pressure gauges on all supply and return lines. In addition, existing R-500 refrigerant will be removed (per EPA guidelines) and replaced with R134A refrigerant. All electric chillers, CW and CHW pumps, pump VFDs, and zone by-pass valves will be controlled by the Metasys® control system. By utilizing the existing Chiller Barrels, the team was able to add a LEED point by improved environmental impact of the retrofit. This lessened the waste that would normally be scrapped or recycled.

VAV Air Handling Units

The Empire State Building's original plan was to replace existing constant volume air handlers with identical units. The team recommended a new air handling layout (two floor-mounted units per floor instead of four ceiling-hung units) as well as the use of variable air volume units. This project involves replacing all existing 485 constant volume air handling units in the building over time.

This recommendation will result in little additional capital cost while reducing maintenance costs. The quantity of air handlers will be able to be reduced and will be floor-mounted making maintenance easier. In addition, comfort conditions for tenants will be improved due to reduced noise and increased thermal accuracy and control.

PROVIDE AND USE CONTROLS

Tenant Demand Control Ventilation

This project involves the installation of CO_2 sensors for control of outside air to the Chilled Water Air Handling and DX Air Handling Units. One return air CO_2 sensor will be installed per unit in addition to removing the existing outside air damper and replacing it with a new control damper. This will result in bringing in appropriate amounts of outside air based on occupancy levels, reducing energy use and improving indoor air quality.

Balance of Direct Digital Controls (DDC)

The balance of the DDC project involves upgrading the existing control systems at the Empire State Building. The proposed project design and layout is based on using Johnson Controls' Metasys® Extended Architecture BACnet controllers and includes Ethernet and BACnet risers with all necessary devices and equipment, ADX server/workstation, printer, software, and web access capability. This system will utilize wireless sensor technology that will lower installation costs and save valuable copper wiring.

This measure includes control upgrades for the following building systems:

- Refrigeration Plant Building Management System
- Condenser Water System Upgrades
- Chilled Water Air Handling Units
- DX Air Handling Units
- Exhaust Fans
- Stand Alone Chiller Monitoring
- Misc. Room Temperature Sensors
- Electrical Service Monitoring

Tenant Energy Management

This project will allow for the independent metering of a greater number of tenants in the Empire State Building. Tenants will have access to online energy and benchmarking information as well as sustainability tips and updates. Tenants will be able to compare their energy use to average high and low performers to understand how well they are performing.

A EnNET/AEM platform will be provided for collecting 15-minute meter data and creating a normalized database that can be used to support Time Series profiling, reporting to the ISO, and integration in the future with property management software for creating a bill based on current meter read. In addition, the AEM application will be commissioned and web pages will be created to properly display metering data, Time Series Analysis, real-time metering information, and to create notifications based on usage parameters.

RESULTS FROM THE EMPIRE STATE BUILDING RETROFIT

Carbon dioxide reductions

The greatest reduction in carbon dioxide emissions from the baseline will come from installing the direct digital controls that had been started in the capital projects. This strategy alone will reduce energy use by 9 percent from the baseline. Tenant daylighting and plug load management will save six percent from the baseline. Three other strategies, installing air handling units with variable air volume controls, retrofitting the chiller plant and addressing window glazing will save 5 percent each. Other strategies contributing to the 38 percent reduction include tenant energy management (3 percent), radiative barrier installation (2 percent) and tenant demand-controlled ventilation

(2 percent). While it is useful to understand the individual energy saving contributions of each measure, the true cost savings come when the projects are considered as one integrated package.

Reduced cost of chiller plant retrofit

The greatest cost savings came from the ability to retrofit the chiller plant rather than replace it. This was made possible by the reduction of the cooling load by 1,600 tons from the demand control ventilation project which reduced total outside air introduction and the window light retrofit, which reduced solar heat gain.

Peak electrical usage reduction

Under the proposed plan, peak electrical usage will also be reduced by 3.5 megawatts, from its current peak and capacity of 9.6 megawatts to just over six megawatts.

Enhanced tenant environment

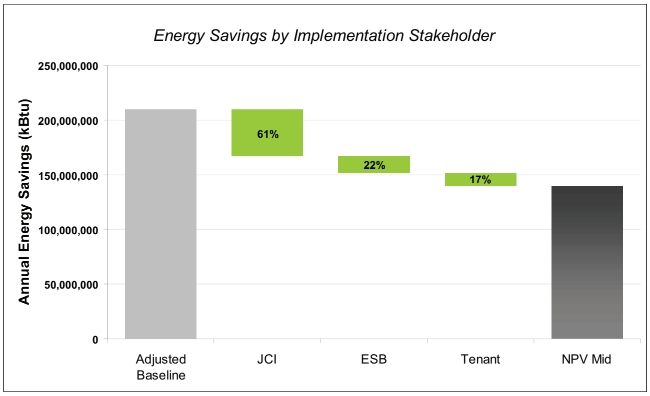
In addition to reducing energy and carbon dioxide emissions, the proposed sustainability program will deliver an enhanced environment for tenants including improved air quality resulting from tenant demand-controlled ventilation; better lighting conditions resulting from coordinated ambient and task lighting; and improved thermal comfort resulting from better windows, the radiative barriers and better controls.

"All portfolio managers and real estate owners to some extent have been concerned with energy efficiency, and they've done small things," says Clay Nesler, VP of Global Energy and Sustainability at Johnson Controls. "What this project shows is that it actually makes sense to make large and significant energy efficiency improvements, not the 5 to 10 percent type things, but the 20 to 30 percent and more type of improvements, and that there is a business case for doing so."

THE FINANCIAL ANALYSIS

Johnson Controls, the Empire State Building, and Tenants are each responsible for delivering some of the total savings. The base building projects will be financed out of ESB cash flow. Work has already started and will be complete by 2013 (55 percent of the savings will be in place by December 31, 2010).

Johnson Controls agreed to deliver 61 percent of the total savings using a performance contract mechanism with a total cost of $20 million and guaranteed savings of ~20 percent. Johnson Controls is implementing the short-term projects that can be done within 18-24 months, while ESB and tenants are implementing the longer term projects that must be coordinated with tenant turnover. Empire State Building will deliver 22 percent of the total available savings as air handling units are replaced over the next four years.



The chart below sums up the cost and projected energy savings for each individual measure as well as the final recommended package. The savings are approximately $4.4 million annually for an incremental capital cost of $13.2 million, representing a 3-year overall payback. In addition to energy savings, several projects also qualify for utility rebates as well as provide operational savings.

How does the Performance Contract work?

Johnson Controls is executing six energy projects under a performance contract. The Empire State Building will pay them a guaranteed maximum price to complete all the work. Johnson Controls guarantees a minimum energy savings from each project. The building energy model will be used in conjunction with current utility, weather, and usage data to track savings each year to determine if savings thresholds have been achieved. If they have not, Johnson Controls will pay the Empire State Building for the shortfall. The savings are guaranteed for a period of 15 years.

