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TENANT SPACE CASE STUDY:

Natural Resources Defense Council (NRDC) Washington, D.C. Office

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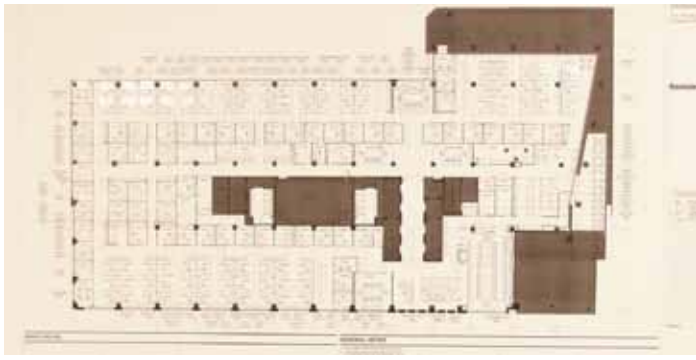

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About NRDC

NRDC (Natural Resources Defense Council) is a national nonprofit environmental organization with more than 1.3 million members and online activists. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, San Francisco, Chicago, Montana, and Beijing. Visit us at www.nrdc.org.

NRDC's policy publications aim to inform and influence solutions to the world's most pressing environmental and public health issues. For additional policy content, visit our online policy portal at www.nrdc.org/policy.

About NRDC's Center for Market Innovation

The core mission of The Center for Market Innovation ("CMI") is to expand the impact of the Natural Resources Defense Council ("NRDC") by creating market conditions that will redirect capital flows toward sustainable uses. While litigation, policy and science are necessary tools in tackling the many challenges to our environment, we believe that engaging mainstream capital is a critical additional component in achieving our common goals. We do so by engaging with the business community to articulate and implement sustainable value propositions, with a current focus on energy efficiency, water management, and regenerative agriculture.

CMI believes that a collaborative approach between building owners and occupants is essential to optimizing the performance of commercial office buildings. CMI's High Performance Demonstration Project (the "Project") is aimed at accelerating demand for high performance buildings and workplaces by demonstrating their economic benefits and other advantages, including corporate social responsibility, and employee attraction, retention and productivity. The Project works to amplify the compounded effect of owner/tenant collaboration, as tenants who value high performance spaces locate or remain in buildings with highly efficient central systems and transparent energy management practices. Building owners investing in energy efficiency improvements yield operating savings and gain competitive advantage in attracting and retaining high value tenants.

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TABLE OF CONTENTS

Executive Summary 4

Case Study Background 8

Case Study: NRDC Washington, D.C. Office Build-Out 9

Project Outcomes 17

Appendix 18

EXECUTIVE SUMMARY

"The integrated process is vitally important to projects such as this. Our extraordinary results are due, in large part, to getting everybody on the same page very early on."
Anthony Guerrero, Director of Facilities and Administration, NRDC

In July 2011, Natural Resources Defense Council (NRDC) relocated its Washington, D.C. office to a new space designed with a focus on energy efficiency and sustainability. NRDC is an international nonprofit environmental organization committed to protecting the world's natural resources, public health, and environment.

The energy-efficient new NRDC office has high performance measures which are projected to yield a 30 percent annual energy savings, compared to expected energy use if the office were built to the minimum energy code requirements (ASHRAE 90.1 2007). Over the life of the 15-year lease, NRDC forecasts a net cash flow savings (cumulative energy savings minus initial incremental cost) of $197,871 from the measures. The largest contributor to the project's energy reduction is the efficient lighting scheme, including the use of daylighting, automated and manual controls, and energy efficient fixtures.

BUILDING INFORMATION

LOCATION: Columbia Center,
1152 15th Street NW, Washington D.C.

PRINCIPAL USE: Office (Class A)

SQUARE FOOTAGE: 423,695 (11 floors)

ENERGY STAR RATING: 88

LEED CERTIFICATION: Silver
(Existing Buildings: Operations & Maintenance)

TENANT INFORMATION

LOCATION: 3rd floor

GROSS SQUARE FOOTAGE: 29,915

RENTABLE SQUARE FOOTAGE: 29,647

USABLE SQUARE FOOTAGE: 26,327

NRDC's new space is also designed to be very efficient in its use of square footage. The projected energy consumption in the new space, per occupant (4.9 MWh/occupant vs. 2.2 MWh/occupant) and per s.f. (20 kWh/s.f. vs. 9.8 kWh/s.f.), is less than half that of the previous office space.

The organization chose to relocate to a previously unoccupied raw space in a 2007 Class A building that already had efficient central systems, in order to provide an enhanced Return on Investment (ROI) from reduced common area energy use compounded by the efficiency measures installed in the tenant build-out. The goal of the new office design was to accrue energy and cost savings over the lease cycle to create a model working space for employees by investing in energy conservation measures (ECMs) and indoor environmental quality (IEQ) improvements, collectively known as high performance measures.

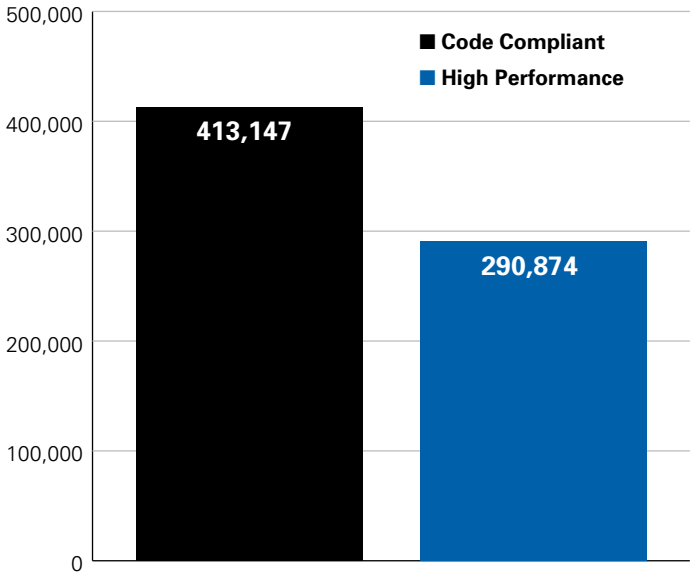
NRDC integrated energy efficiency into design choices at an early stage by bringing in a mechanical, electrical, and plumbing (MEP) engineer and an environmental consultant at the start of design discussions. The early decision-making process played a critical role in keeping the high performance measures' first costs to a minimum. The organization also negotiated its lease to have an annual base rent that excluded charges for electricity in the leased premises, which would be sub-metered and paid directly by NRDC. This structure allows NRDC to directly benefit from the energy and cost savings from the efficient build-out.