Project Description	Projected Capital Cost	2008 Capital Budget	Incremental Cost	Estimated Annual Energy Savings*
Windows	$4.5m	$455k	$4m	$410k
Radiative Barrier	$2.7m	$0	$2.7m	$190k
DDC Controls	$7.6m	$2m	$5.6m	$741k
Demand Control Vent	Inc. above	$0	Inc. above	$117k
Chiller Plant Retrofit	$5.1m	$22.4m	-$17.3m	$675k
VAV AHUs	$47.2m	$44.8m	$2.4m	$702k
Tenant Day/Lighting/Plugs	$24.5m	$16.1m	$8.4m	$941k
Tenant Energy Mgmt.	$365k	$0	$365k	$396k
Power Generation (optional)	$15m	$7.8m	$7m	$320k
TOTAL (ex. Power Gen)	$106.9m	$93.7m	$13.2m	$4.4m

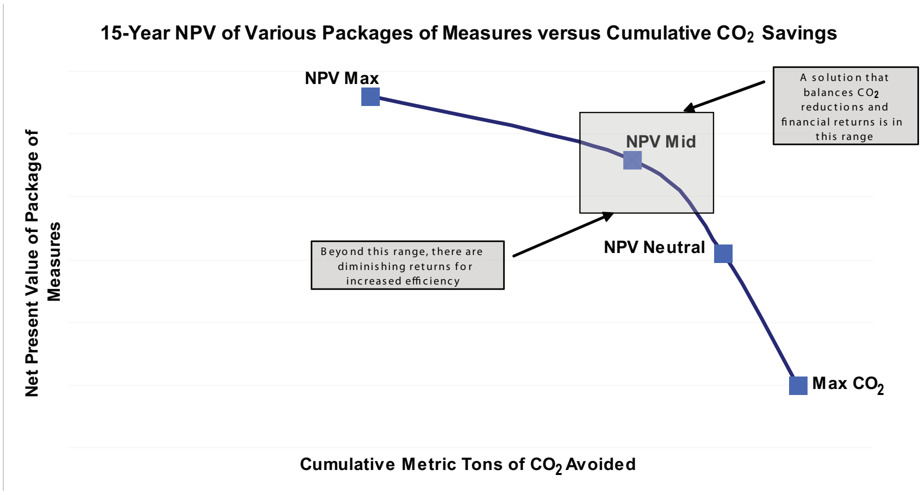
*Note that energy savings are also incremental to the original capital budget.

Net Present Value (NPV)

As described in the process article which follows, a significant amount of time was spent modeling various packages of improvement measures to determine the best balance between economics and CO_2 reductions. The chart below shows net present value on the y-axis and cumulative CO_2 saved on the x-axis. As one might imagine, the curve plotted shows that the more CO_2 you seek to save, the more it will cost. On one end of the spectrum, you can maximize net present value and save about 50,000 metric tons of CO_2; on the other end, you can save about 130,000 metric tons and spend more money than will be realized through resultant energy savings. The key is to find the point in the curve where only a slight amount of NPV is left on the table for twice the CO_2 savings. That point is the "NPV Mid" package, which is ultimately what the team recommended and what is being implemented.

The net present value of the midpoint option was estimated at $22 million over 15 years, compared with $32 million if NPV was maximized and negative $17 million if carbon dioxide reduced as much as possible regardless of NPV.

The most important aspect of the analysis was properly accounting for the incremental capital cost of each measure. Because the baseline included the planned capital projects, the cost of many measures considered only the incremental capital cost, not the full



capital cost of each measure. This became a huge lesson learned for the team – the projects that are coordinated with planned equipment replacement are generally the most cost-effective. Thus, for any retrofit project, establishing a "capital cost baseline" (what the owner would need to spend anyway to keep the building operational regardless of energy efficiency) in addition to an energy cost baseline is critical to conducting a complete and accurate analysis.

A key variable investigated in the NPV calculation was the rent premium that could be gained from establishing the Empire State Building as a green building. The baseline calculation assumed that sustainable features would allow the building to gain rents one percent higher than if no such program were implemented. If in fact the sustainability program did not result in higher rent, the NPV over 15 years would be cut in half, to about $11 million (still far exceeding the NPV of the original planned capital projects). In its due diligence for making the assumption, the team compared key, sometimes controversial, studies from CoStar Group, University of California-Berkeley and the University of Reading, which estimated the rent premium for green buildings between 3 and 9 percent compared with similar buildings without those features. If the Empire State Building were to achieve the low end of this estimated spectrum by gaining a 3 percent average rent premium, the 15-year NPV would be greater than $40 million.

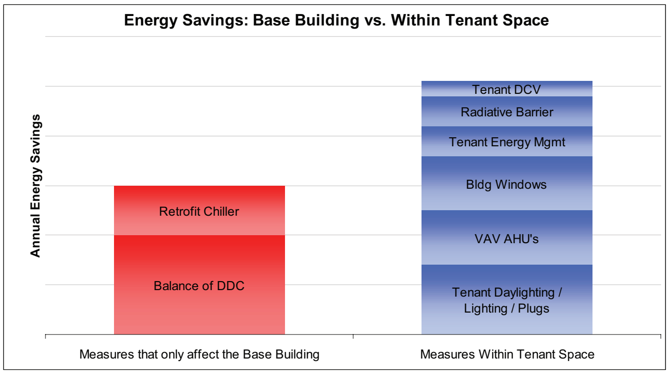
In addition to recommendations on which strategies to implement, the sustainability team had also examined the length of time it would take to implement various strategies. This was a significant consideration, because a key metric of each strategy was the payback period for capital invested. If a strategy with a relatively short payback period required a long period of time to implement, that would affect the cost-benefit equation for that strategy.

Under the proposed plan, 61 percent of the energy savings were part of a program that Johnson Controls would implement quickly. Another 22 percent of the savings would come from two projects that the Empire State Building Company would implement over several years: the tenant energy management program, and the installation of two variable air volume air handling units on each floor. The other 17 percent of energy savings would depend on tenant actions that would not be fully complete for 12 years as leases rolled over, a front-loaded process given that 40 percent of leases are set to expire over the next four years.

Capturing Tenant Energy Savings

In existing commercial buildings, capturing many profitable energy efficiency opportunities requires engaging with tenants. In the Empire State Building retrofit, over 50 percent of the opportunities required some level of tenant engagement. Often energy efficiency opportunities that require tenant engagement are not implemented because of numerous real or perceived barriers, including split incentives and business interruption. In order to deliver real reductions, owners, ESCOs, tenants and building managers need to be engaged and incentivized by the process.

The team identified three key programs to influence tenant energy use: the tenant pre-built program, tenant design guidelines, and a tenant energy management program. Nearly 40 percent of tenant space will turn over in the next four years, so aggressive guidelines were needed immediately. The team's proposed green pre-built design will save $0.70–0.90 per square foot in operating costs annually for an additional cost of $6 per square foot and help ESB demonstrate design principles for all tenants to adopt. The pre-built program demonstrates implementation of the Tenant Design and Energy Management Guidelines developed by the team. Tenants can verify the technical and economic validity of the recommendations by using a financial decision-making tool the team created specifically for ESB. For the tenant energy management program, ESB will begin sub-metering all tenant spaces and manage a feedback/reporting system to inform tenants about their energy use. This program will also help tenants with their own carbon reporting efforts.