NRDC installed a package of high performance measures that carried an initial cost premium of $110,665 over the baseline code compliant practices—including advanced lighting measures, electrical submetering, and controls—with a projected payback period of 5.8 years. These choices helped NRDC to achieve a Leadership in Energy and Environmental Design (LEED) for Commercial Interiors Platinum rating, the highest level LEED certification that the U.S. Green Building Council (USGBC) awards for commercial interiors.

ENERGY REDUCTION AND COST SAVINGS

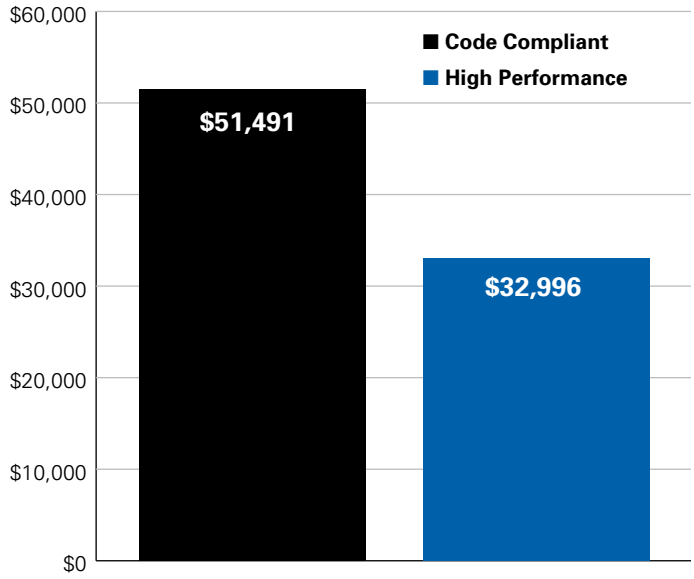
NRDC's energy analysis, based on modeled[1] results for the high performance build-out of the premises, compared against a theoretical baseline "code compliant" build-out, yields an annual electricity cost reduction of 35.9 percent and a reduction in annual energy consumption of 29.6 percent.[1] All results in this study pertain only to electricity use.

Figure 1: Annual Energy Consumption (kWh)



Energy Consumption: 29.6 percent Reduction

Figure 2: Annual Electricity Costs (2011$)



Electricity Costs: 35.9 percent Reduction

Cost Analysis

The incremental cost for the high performance energy efficiency measures on this project was $110,665 ($3.73/s.f.). This initial investment was self-financed and integrated into the project budget. It is projected to pay for itself in 5.8 years and will generate cost savings for the remainder of the 15 year lease term.

NRDC's selection of an energy efficient building provided opportunities for significant energy savings (compared to a code-compliant build-out) at a lower incremental first cost due to energy efficiency measures made available by the landlord. A code-compliant (ASHRAE 90.1-2007) build-out of a tenant space allows for a constant air volume (CAV) HVAC system that is typically less expensive and less energy efficient than the variable air volume (VAV) system that was installed prior to NRDC's build-out. This condition enabled NRDC to reconfigure and expand the existing VAV system at a far lower cost than upgrading an entire CAV system.

High Performance Measure	Incremental Cost	Cost / s.f.
Energy Modeling		$0.52
Design Option Development	$2,000	–
Baseline Energy Model	$7,000	–
System Scenario Modeling	$4,000	–
Data Reporting and Analysis	$2,500	–
Light Switching Dimming Controls	$44,471	$1.50
Daylight Harvesting	$40,000	$1.35
Additional VAV boxes	$1,800	$0.06
Temperature Controls	$8,894	$0.30
Total	**$110,665**	**$3.73**

Total build-out cost	$3,400,000	$114.68
ECMs as % of total build-out cost	3.25%	

Lease Cycle Cost Analysis

Time Period	Year	ECM Costs/Savings[a]	Cumulative Savings	Present Value
0	2011	($110,665)	–	($110,665)
1	2012	$18,495	$18,495	$17,614
2	2013	$18,775	$37,267	$17,027
3	2014	$19,054	$56,321	$16,460
4	2015	$19,340	$75,661	$15,911
5	2016	$19,630	$95,291	$15,381
6	2017	$19,924	$115,216	$14,868
7	2018	$20,223	$135,439	$14,372
8	2019	$20,527	$155,965	$13,893
9	2020	$20,834	$176,800	$13,430
10	2021	$21,147	$197,947	$12,982
11	2022	$21,464	$219,411	$12,550
12	2023	$21,786	$241,197	$12,131
13	2024	$22,113	$263,310	$11,727
14	2025	$22,445	$285,755	$11,336
15	2026	$22,781	$308,536	$10,958
Total		$197,871	$308,536	$99,976

5.8 YEAR PAYBACK

[a] Assuming annual Pepco rate increase of 1.5%. (Pepco, a subsidiary of Pepco Holdings, Inc., delivers electric service to the Washington Metropolitan area.)

Costs and Savings:

PROJECTED ANNUAL ELECTRICITY COST SAVINGS: 35.9%

LIFE OF LEASE: 15 years

TOTAL ELECTRICITY COST SAVINGS OVER LIFE OF LEASE: $308,536

NET ELECTRICITY COST SAVINGS OVER LIFE OF LEASE: $197,871

NET PRESENT VALUE OF ECMS (5% DISCOUNT RATE): $99,976

RETURN ON INVESTMENT: 90.3%

VIRTUAL COST OF ELECTRICITY USED: $0.125 kWh

(The model applied electricity costs of $0.09/kWh plus a $6.50/kW Demand Charge, resulting in a virtual rate of approximately $0.125/kWh.)

SUMMARY OF HIGH PERFORMANCE MEASURES INSTALLED

- 26.8 percent lower lighting load compared to a typical code-compliant tenant space as a result of: automatically dimming lights when daylight is available; manual dimming switches; open office layout; efficient fixtures; robust reporting and control features.
- Vacancy sensors to turn off overhead lights, task lights, and computer monitors when not in use.
- 94 percent of all seated spaces have a direct line of sight to an exterior window.
- The Heating, Ventilation, and Air Conditioning (HVAC) system has VAV (Variable Air Volume) boxes tied to the Building Management System (BMS), which reduces the energy consumed by the HVAC fans. These are controlled by both temperature sensors and CO_2 sensors helping to achieve an optimum balance between energy use and indoor air quality.
- Ambitious plug load reduction: Power strips with personal sensors control desktop equipment, and 99 percent of all office equipment is Energy Star rated.
- Third-party commissioning agent to ensure building systems are functioning as designed.
- Optimized workspace usage with a reduced number of offices generates significant energy savings per person for a fully occupied office.
- Efficient data center energy use and air flow management that reduces cooling needs.
- Automated BMS (Direct Digital Control Alerton BACtalk system) which monitors and controls building floor units and fan powered VAV boxes. The BMS system has the capacity to deliver information for the tenant space through a separate NRDC interface or tenant management portal specifically for cooling and heating.
- Efficient base building filtration that passed all LEED indoor air quality tests and screening for a broader spectrum of injurious building materials, allowing for a healthier and more productive working environment.

NRDC tracked its overall project costs and identified the incremental cost of the final package of high performance measures, and installed submeters that separately monitor the energy use of lighting, HVAC, data center, and plug loads. We will use the information provided by the detailed submetering (starting November 2012) to calculate the energy savings achieved from the installed high performance measures, and to distill the business case for the project in terms of the actual ROI generated by NRDC's efficiency investment. Our monitoring and verification program will allow a robust cost-benefit analysis of the major categories of high performance measures undertaken, making the process of an efficient fit out transparent, scalable, and replicable for both the NRDC portfolio and the wider community. These results are scheduled for publishing in the last quarter of 2013.

NRDC intends to use the energy model and submeter data to provide a continuous commissioning system. Now that NRDC has moved into its new space, the energy model for the premises will be calibrated for actual weather, occupancy and operating conditions. Once calibrated for actual conditions, the energy model should be very accurate in its projection of energy usage. By comparing the calibrated projections with the submeter data showing actual energy usage, we expect to be able to identify and investigate aberrations in real time to make sure all equipment is operating properly.

CASE STUDY BACKGROUND

This case study is part of a series by NRDC's Center for Market Innovation (CMI) to highlight the compelling business case for high performance build-outs of tenant spaces and energy efficient retrofits of central building systems. By publishing this series of case studies and a companion high performance build-out process guide, CMI intends to provide transparency and a replicable blueprint that will help scale the high performance tenant build-out market. Our goal is to drive tenant demand for cost-effective, efficient spaces, which in turn should drive demand for base building system retrofits. The case studies demonstrate the value that can be achieved through direct energy savings in these spaces.

This case study analyzes a project which had completed design and implementation at the time of documentation, and documents all relevant information that is currently available on the benefits to the tenant from pursuing a high performance build-out. We will measure and document the savings that actually result from the tenant's investment and update the study accordingly.

PROJECT BACKGROUND

Tenant background

The Natural Resources Defense Council (NRDC) is an international nonprofit environmental organization with more than 1.3 million members and online activists. Founded in 1970, NRDC has a staff over more than 350 lawyers, scientists, environmental specialists and other professionals who work to protect the world's natural resources, public health, and the environment.

NRDC has offices in New York City, Washington D.C., Los Angeles, San Francisco, Chicago, Livingston Montana, and Beijing. All NRDC offices are incorporated into Energy Star's Portfolio Manager to enable energy reviews, and the 8th floor of NRDC's New York office scored the highest number of LEED Commercial Interior (version 2) points ever earned on a project. The design of the new D.C. office space furthers NRDC's ongoing mission to drive high performance tenant spaces.

Building owner company background

UBS Global Asset Management, Global Real Estate-U.S. (UBS Global) has over 33 years of real estate investment advisory experience, and the U.S. real estate business of UBS Global has approximately $16.1 billion under management on behalf of over 350 clients. As a multi-disciplined real estate organization with staff of approximately 169, it is headquartered in Hartford, Connecticut with regional offices in San Francisco and Dallas. In addition to its U.S. real estate business, UBS Global manages investments in Europe, Asia and Australia, totaling over $61 billion in real estate and real estate securities worldwide. UBS Realty Investors LLC is one of UBS Global's U.S. operating entities.

UBS Global acknowledges that buildings contribute significantly to CO_2 emissions and is committed to responsible ownership and operation of property for a significant positive impact on the environment. The group delivers superior risk-adjusted investment performance to investors through integrating sustainability and Responsible Property Investment; implements sustainable practices through innovation and the sharing of best practices; and is a responsible property investor, developer and operator that addresses environmental impacts while enhancing property operations and values.

UBS is a founding member and signatory of the United Nations Environment Programme Finance Initiative (1992). It has been certified in accordance with the standards of environmental management ISO 14001 since 1999. UBS is listed in the Carbon Disclosure Project's Carbon Performance Leadership Index for 2010. The company signed the Carbon Disclosure Project's *Principles for Responsible Investment* in 2009, and is a member of the USGBC.