The ESB team designed and has completed construction of a space on the 42nd floor for the Empire State Building to use in marketing space to prospective tenants. Key design features include a low-pressure drop HVAC system, an indirect layered lighting system (ambient–task–accent lighting), new high-performance glazing, light shelves and blinds, daylighting, and local, high-recycled content, VOC-free, rapidly renewable construction materials.

LESSONS LEARNED

Since one of the most important goals of the project was to develop a replicable model for use by other buildings, the team focused on distilling the most important insights they had gained from the eight month project. They are as follows:

Developing robust solutions requires the coordination of numerous key stakeholders

Developing robust solutions requires the coordination of numerous key stakeholders. Planning energy efficiency retrofits in large commercial office buildings must address a dynamic environment, which includes changing tenant profiles, varying vacancy rates, and planned building renovations. In the Empire State Building, the project team included engineers, property managers, energy modelers, energy efficiency experts, architects, and building management.

Each of these stakeholders was needed to help build a robust energy model that addressed the building's changing tenant profile and helped the team model the impacts of its energy efficiency strategies. Coordination also included the tenants. Involving tenants and considering their perspective early on is critical because more than half of the energy efficiency measures that will be implemented at the Empire State Building involve working both with tenants and within their spaces.

Maximizing Energy Savings Profitably Requires Planning and Coordination

For an energy efficiency retrofit to be cost effective, the retrofit needs to align with the planned replacement or upgrades of multiple building systems and components. For instance, the Empire State Building had plans underway to replace its chillers, fix and reseal some of its windows, replace air handling units, change corridor lighting, and install new tenant lighting with each new tenant.

Since these upgrades were already going to be carried out, the team redesigned, eliminated and created projects that cost more than the initial budget but had significantly higher energy savings over a 15-year period. When these energy savings were accounted for along with the added upfront project costs, the net present value of the energy efficient retrofit projects was better than that of the initial retrofit projects. The total additional cost was $13.2 million with $4.4 million of annual savings, representing an overall 3-year payback for the added cost. However, had energy efficiency projects not been coordinated with planned projects, the incremental cost would have been far greater than $13.2 million. Doing energy efficiency projects well before major systems and components are ready for replacement will likely be cost prohibitive, with a poor net present value. The large volume of existing commercial buildings suggests that there is a tremendous opportunity to reduce carbon emissions from existing buildings through energy efficiency; however, capturing these reductions in a profitable manner demands careful planning and coordination to ensure that energy efficiency retrofits align with building replacement cycles.

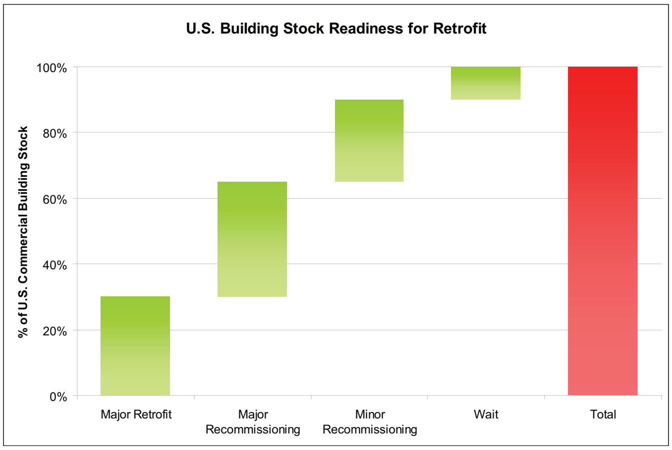
For many buildings that are not in or approaching major replacements, there may still be a major opportunity to perform existing building commissioning (EB-Cx). EB-Cx improves the operation of existing buildings, many of which are typically run to minimize complaints, rather than optimize energy performance and create comfortable working environments. EB-Cx can typically reduce energy use between 5 – 15 percent in most buildings. Developing a tool or set of tools that can quickly triage a building to determine if the building is a candidate for a whole building retrofit, existing building commissioning or no action for a few more years, will dramatically improve the effectiveness of funds and efforts directed towards energy efficiency retrofits of existing buildings.

There is a Tension between Business Value and Reducing CO_2 Emissions

In the Empire State Building, maximizing profitability from the energy efficiency retrofit leaves almost 50 percent of the CO_2 reduction opportunity on the table. The building owner, while still selecting an optimal package of measures with a high net present value, sacrificed 30 percent of projected profit to deliver more CO_2 reductions and improve the lighting and tenant comfort within the building. Changes in energy prices and/or the cost of energy efficiency technologies may help to better align profit maximization and CO_2 reduction. However, as things stand currently, there is a gap between the socially desirable amount of CO_2 reduction and the financially beneficial amount of CO_2 reduction from a building owner's perspective.

A Replicable Streamlined Process for a Whole Building Retrofit is Needed

Developing the energy efficiency strategies that will be implemented in the Empire State Building took over eight months of intensive building audits, brainstorming charrettes, energy modeling, documentation, and financial analysis. Although the Empire State Building is a very unique building with unusual challenges, the process that drove deep energy and carbon savings in the Empire State Building can be made much more accessible. Having completed the recommendations for the Empire State Building, the project team recognizes a number of opportunities for condensing the study period exist, including: developing experienced teams, creating tools for rapidly diagnosing and categorizing a building (or a portfolio of buildings) as "ripe" or not, quickly developing a "first-cut answer," and developing and using tools to quickly iterate between financial and energy modeling to arrive at the optimal package of measures.



Carbon Regulation Does Not Significantly Affect the Empire State Building Recommendation

The financial decision-making tool, described in the next article, helped to clarify that the recommended package of energy efficiency measures would not significantly change if there were carbon regulation that led to slightly higher energy prices over time. Carbon regulation that changed energy prices by less than two percent per year had little effect on the financial performance of the modeled packages. However, if energy prices rise by over 8 percent (associated with a carbon price of approximately $30/metric ton of CO_2), a package with all of the energy efficiency measures that were analyzed (as opposed to those that were recommended), rises to NPV neutral instead of NPV negative.

What is Needed Next?

Research is needed to collect case studies demonstrating the business case for engaging tenants in building retrofits. In addition, best practices and recommendations for engaging tenants could help spur building owners to pursue tenant energy savings potential. Recommendations could include a set of actionable items such as sub-metering, creating green lease rider templates, creating programs to incentivize and engage tenants, etc. that will help owners and operators overcome real and perceived barriers to engaging tenants in energy efficiency projects.