CASE STUDY: NRDC WASHINGTON, D.C. OFFICE BUILD-OUT

BUILD-OUT TEAM
DESIGN ARCHITECT: Gensler

ARCHITECT OF RECORD: Gensler

GENERAL CONTRACTOR: Balfour Beatty Construction

MECHANICAL, ELECTRICAL ENGINEER: GHT Limited

LIGHTING DESIGN: HDLC Lighting

ENVIRONMENTAL CONSULTANT: GHT Limited

LEED CONSULTANT: Gensler

PROJECT MANAGER: Greenebaum & Rose Associates

BUILDING MANAGER: Lincoln Property Company

TENANT BROKER: Jones Lang LaSalle

COMMISSIONING AGENT: BK Commissioning

AV CONSULTANT: CMS Audiovisual

BUILDING INFORMATION
LOCATION: A mid-block building,
1152 15th Street NW, Columbia Center, Washington D.C.

SQUARE FOOTAGE: 423,695 (11 floors)

PRINCIPAL USE: Office (Class A)

TENANT LOCATION
3rd floor

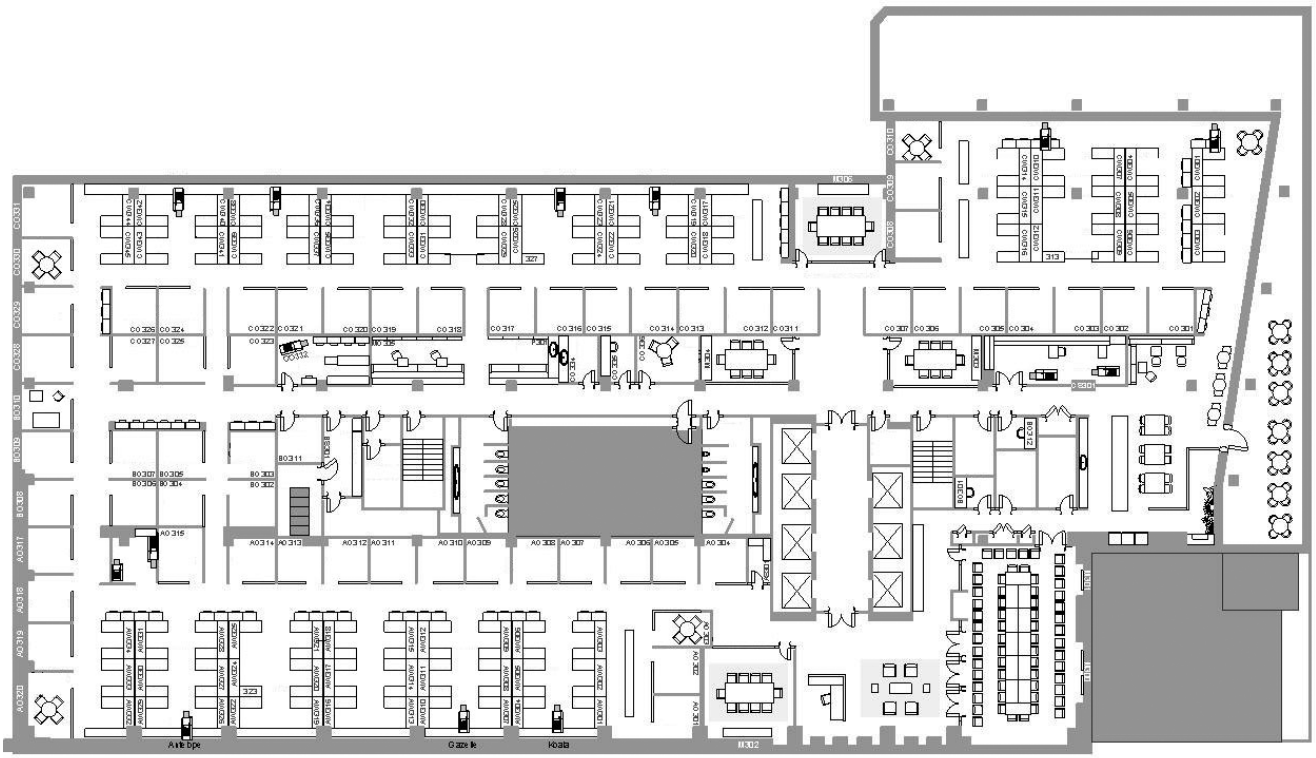
TENANT SQUARE FOOTAGE
NRDC Rentable Square Footage (RSF): 29,647
NRDC Gross Square Footage (GSF): 29,915
NRDC Usable Square Footage: 26,327

TENANT USE
OFFICE SPACE: 10' x 10' interior offices;
7' x 8' open plan workstations

NUMBER OF EMPLOYEES: 115 current (the space was built out to accommodate growth up to 135 people)

START AND COMPLETION DATE OF BUILD-OUT
LEASE SIGNED: 23 July 2010
START OF BUILD-OUT: 14 February 2011
MOVE IN DATE: 4 July 2011

BUILDING CONSTRUCTION TYPE
Completed in 2007. Cast-in-place, post tension concrete (100 lb/sf; 20x40 column spacing; 8'4" floor-to-ceiling; 10'8" slab-to-slab; 12 percent core factor (full floor)).



BASE BUILDING DESCRIPTION, INCLUDING ENERGY EFFICIENCY MEASURES AND PRACTICES

Columbia Center, the office building to which NRDC relocated, was LEED Existing Buildings: Operations and Maintenance (LEED EBOM) Silver certified in 2010, but was not fully occupied at the time. The building owner spent the first year after construction evaluating the building's operating practices and consequently made a number of improvements to create a more sustainable working environment.

HVAC system:

- Heating and cooling in the building is provided by electricity. There is no gas or fuel oil heat.
- The HVAC system has a VAV system, which reduces the energy consumed by the HVAC fans (a substantial part of the total cooling energy requirements of a building).
- The space is served by two self-contained, water-cooled A/C units, sized for approximately 325 s.f. per ton. The two units, as well as the main duct loop and VAV terminals, exist as part of the base building system. Low-profile, parallel, fan-powered VAV terminals with electric heat are installed to serve the perimeter zones. Shutoff-type VAV terminals are installed in the interior zones and core areas. The VAV terminal layout is based on approximately one fan-powered VAV terminal per 450 s.f. of perimeter space and approximately one shut-off type VAV terminal per 1,000 s.f. of interior space.

Building ventilation system:

- Air change effectiveness is greater than or equal to 0.9 as determined by ASHRAE 62.1-2007, for acceptable Indoor Air Quality.
- Fresh air provided to each mechanical room via medium pressure ducted risers and VAV valves at the rate of 20 cubic feet per minute (CFM) per person, or 1 person per 142 s.f.

Building Energy Management System:

- Fully automated Direct Digital Control Alerton BACtalk system which monitors and controls floor units and fan powered VAV boxes. The system did not include lighting control within tenant spaces at the time of move in. The BMS allows remote monitoring (with the ability to make changes) to energy usage, to enable the building manager to shut-down equipment, for example when a particular floor is not in use.
- Building utilizes a program called MACH Energy that sends regular reports on energy consumption, including email alerts when usage rises above a pre-set average based on comparable weather days.
- The BMS has the capacity to deliver information for cooling and heating equipment in the tenant space through a separate interface or tenant management portal. NRDC is currently connecting its equipment to the system interface.
- Compliance with all ASHRAE/ESNA 2004 and 2007 standards as referenced in Washington D.C.'s commercial building code and the LEED CI V3.0 program.
- Encouraged the use of IEQ compliant products and recyclable materials during tenant construction.

Additional base building energy efficiency features:

- Enrollment with Energy Star to track relative building energy consumption
- Use of energy efficient bulbs and ballasts
- Motion sensors in fitness center and other operational areas
- Requirement for automatic shut off on all new lighting
- LEED-CI guidelines for tenant construction provided in the lease
- "Turn out the lights" program that gives incentives to cleaners who ensure lights are off upon completion of night cleaning services

TENANT BUILD-OUT PROJECT SCOPE

Integrated performance

NRDC chose to relocate to a building with:

A. efficient central systems in order to provide an enhanced ROI from reduced common area energy use and the high performance measures installed in the tenant build-out;

B. a high Energy Star rating (88); and

C. access to daylighting.

Although these attributes are not quantified as part of the analysis of this case study, they deliver value.

The building's BMS provides NRDC with an energy management portal that it can plug into and the organization's submetering and energy management initiatives were readily incorporated into base building practices. The large floor plates and large spaces between the columns allow the NRDC floor to be space-efficient and thus fit all employees on one floor.[2]

Energy Savings Target

NRDC's goal was to demonstrate with ongoing monitoring and verification the energy and cost savings achieved by installing high performance measures and maintained through ongoing commissioning. The cost analysis of the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build-out projects an annual electricity cost reduction of 36 percent over the 15-year lease term versus a baseline of the electricity cost in the space if it were built to ASHRAE 90.1-2007 standards. The high performance measures also contributed to a LEED Commercial Interior (version 3) Platinum certification, with 92 points (out of a possible 100 points).

PROJECT DETAILS

Motivation to undertake the build-out

In July 2011, NRDC relocated its Washington, D.C. office space to allow for increased operating efficiency and an increase in staff members. The organization moved from two floors in a Class A building located on New York Avenue to a new one floor location. An efficient layout of the new space increased NRDC's occupancy by 23 percent while adding just 11 percent additional square footage (square footage per occupant decreased by 11 percent). As a result of the energy and space efficiency, the energy consumption in the new space is projected to be less than half of that at the previous office space.

NRDC relocation criteria were aligned with its aims to have a high performing space, which also enabled a LEED Platinum rating. Implementing the highest end of cost-effective efficiency measures was important to the organization so as to lead by example in proving the business case and environmental benefits of energy efficiency and sustainability as well as to reap the benefits of the net savings from this investment. The senior management was extremely supportive of this commitment. The new chosen space was also close to mass transit and offered a wide variety of transportation options; another important selection criterion in line with the comprehensive transportation plan that NRDC has for encouraging use of mass transit, bicycles, and car pooling.

NRDC's Building Selection Process

NRDC occupied its previous leased space for 15 years. To select a new space, NRDC toured 65 buildings in 2009 in the downtown D.C. market. Daylight, views, Energy Star ratings, efficient central systems and space layout, LEED certification and proximity to public transportation were all carefully considered as part of the selection criteria to reduce NRDC's operating costs by saving on occupancy costs and base building energy expense pass-throughs. As Washington, D.C. already has many "green" buildings, NRDC was looking for a building with additional sustainable and energy efficient elements in the base building systems. The chosen building, Columbia Center, allowed for a space layout on one floor, which provides several advantages for energy use and productivity. There was a single move into the completed space, situated in a well designed building that was already undertaking enhanced commissioning. A negative attribute of the space was an uneven distribution of daylight and views, the effects of which would be reduced by implementing high performance lighting measures.

Lease Type and Term

NRDC negotiated its lease so that annual base rent would exclude charges for the electricity used in the leased premises, enabling the organization to sub-meter its electricity use and pay for it directly. NRDC also pays a proportionate share of the base building's monthly common area utility (water, electricity, etc.) costs—lobby, public corridors, restrooms—as factored into the rentable square footage. The initial lease term is 15 years, with two 5-year extension options. Long term occupancy permitted NRDC to extend its payback periods. This structure allows NRDC to benefit directly from the energy and cost savings resulting from the high performance build-out.