In a typical energy efficiency retrofit project led by an ESCO, the ESCO focuses on upgrading lighting systems and HVAC controls[1,2]. This focus can usually generate 15-20 percent reduction in a building's utility bills. In the Empire State Building retrofit, the team initially conjured up more than 60 potential energy efficiency retrofit measures. Rigorous energy and financial analyses whittled the list down to eight measures that will generate approximately 38 percent reduction in the Empire State Building's utility bills. Why did the other measures not make the cut? Why do most retrofit projects fail to incorporate measures beyond lighting systems and HVAC controls?

Evidence from the Empire State Building retrofit suggests that proper planning is essential to realize energy and carbon reductions that pay back initial investments in a timely manner (i.e., NPV positive). For energy savings to adequately compensate for initial capital investments, a major system retrofit must typically be performed during the time when the building would replace these systems and/or components like windows, lighting, and HVAC. Aligning a building's replacement cycle and an energy efficiency retrofit requires planning, particularly if a large amount of the 75 billion square feet of commercial buildings in the U.S. are to receive energy efficiency retrofits in the future.

A diagnostic tool that could determine when a building is "ripe for retrofit" or ready for other types of energy efficiency improvements like existing building commissioning or tune-ups would improve the industry's ability and effectiveness in planning retrofits across the building stock. Such a tool could help the government and many other large building owners determine how to allocate billions of dollars of capital devoted to energy efficiency retrofits—identifying when and where money should be allocated to bring about the greatest financial returns and cheapest carbon reductions.

Significant opportunities exist to reduce the time and cost of the analysis process. These include ensuring the right buildings are selected for whole-building retrofits, using better and more compatible tools for the given situation, and applying insights learned from other buildings and your own experience.

Research and case studies are also needed to help identify broader sets of measures with commercially viable financial returns and to establish the conditions that will make other measures technologically and commercially viable in a typical building retrofit. Value-chain analyses could help determine opportunities for cost reductions for technologies that can save significant amounts of energy. Examples might include:

- Additional controls
- Easy-to-install methods to retrofit exterior wall systems to increase thermal resistance
- LED lighting
- DALI lighting controls
- Chilled beam systems
- Heat recovery systems
- Green roofs
- Rainwater collection
- Condenser water savings
- Dessicant systems
- Even higher performance windows

CONCLUSION

There is a compelling need as well as an economic case for reducing greenhouse gas emissions in existing buildings. The Empire State Building case study provides an example of how this can be done. However, significant challenges remain that must be addressed in order to quickly and cost-effectively capture the full greenhouse gas reduction opportunity for building retrofits on a widespread basis.

Footnotes:

1. Hopper, Nicole, Charles Goldman, Jennifer McWilliams, Dave Birr and Kate McMordie Stoughton, 2005. "Public and Institutional Markets for ESCO Services: Comparing Programs, Practices and Performance" Lawrence Berkeley National Laboratory: LBNL-55002, Berkeley, CA, March.

2. Goldman, C., J. Osborn, N. Hopper, and T. Singer, 2002. "Market Trends in the U.S. ESCO Industry: Results from the NAESCO Database Project" Lawrence Berkeley National Laboratory: LBNL-49601, Berkeley, CA, May.

THE MODEL: A WORK IN PROGRESS

Optimizing the Empire State Building Retrofit Process

Empire State Building Sustainability Team

The process of identifying, evaluating and choosing energy efficiency measures for the Empire State Building took over eight months. Typical energy efficiency retrofit recommendations take 2-3 months. Many unique project elements contributed to the length of time needed to finalize a set of energy efficiency measures for the Empire State Building. These unique elements included:

- Size of the building and diverse tenant profile;
- Documentation of the process to help other owners and ESCOs produce similar retrofits and results;
- Collaboration and coordination among a project team that included the building owner, the property management firm, the ESCO, the sustainability advisor, and select tenants;
- Modeling of the energy use of the building and the reduction potential of energy efficiency measures using eQUEST;
- Evaluation of efficiency measures to reduce energy use in tenant space, and not just in the base building.

Many of these elements contributed to the project's ability to achieve savings that are more than twice that of typical commercial building energy efficiency retrofits. However, to make the Empire State Building process replicable, the process needs to be made simpler and easier. The development of a streamlined process complemented by a set of tools to more quickly identify and evaluate efficiency measures would improve the likelihood that other energy efficiency retrofits could replicate the savings that were identified in the Empire State Building.

The following briefly describes the basic model and steps that were pursued by the Empire State Building Sustainability Team over the course of the eight month project.

Phase I: Investigation, Programming and Project Integration

Team members began by conducting reviews of the building's mechanical systems and equipment, calculating tenant energy usage, and developing a baseline energy benchmark report. A gap analysis was conducted to determine which LEED® and Green Globes criteria the building was already meeting, and which could be achieved feasibly. A plan was developed for the creation of pre-built green offices to serve tenants with an immediate need for finished space. From April through June, the team steering committee met twice to discuss progress and refinements to the program and conducted a separate cross-functional workshop to look specifically at lighting strategies.

The central initiative involved in the first phase was the integration of sustainability goals with the capital projects team.

	Phase I: Investigation, Programming and Project Integration	Phase II: Analysis and Implementation	Phase III: Tenant Engagement and Further Analysis	Phase IV: Creating an Integrated Sustainability Master Plan
Activities	• April 14th kick-off meeting • May 7th/May 14th team workshops • June 2nd Presentation to Ownership	• June 18th Theoretical Minimum workshop • July 2nd workshop • July 15th Presentation to Ownership	• July 30th Tenant Focus workshop • August 13th eQuest workshop • August 27th Presentation to Ownership	• Sept. 10th workshop • Sept. 29th Presentation to Ownership • October 6-8th Finance workshop (Boulder) • Nov. 10th Presentation to Ownership
Outputs	• Baseline Capital Projects Report	• Baseline Energy Benchmark Report	• Tenant Initiatives (prebuilts, design guidelines, energy management) Report • Tuned eQuest model	• Model (eQuest, financial, GHG) outputs • Integrated Sustainability Master Plan Report (including Energy Master Plan)

The Empire State Building had already embarked on a major capital program that included a combination of restoration and upgrades to lobbies, hallways, restrooms and other common areas. The process of value-engineering existing capital projects was a high priority for the sustainability team as a way to avoid having to make changes later.

To accomplish the process effectively, an integrated team approach was adopted to deliver building improvements with minimal disruption to tenants and visitors. The Empire State Building Company capital program team, led by Jones Lang LaSalle as project manager, guided the work performed by TPG Architects, mechanical-electrical-plumbing (MEP) consultant Lakhani & Jordan Engineers and others. For the sustainability program, a separate project management team of Empire State Building Company and Jones Lang LaSalle interfaced with the capital program team and worked with Johnson Controls and Rocky Mountain Institute to identify opportunities for sustainable improvements.

The integration of the capital team and the sustainability team allowed the latter to pursue a "whole-building" approach, modifying existing capital projects so that they conformed to higher sustainability standards. In so doing, the team was able to make the building greener while staying within budgetary parameters.