HIGH PERFORMANCE BUILD-OUT: BARRIERS AND SOLUTIONS

- *Access to energy savings:* The future monetary savings from efficiency improvements were not accessible to NRDC under the standard lease structure, which would have included an Electric Rent Inclusion clause. Under this standard structure, future electricity savings from improvements made by NRDC would have been passed to the owner and not to NRDC. To overcome this potential barrier, NRDC worked with UBS Realty Investors to modify the lease to provide that NRDC's office space would be submetered and its energy use paid for directly by NRDC.
- *Justifying additional initial cost:* The high performance design had a higher initial cost. This potential barrier was overcome by considering the cost savings that would accrue from reduced energy use over the life of the lease. It was projected that the energy savings from the high performance measures[2] would repay the up-front investment in less than 6 years. The lease cycle cost analysis showed an annual electricity cost reduction of 36 percent.
- *Assembling a skilled team:* Implementing new and higher performing measures required a skilled workforce, both in terms of finding and hiring the right architect and engineering firms, and training NRDC staff to operate the new technologies. While the staffing and training required an initial time investment, it will serve the organization in the long run by equipping its staff with the ability to analyze, install, operate, and manage for a high performance environment. This knowledge will be extended to all current and future office spaces.
- *Quantifying intangible benefits:* Some of the benefits of the high performance measures were hard to quantify and attribute to specific measures, such as better working conditions[3] and attraction and retention of talent,[4] which can be supported by better indoor air quality, better lighting, access to views, and better comfort. NRDC was able to justify the incremental cost of the high performance measures based solely on the projected tangible savings from decreased energy usage, and reap the additional benefits of employee retention and productivity gains above and beyond that.

Decision-Making Process for Selecting Appropriate and Cost Effective High Performance Measures

A meeting among the key design participants—a "charrette"—was held to ensure the team was well coordinated from the beginning on the design goals while optimizing financial resources, natural resources, and time. The charrette included key members from the tenant, architecture, space planning and engineering teams. Two particular features that added value are:

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- The engineers (who did the energy modeling evaluations) were brought into the team at the start, rather than after the construction drawings were completed by architects.
- The general contractor was brought on board at the start. This was particularly important for NRDC to compare floor design options according to costs as the general contractor has the most realistic knowledge of project market costs.

The core programmatic process of the client/architect team was a collaborative series of work sessions. The sessions ranged from a self-critical analysis of NRDC's existing facilities and operational procedures, to visioning sessions that identified emerging environmental issues that would impart mission-specific relevance to NRDC's approach to facilities design. The project team started meetings in October 2010 and was given two months to determine how high performance measures should be incorporated into the project design. The results of the work sessions were expressed in the list of top design values, delivering qualitative and quantitative attributes:

- Maximize the availability of day lighting and preserve outside views for everyone
- Maximize energy efficiency, individual controls and the ability to monitor energy use
- Have high quality commissioning to make sure the building systems are functioning properly and as designed
- Ensure overall quality of the indoor environment (air quality, construction practices, temperature, visual acuity, acoustics, controls)
- Optimize office space by greatly reducing the number of offices and generating significant energy savings per person
- Have a comprehensive transportation plan (metro, bike, bus, car pooling); and
- Track overall costs and share cost-effective green strategies, systems and materials to help others seeking high performance build outs on a budget.

FINANCING MECHANISMS

The NRDC floor fit-out was entirely self financed and did not make use of external financing products.

PERFORMANCE MEASURES INSTALLED

Daylight-based lighting scheme

By leasing the entire floor, NRDC has access to daylight from all directions up to 15 feet into the office from the window line. The design team took maximum advantage of the ample daylight opportunities and the overall lighting power density is 0.75 watts per s.f, a 26.8 percent reduction from the ASHRAE 2007 code allowance. This metric includes overhead lighting and all task lighting. In practice the consumption will probably be less than the allotted connected load at all locations due to the robust control methodology (e.g., occupancy sensors) employed. The daylighting scheme includes:

- Lutron Ecosystem lighting with control features, dimming switches, and robust reporting, allowing NRDC facilities management to calibrate the system when required.
- Closed offices placed against the core to preserve views and maximize the availability of daylight for most occupants. 94 percent of seated spaces have a direct line of sight to an exterior window.
- Aggressive system of occupancy sensors in the common space on a fine increment of square footage; sensors are approximately 15 feet apart in this dense array.
- Open workstation strategy:

  Overhead direct lighting: Single lamp fluorescent recessed fixtures illuminate the areas of the desktop that the task light can not affect. This is controlled by occupancy sensors and/or daylight dimming.

  Task lighting: LED task lights provide lighting at the task surfaces below the workstation storage units, which reside in shadow from the overhead lighting. The task lights are controlled by occupancy sensors.

  Ambient indirect lighting: Single lamp fluorescent lighting on top of the workstation storage units which supplements the direct lighting. This lighting also illuminates the general circulation path as the office has no lighting in corridors contiguous to open workstations. Indirect lighting enhances the user experience and is considered a preferred light quality from an ergonomic standpoint. It is coupled with direct task lighting for efficiency. Indirect lighting is daylight-dimmed and provides constant light to the workspace in the event that occupancy sensors turn off the lighting in other areas.
- Interior enclosed office strategy:

  Overhead direct lighting: as in the open workstation area mentioned previously.

  Tasklighting: as in the open workstation area mentioned previously.

  Wallwashing: A direct low-output fluorescent cove light is used to provide light along the rear task areas. Reflecting light off the rear wall produces a sense of light that emulates the effect of the naturally daylit window wall of the perimeter enclosed offices. This light is controlled via occupancy sensors.

  Perimeter enclosed office strategy emulates the interior enclosed offices with the exception of the wallwashing component as there is no natural daylight component. Occupancy sensors are installed.

For details on the lighting power density in different areas of the NRDC floor, see appendix.

Indoor Environmental Quality measures

- Materials were selected to emit very few volatile organic compounds (VOCs) into the air.
- Construction practices were careful to control dust and airborne contaminants.
- The project passed all LEED indoor air quality tests.
- Sustainable furniture selection process focused on Greenguard certification which regulates and limits the amount of airborne toxins emitted from new furniture.
- MERV 13 filters provide high quality filtered air throughout the office, delivered at a maximum of 26 CFM per person. A MERV 13 filter moves the HVAC filtration system into the realm of controlling respirable-size particles, including most bacteria. Its higher efficiency also reduces airborne mold spores.
- Increased ventilation (outside air) to the space exceeding code-required ventilation by 30 percent improves indoor air quality.
- Reducing the number of private offices offers IEQ values and productivity gains. Small, enclosed air pockets of rooms are more vulnerable to a spill or error in paint selection over a weekend. Also, the space has a lot of diffusing common light and air.

HVAC measures:

- VAV boxes are tied to the BMS and controlled by both temperature sensors and CO_2 sensors, helping to achieve an optimum balance between energy use and indoor air quality.
- Each VAV terminal is controlled by its own thermostat.
- CO_2 sensors control VAV terminals: when the space CO_2 level rises above its setpoint, the VAV terminal modulates to supply the space with more fresh air. The overall rate of outdoor air being supplied to the space is also monitored by the BMS. If the outdoor air flow rate drops below 90 percent of its minimum setpoint, an alarm is generated at the BMS so corrective action can be taken. The system is designed to limit the space CO_2 level to 930 parts per million (ppm), or 530 ppm above the outdoor air CO_2 level. ASHRAE standards for CO_2 levels inside buildings are 1,000 ppm, approximately 600 ppm above the outdoor air CO_2 level.
- The data center design for configuration and ductwork is industry best practice—a cold aisle/hot aisle configuration—that provides optimum energy savings and is set to maintain 73°F in the space. It is supplied by two water-cooled A/C units with capacity modulation, high-efficiency fan motors, and dehumidification control. The design uses air conditioners, fans, and a coordinated duct configuration as cooling infrastructure and focuses on separating the cold supply airstream (on the inlet side of the data center equipment) from the warm exhaust airstream (on the outlet side of the equipment). This layout increases system efficiency by minimizing the amount of warm exhaust air that gets short-circuited to the inlet of the data center equipment.
- The data center cooling system layout and air flow management reduced the previous 5-ton A/C units to 3-ton, high-efficiency units with energy efficiency ratios (EER) of 14.7. This allows for optimum capacity turndown and low energy usage during part load conditions while having spare capacity for future growth.
- The temperature set points are set to 75-77°F.

Other operational practices

- Ambitious plug load reduction: To reduce power usage, 99 percent of all office equipment is Energy Star rated.
- Miscellaneous kitchen equipment, printers and scanners were eliminated as part of the move. Instead, employees share printers and scanners and hoteling stations.[5]
- Enhanced commissioning agent commissioned all high performance features and will periodically check to ensure the building systems are functioning properly and as designed.
- The number of offices was greatly reduced relative to NRDC's prior leased space, and workspaces in the new office have a higher density to generate significant energy savings per person. Large spacing in between building columns allow for more open space features and a more open office perimeter that is expected to improve airflow to reduce cold-spots or hot-spots.

All these measures aggregate to make the NRDC space 30 percent more energy efficient than the code established baseline.

MONITORING & VERIFICATION PROTOCOLS

Details of Sub Metering

The base building Alerton BACtalk BMS system, installed and maintained by Advanced Power Controls, allows remote monitoring and adjustment of all base building mechanical systems.

For the NRDC space, 12 subpanels are submetered to independently measure the HVAC load (the general floor, multi-purpose conference room, and data center); lighting (North, South, East, and West zones); water heaters; and plug loads. Through these submeters NRDC is keeping continuous track of its indoor working environment and energy use.

The cost of the submeters installed has not been included in the total incremental cost of $110,665 because resulting energy savings are behavioral in nature, and unpredictable (therefore, no resulting savings were included in any projections or calculations). NRDC decided to make the additional investment in the submeters ($37,800), as it recognizes the potential for substantial savings that should be achievable from ongoing commissioning and segregated monitoring of energy use. There are also additional savings from the avoided costs in energy audits and consulting fees. These costs and savings will be included in the update to this case study that will report on the project's actual energy results, which we expect to publish in the last quarter of 2013.

Details of Selection Process for Sustainability Management Software

In order to pick NRDC's Sustainability Management Software, an RFP was put out to solicit the firm that could best meet NRDC's comprehensive sustainability goals. The main environmental performance categories that NRDC wants measured are energy consumption, greenhouse gas emissions, water consumption, waste generation, and material intensity. Over 30 software packages were considered which could best satisfy the organization's Sustainability Management Priorities of:

- *Energy:* Real-time monitoring, tie-in with demand response systems, weather normalization.
- *Water:* Detailed consumption capture, storm water capture rates, green/living roof monitoring.
- *Metrics:* Aggregated building performance, reports, measurements at every level from the entire portfolio of NRDC's buildings to the lowest level of submetering, configurable dashboard views for various internal

stakeholders as well as the public; seamless integration with Energy Star's Portfolio Manager, import of baseline environmental performance data, all data to belong to NRDC which can be downloaded or transferred at any time, data normalization based on square footage and number of occupants.

- *Engaging Staff:* Custom views, competitions, extensive training and support (in person, webinars, video tutorials, forums, email and phone tech support), integration with multiple social media platforms, solutions for staff engagement.

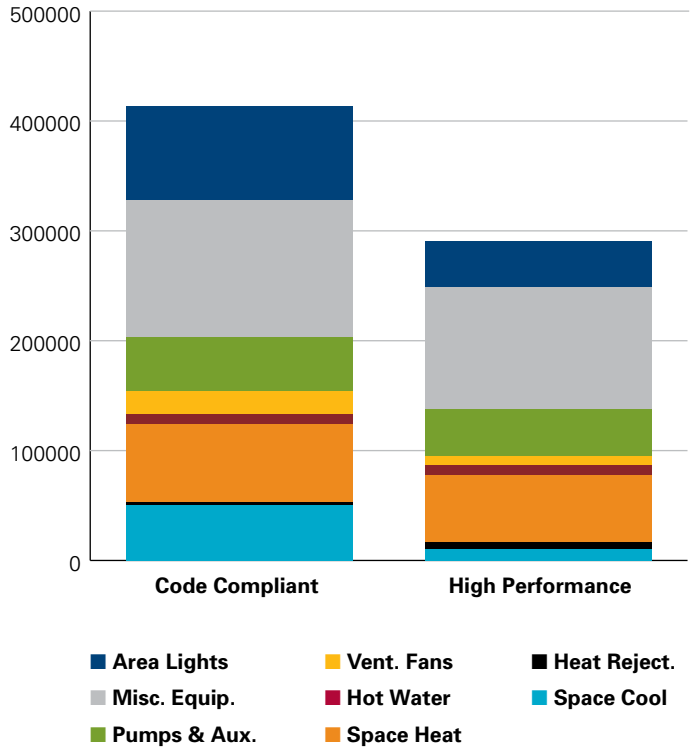
The RFQ process was analyzed by a consulting firm that recommended 2 sustainability management firms. The fit of both firms was compared, with attention to the benefits, drawbacks, and pricing (hardware, software, configuration, testing, and project closeout costs) of both. NRDC chose Closed Loop Advisors to work with for its sustainability management.