EXPECTED INCOME STREAM ENHANCEMENTS

- Reductions in existing capital improvement program costs
- Reduced utilities budget due to greater efficiencies in energy and water usage
- Reduced building operations budget due to lower maintenance and repair costs
- Increased rent and occupancy due to enhanced value placed on updated services
- Additional income from new tenant service offerings, such as chilled water and emergency power

The sustainability team was even able to suggest ways to lower the cost of several capital projects while enhancing environmental factors such as energy, water and ventilation.

The integrated team started by identifying baseline budgets for 23 existing capital projects and then examined how sustainable alternatives could affect costs. It was determined that sustainable improvements would result in a high level of savings on six projects. Four of those projects were put on hold while they examined alternatives thoroughly, including a multi-year air conditioner replacement program, central cooling plant replacement, exterior tower lighting and mid-pressure steam riser replacement. The corridor renovation project—the largest single budget item in the capital program—was also viewed as one of the greatest opportunities to reduce costs by improving lighting and air handling.

Another six projects presented a moderate level of cost savings. The sustainability team recommended exploring gray water sources in restroom renovations and looking at modular green roof alternatives on selected setbacks. As the capital projects team worked on the initial priorities, the sustainability team pursued a parallel track to identify additional opportunities not contained within the scope of the original projects.

One exciting outcome of the first phase was a cost reduction of the baseline capital project of between three and four percent based on the review and suggestions of the sustainability team. In addition, a preliminary budget analysis was prepared for the recommended energy projects including the projected annual energy savings. This analysis indicated a payback period of 15 years for energy-related work based on current energy costs but when the savings from the capital budget were included, the payback period was reduced to about three years.

Phase II: Analysis and Implementation

By the time the Phase II kickoff meeting took place in early July, the team had already made substantial progress on several fronts: documenting tenant energy use, conducting preliminary mechanical tests, and refining criteria for measuring and benchmarking efficiency. The team was nearing completion of the LEED® gap analysis checklist for the base building, and a similar checklist for tenant spaces also was under way.

ACCOMPLISHMENTS OF PHASE I

- Knowledge sharing within the team via weekly team reports, bi-weekly team calls, two full-team workshops and a third workshop for lighting.
- Establishment of a Sharepoint site for all team members
- Feedback gained from building stakeholders, including a tenant sustainability charrette to discover green tenant needs
- Collaboration with building operations to implement immediate systems improvement measures
- Review of existing capital projects and implementation of a lobby lighting test case for energy improvement
- Measurement and verification of building equipment and conditions to establish a baseline for energy and sustainability performance
- Strategy session engaging advisory expertise, ownership and teams
- Development of a Sustainability Scorecard , LEED® EBOM Checklist and Green Globes Report

An important element of Phase II was to narrow a myriad of issues down to a manageable number of potential solutions. This winnowing process occurred throughout all four phases of the program, but it was primarily in the second phase that the many potential options were consolidated into a relatively small number of likely scenarios.

GOALS OF PHASE II

- Create "360-degree" understanding of resource use at ESB
- Develop theoretical minimum energy use at ESB to help identify key levers of energy reduction potential.
- Outline sustainability recommendations for pre-built spaces
- Initiate tenant engagement and design partnerships
- Begin development of energy-efficiency measures
- Continue development of project tools (Sustainability Scorecard, LEED®, Green Globes, GHG Protocol)

Johnson Controls presented the Baseline Energy Benchmark Report in mid-July. The report examined energy usage between April 2007 and May 2008 from a number of perspectives:

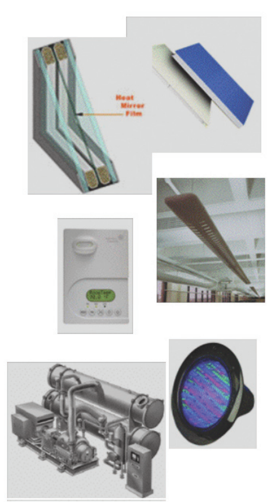
- A month-by-month breakdown of electricity usage by kilowatt-hour, of steam usage by Mlbs, and the cost associated with each, along with a total energy cost, both with and without the broadcast towers

Determining the Optimal Package of Retrofit Projects

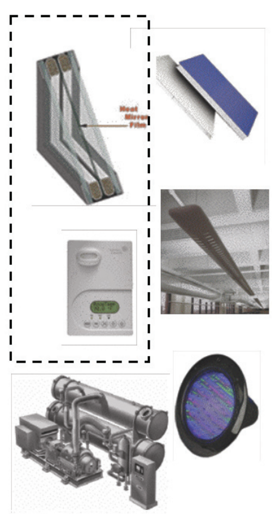
Identify Opportunities

4	Chiller-4	CW Waterside economizer for year round cooling for all zones
5	Chiller-5	Multiple Tonnage Chiller Sizing
6	Chiller-6	Best Practice Cooling Tower Sizing and Efficiency Pumping
7	Chiller-7	Chilled water temperature reset
8	CHW Pumping -1	Variable Flow CHW Pumping
9	CW Pumping-1	VFD on CW Pumps, Flow Control
10	CW Pumping-2	Best Possible Pumping Design - Reduced Pressure Drop and Max Pump E
11	Heating-1	Heat Recovery from Broadcast Floors
12	Heating-2	Run Around Glycol loop to preheat OA to observatory
13	Heating-3	Basecase w/ electric reheat (space heaters)
14	AHU-1	Install new VFD AHUs
15	AHU-2	Best Practice AHU (Low dP,Higher Fan Eff)
16	AHU-3	Underfloor/Displacement Air Distribution
17	AHU-4	Install Low dP VFD AHUs
18	AHU-5	Move to Central OA Supply
19	AHU-6	Core Space Conditioning - Dedicated Unit
20	AHU-7	Core Space Conditioning - Shared Unit (Cascade)
21	AHU-8	Nighttime Purge to Precharge Thermal Mass
22	AHU-9	Natural Ventilation.
23	AHU-10	Eliminate local AHU and use chilled beams and radiant.
24	Controls-1	Chiller Plant
25	Controls-2	Controls - Chiller sequencing
26	Controls-3	Controls - Optimized Start/Stop
27	Controls-4	Controls - Variable Primary/Secondary control
28	Controls-5	Radiator Control
29	Controls-6	Radiator Control/Window Opening
30	Controls-7	ESB Local HVAC Equip. (Air cooled chiller, CHW AHUs tied to ACC, DX AH
31	Controls-8	Old AHUs Control (S/S, OA Damper, CHW Valve, Zone Temp
32	Controls-9	New AHUs Control (S/S, OA Damper, CHW Valve, Zone Temp)
33	Controls-10	New VFD AHUs Control (S/S, OA Damper, CHW Valve, Zone Temp,VFD)
34	Controls-11	New VFD AHUs with OA Demand Control
35	Controls-12	Thermal Comfort Space Temperature Control (ASHRAE 55)
36	DHW-1	Electric Instantaneous DHW 19+/LL-18 Heat Recovery
37	Envelope-1	Install Window Film
38	Envelope-2	Install New Window Glazing Option A
39	Envelope-3	Install New Window - Glazing Option B
40	Envelope-4	Install Thermally Broken Frames
41	Envelope-5	Provide and install insulated sheet metal barriers behind each radiator.
42	Envelope-6	Provide furring strip insulation on Perimeter Walls
43	Envelope-7	Install Green Roof
44	Envelope-8	Install White Roof
45	Cogen-1	Steam driven back-pressure turbine/Absorption Chiller/DHW/Electric Chiller
46	Cogen-2	Install Fuel Cell/DHW Heat Recovery/Absorption Chiller
47	Lighting-1	Lighting -Restrooms Occ Sensor Commission
48	Lighting-2	Lighting - Restrooms Lighting Retrofit
49	Lighting-3	Lighting - ESB Common Hallways Retrofit

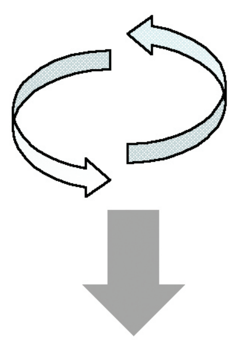
Model Individual Measures



Create Packages of Measures



Model Iteratively



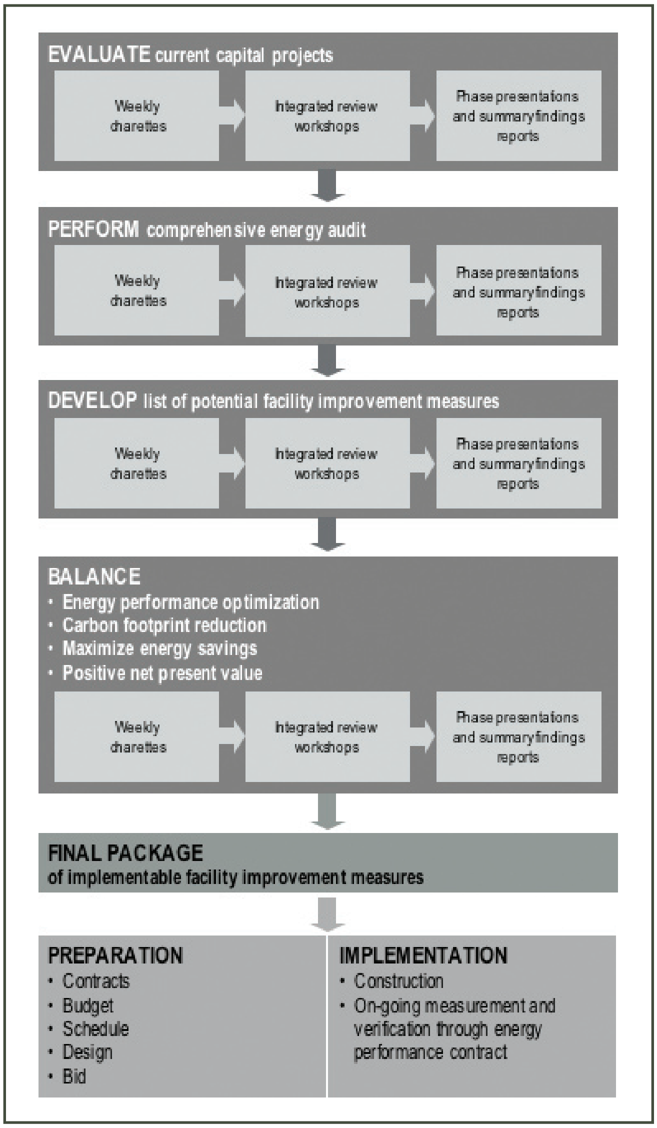
Outcome:
Package of measures with best economic & environmental benefits

- Month-by-month breakdowns of electrical and steam usage showing the amount of energy expended toward lighting, ventilation, broadcast towers, main plant cooling, tenant sub-metering and other uses
- An annual breakdown showing the share of total energy expended that went to different tasks, including broadcast (23 percent), radiator heating (17 percent), lighting (16 percent), main plant cooling (15 percent), tenant sub-metering (7 percent), steam cooling (4 percent), and ventilation (5 percent), as well as the same data without including broadcast uses
- Areas of opportunity for using steam power more effectively, in particular radiator steam load (60 percent of total achievable gain), base load steam (19 percent), steam chiller (15 percent) and AHU HW HX (6 percent)

How Low Can We Go?

It was at this point that Rocky Mountain Institute presented its findings on the theoretical minimum energy usage needed to address occupant comfort requirements, passive measures and other systems impacts, system design characteristics, technology, controls and changed operating schedules. By raising the cooling set-point, enhancing the envelope and ventilation, reducing internal gains and improving cooling efficiency, Rocky Mountain Institute estimated that the building could reduce non-broadcast energy usage by up to 65 percent; however, the goal under the existing charter was between 15 and 25 percent. Rocky Mountain Institute's analysis suggested that a reduction of 40 to 50 percent was not merely theoretical but achievable—if the cost-benefit equation did not devolve into a cost-avoidance strategy in the latter stages of the process.

In July, Jones Lang LaSalle and Johnson Controls made recommendations on sustainable tenant pre-built spaces, comparing two potential options to standard pre-built spaces from an architectural, mechanical and lighting standpoint. Recommendations included reducing the number of interior wall enclosures to enhance natural light and views, selecting interior finishes to support sustainable goals and using task lighting to complement higher efficiency overhead lighting.



GOALS FOR PHASE III

- Complete Tenant Energy Management Report (guidelines for existing tenants)
- Complete Pre-Built Space Design Report (design for new pre-built spaces)
- Complete 90 percent of eQUEST model (test and understand key hypotheses)
- Begin financial modeling of synergistic combinations of measures, not isolated measures
- Begin in-depth lease review and tenant surveys
- Develop LEED® EB and CI Feasibility Report

Phase III: Tenant Engagement and Further Detailed Analysis

Phase III centered on two major deliverables: a final report assessing the tenant energy usage and the impact of pre-built spaces; and the development and refinement of the eQuest Energy Model.

The tenant energy program had four basic components:

1. Establish electric sub-metering for each tenant so that energy used by the tenant can be displayed and compared to industry norms via a dashboard linked to the building web page.
2. Identify key building personnel to be the face of the program, suggest each tenant designate a point of contact. Provide training to the contact so they understand the basics.
3. Provide education through online training, and seasonally specific recommendations and best practices for tenants to reduce their carbon footprint.
4. Report on progress.

Tenant energy usage had been documented over a period of months ending in mid-August. The sustainability team, looking for a way to easily monitor energy usage of each floor and each tenant on that floor, proposed to create a computer "dashboard" that would automatically translate numeric data into visual data (charts and graphs) so that managers could more easily spot trends and act on them. A typical tenant's data might show month-to-date and year-to-date energy usage in terms of kWh and cost, as well as high, low and average usage per square foot and a month-by-month breakdown of actual and ideal usage.

The plan was to optimize energy systems floor-by-floor as spaces became available through vacancy or restacking tenants within the building. Following the building's existing restacking plan, 14 floors would become immediately available for optimization, with up to 33 floors available by the end of 2011.

The team also finalized plans for pre-built tenant spaces and had started the vendor bid process. Different pre-built layouts had different sustainability impacts and the team developed multiple scenarios to achieve different levels of energy efficiency within these spaces. The cost of the different more sustainable scenarios exceeded the cost of non-sustainable pre-built spaces by 6.5 percent to 12 percent.

Using the Energy Model

The most sophisticated element of Phase III was the further development of the eQuest Energy Model. Drawing on a program developed by the U.S. Department of Energy, the model was designed to be used for cost / benefit analysis for future improvements, modifications and operational changes. The purpose of the eQuest Energy Model was to allow comparisons of the energy consumption baseline to various Facility Improvement Measures (FIM) in order to calculate energy savings on a stand-alone basis and in combinations with other measures. The sustainability team created a matrix that analyzed the costs and financial benefits of FIMs and other potential green strategies, and integrated the data with sustainability ratings, architectural programming and operational best practices, creating a comprehensive sustainability scorecard . The result was a sophisticated understanding of how different strategies, implemented individually or in various combinations, would affect project cost and building performance.

Johnson Controls and Rocky Mountain Institute conducted parametric runs on strategies relating to chillers, heating units, water pumping equipment, air handling units, controls, co-generators, lighting, plug loads and the building envelope. These exercises helped identify scenarios that would provide the most value, taking into account life-cycle costs and benefits, economics and logistics of implementation. For each scenario, the team needed to document variables that could affect the results. For example, if tenant engagement and adoption rates were higher or lower than anticipated, or if more of the building was used for broadcast than anticipated, there could be an impact on the estimated results. Recognizing these variables and attempting to quantify their impact was a significant element of the analysis.

Phase IV: Creating an Integrated Sustainability Master Plan

The final phase of the analytical process was to create a Final Report and Sustainability Master Plan for Ownership, synthesizing data from all available standards and measurement tools, including ENERGY STAR, LEED®, Green Globes, eQUEST Energy Modeling Tool, the Sustainability Metrics Tool and Financial Modeling Tool.

Sophisticated modeling helped to pull the different project analyses together via iterations between the energy (eQUEST) and financial (spreadsheet) models. The following global energy and financial assumptions were utilized:

- Base case fuel escalation = 1%
- Base case construction escalation = 2.5%
- Base case inflation = 2%
- Base case real discount rate = 8%
- Base case green rent premium = 1%
- 15-year time horizon

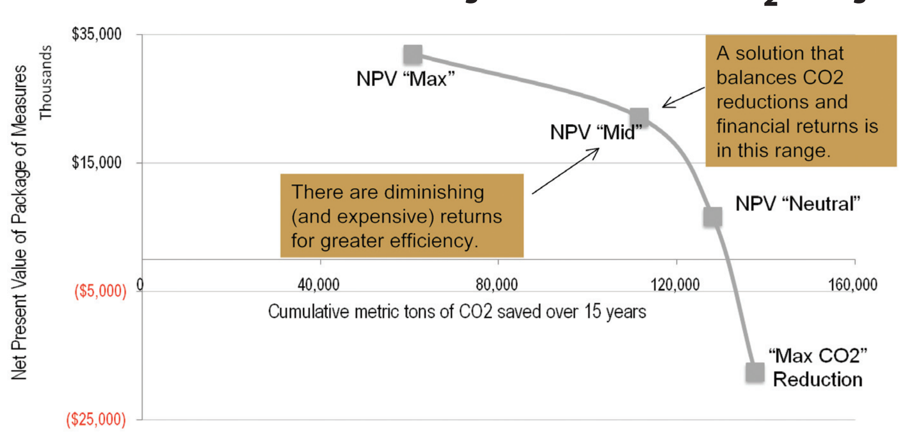
The Net Present Value Mid-Point

The recommended strategy was called the "net present value mid-point" because it considered strategies based on a balance of NPV with the amount of carbon dioxide avoided. The NPV midpoint was compared with other options, including one that would maximize NPV, and another that would maximize carbon dioxide reductions regardless of NPV. Comparing the midpoint option to the two extremes would help identify best-case scenarios.

The results pointed to a clear solution: The team should pursue a program that would reduce energy use and greenhouse gas emissions by 38 percent, saving 105,000 metric tons of carbon dioxide over the next 15 years.

Achieving an energy reduction greater than 38 percent appears to be cost-prohibitive. The analysis had examined strategies that could have reduced emissions by nearly 45 percent, out of a theoretical

15-Year NPV of Package versus Cumulative CO_2 Savings



maximum of 55 percent. A total of 60 energy efficiency ideas were narrowed down to 17 implementable strategies that were analyzed in depth. Of these, the first 90 percent of reduced carbon dioxide would also save costs over time by an average $200 per ton of carbon saved. The last 10 percent, by contrast, would carry a life cycle cost of more than $300 per ton of carbon saved.

Tenant Participation Drives Energy Savings

In order to capture the 17 percent of energy savings involving tenant spaces, the Empire State Building team was given the responsibility for a program that would include both aggressive guidelines and incentives for tenants to achieve energy savings of about six percent. Since nearly 40 percent of the building's leased space was due to turn over within four years, the team emphasized immediate adoption of guidelines for tenant improvements. The proposed green pre-built design would help the team establish design principles for all tenant spaces. Tenants could review the experience of the pre-built spaces and access the eQUEST model and tenant financial tool to verify the economic validity of the guidelines in terms of cost (estimated at $6 per square foot) and operational cost savings to the tenant ($0.70 to $0.90 per square foot annually).

A program of sub-metering all tenant spaces and management of a reporting tool to inform tenants of their energy use was considered essential both to drive tenant focus on energy efficiency within their own space and to assist tenants in calculating their carbon footprints. Sub-metering would encourage tenants to follow the building guidelines on recommended strategies such as daylighting (creating space plans that maximize the use of natural light), and use of efficient lighting techniques, such as task lighting. The sustainability team also recommended exploration of tenant incentive programs such as a "feebate" plan wherein tenants that missed sustainability targets would pay fees that might be redistributed to those that exceeded sustainability targets.

Conclusion

The most extraordinary part of the whole process was the fact that the team put aside organizational loyalties and worked together collaboratively in an integrated manner to deliver superlative results.

The analytical process was merely the first step toward achieving an optimal energy and sustainability profile at the Empire State Building, but it was critically important to the ultimate success of the program. The strategies selected from this process will not only have a significant impact on the building's carbon footprint but will open doors to additional cost-effective avenues for financing the project.

The Empire State Building is just one drop in an ocean of commercial buildings that must undergo some form of rational energy and sustainability retrofit in the next several years, if we as a society are committed to reducing the impact of buildings on the environment. It is hoped that by making available documentation and information, the Empire State Building sustainability team can clear a path for thousands of other buildings to follow.

DECISION MAKING TOOLS

Owner Financial Decision Making Tool

To determine the relative financial impacts of implementing individual measures and packages of measures, the team developed a decision making spreadsheet tool. Unlike the widely used energy modeling software, the financial modeling tool was developed specifically for this project. The financial model calculates the net present value of the incremental cash flows over a 15-year period (2008 to 2023) resulting from the proposed energy efficiency measures. The financial model provides net present value figures that reflect the approximate project impact for ESB. The study timeline is intended to reflect the typical financing period for projects of this nature. The incremental cash flows are the difference in cash flows between executing the Empire State Building`s original capital budget (or an appropriate industry standard) and executing the proposed energy efficiency measures. While energy efficiency projects are often evaluated simply by comparing capital costs with utility expense savings, the team sought to create a more comprehensive and accurate story by incorporating other relevant incremental cash flows including repair and maintenance impacts, revenues, and rebates; based in part, on inputs from ownership.

To download a beta version of the financial decision making tool, go to: http://216.40.252.67/SocMe/Content/Files/DecisionMakingTool_OwnerFinancialv2.xls

Tenant Financial Decision Making Tool

The Tenant Design Assistance Feedback Tool is intended to help tenants in the Empire State Building easily and quickly understand the economic impact of incorporating energy efficiency measures into fit-out designs. If tenants understand the financial benefit, they are more likely to make the added capital investment. The Excel based tool (currently a beta version requiring refinement of assumptions) includes three key input steps. Once the input information is complete, tenants are provided with a cash flow chart showing the expected additional capital expenditure in year one (e.g. additional costs during fit-out) and the expected savings each year thereafter for the life of the lease. The tenant is also provided with a net present value of the capital costs and energy savings. These calculations do not include any other financial impacts besides capital costs and energy savings.

Integrated Design Checklist

Because the integrated design process allows for the introduction of more variables and "what-if's" than a conventional value engineering process, design decisions can become more complex; and, there is no form or questionnaire that determines the best outcome. Decisions are based on a variety of factors ranging from benefits (energy reduction, cost reduction, LEED points, aesthetics, comfort), to upstream and downstream impacts on other building systems and infrastructure, to the degree to which certain measures achieve overall project goals. To determine the viability of various design solutions, several levels of inquiry can be explored. Answers to these questions can supplant typical value engineering (where design decisions are based primarily oncost per unit of energy reduction for individual measures without accounting for interaction between systems) and help a design team understand how well a particular design measure meets the ultimate needs of the project across a range of topics and metrics. The checklist can help ensure the right questions are asked during the project development process.

To download a pdf of the Integrated Design Checklist go to: http://216.40.252.67/SocMe/Content/Files/DecisionMakingTool_IntegratedReviewChecklist.pdf

RATING TOOLS

Energy Star Target Finder

EPA`s Target Finder tool helps architects and building owners set aggressive, realistic energy targets and benchmark a building design's estimated energy use relative to the energy use of similar building types.

Leadership in Energy and Environmental Design (LEED)

The LEED Green Building Rating System is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings. LEED gives building owners and operators the framework and guidance they need to have an immediate and measurable impact on their buildings' performance. LEED promotes a whole-building approach to sustainability by recognizing performance in six key areas of human and environmental health including sustainable site development, water savings, energy efficiency, materials and resources selection, indoor environmental quality, and innovation in design.

The two rating systems used for benchmarking the Empire State Building included the LEED for Existing Buildings: Operations & Maintenance rating system and the LEED for Commercial Interiors program.

Green Globes

Green Globes is a green building rating system based on 1000 points over six categories: energy, water, resources, emissions/ effluents/ pollution control, indoor environment, environmental management system.

Greenhouse Gas Inventory Tool for Buildings

The Sustainability Metrics Model for Greenhouse Gas Emissions has been developed by the project team to scientifically evaluate a facility or company's impact on global warming and local environment resulting from the implementation of sustainability measures. This tool will enable the Empire State Building, and other buildings, to quantify the impact of their sustainability initiatives by converting their impact to Global Warming Potential (GWP).

The quantitative tool is based on internationally accepted scientific data and calculations. Tools, information, and data developed and published by the EPA, EIA, WRI, and DOE are used to support the Sustainability Metrics Model. The model is Excel-based to allow ease of integration as the Model is shared.

To download a beta version of the tool, go to: http://216.40.252.67/SocMe/Content/Files/GHG_ACCOUNTING_V1.6_Template.xls

DESIGN TOOLS

Energy Modeling Tools

eQUEST Energy Modeling Program

Whole building energy modeling typically consists of the use of a computer-based program for the analysis of annual energy consumption in buildings. The simulation programs used for energy modeling use an hourly weather file along with inputs for the building construction and operating parameters including building envelope, internal gains, occupancy schedules, and building systems to calculate energy consumption and peak demand by end use and by zone.

There are several different energy modeling programs available to engineers and modelers. For the Empire State Building, the team selected eQUEST, a user-friendly front end to the DOE-2.2 simulation engine (an update to the original version of DOE-2.1e).

To download a free version of eQUEST, go to: www.doe2.com/equest

DAYLIGHTING DESIGN TOOLS

SPOT™

SPOT is intended to assist a designer in quantifying the existing or intended electric lighting and annual daylighting characteristics of a given space and to help establish the optimal photosensor placement for the space relative to annual performance and annual energy savings.

To download a free version of SPOT, go to: www.archenergy.com/SPOT/download.html

AGi32

AGi32 can predict lighting system performance for any application from one luminaire in a jail cell to hundreds of luminaires in a professional sports facility. Interior or exterior, AGi32 can build environments for most any electric lighting or daylighting application with unlimited luminaires, calculation points, and reflective or transmissive surfaces.

To learn more about AGi32 go to: agi32.com

SCHEMATIC DESIGN TOOLS

Google Sketch-Up

Google SketchUp is software that you can use to create 3D models of anything you like.

To download a free version of Google SketchUp go to: http://sketchup.google.com/download/

Climate Consultant

Climate Consultant graphically displays climate data in either metric or imperial units in dozens of ways useful to architects and engineers including monthly bar charts, timetable charts, and psychrometric charts, sun shading charts, and sun dial charts.

To download a free version of Climate Consultant, go to: www2.aud.ucla.edu/energy-design-tools/

Process of elimination

1 Identify opportunities

- 60+ energy efficiency ideas were narrowed to 17 implementable projects
- Team estimated theoretical minimum energy use
- Developed eQUEST energy model

2 Evaluate measures

- Net present value
- Greenhouse gas savings
- Dollar to metric ton of carbon reduced
- Calculated for each measure

3 Create packages

- Maximize net present value
- Balance net present value and CO_2 savings
- Maximize CO_2 savings for a zero net present value
- Maximize CO_2 savings

4 Model iteratively

- Iterative energy and financial modeling process to identify final eight recommendations