ENERGY PERFORMANCE PROJECT RESULTS

Baseline Energy Use

The baseline electricity use of the office space was determined by modeling the mandatory and prescriptive requirements for ASHRAE Standard 90.1-2007 (minimum code for D.C.) using eQuest v3.64.

Figure 3: Modeled Electricity Consumption (kWh) for the NRDC Washington, D.C. office



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NRDC's project team is tracking electricity consumption and costs since its move in on July 5, 2011 and this study will be updated with actual results as the information is available.

Over the course of its 15-year lease term, NRDC projects that the installed package of performance measures will deliver net cash flow (cumulative energy savings minus initial incremental cost) of $197,871. That net cash flow translates to a Net Present Value (NPV) of just under $100,000 (using a 5% discount rate), yielding a Return on Investment (ROI) of 90.3% on the up-front incremental cost of the measures.

Demand Charges

Many utilities charge their larger customers for both kilowatt-hours (kWh) used and the "peak" kilowatt (kW) demand based on the highest use hour of the month. The peak demand charge reflects the higher cost to meet the maximum customer demand at peak times, and can be a significant portion of a building's energy bill.[6]

Reducing energy consumption during times of peak demand increases cost savings. The high performance measures in the new D.C. office space reduced energy consumption by 29.6 percent and costs by 35.9 percent due to lower peak demand. The new space was modeled assuming electrical costs of $0.09/kWh and demand charges of $6.50/kW.

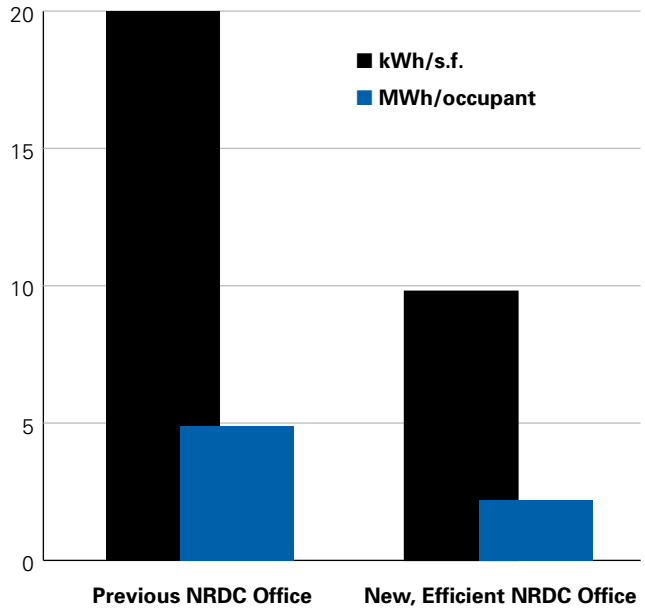
ENERGY USE IN PREVIOUS SPACE

NRDC's previous office space did not allow for a separate metering of office energy use. Instead, NRDC paid a pro-rata share of the whole building's energy use. This was one of the drawbacks of the organization's previous space, and the inability to monitor and track energy use was an obstacle to operation efficiency.

NRDC's previous office presented obstacles to energy efficient operations as it lacked the ability to segregate and monitor energy usage. In their new space, NRDC paid particular attention to ensure that the new office could separately meter its energy use and installed 12 submeters to break down energy use. Additionally, NRDC implemented a detailed M&V plan to accumulate the additional savings from tracking and monitoring real time energy use.

The new space increased NRDC's occupancy by 23 percent while adding just 11 percent additional square footage (square footage per occupant decreased by 11 percent). The new office is designed to accommodate 135 persons in about 30,000 s.f. (220 s.f. per occupant), compared with the previous space of about 27,000 s.f. designed for 110 employees (or 245 s.f. per occupant). As a result of the energy and space efficiency, the energy consumption in the new space is projected to be less than half of that at the previous office space.

Figure 4: Energy Consumption Comparison: Previous NRDC Office vs. New, Efficient NRDC Office



PROJECT OUTCOMES

15-yr Energy Reduction (kWh)	1,834,500
15-yr Electricity Cost Savings	$308,536
Net Present Value of ECMs	$99,976
Return on Investment	90.3%
ECM Payback	5.8 years

AWARDS ACHIEVED

LEED Platinum-CI (V 3.0)

LESSONS LEARNED

NRDC's Washington, D.C. office renovation demonstrates key ways to integrate energy efficiency and IEQ into a tenant office space build-out and realize energy savings in the process. We believe other tenants and building owners could realize similar benefits by considering the lessons learned in this case study, specifically:

1.Include efficiency goals from the beginning of the process

Design choices like bringing in an MEP engineer and environmental consultant at the project start (instead of after the construction drawings are complete), with an upfront statement of the high performance goals, played a critical role in helping to identify measures that will deliver value while minimizing first costs. Additionally, the general contractor could give more accurate estimates of the real project costs vs. cost of building to code by being on board at the beginning. NRDC brought in a LEED Project Manager at the time of lease negation to help optimize energy use, understanding, and savings calculations.

2. Incorporate Modeling

NRDC evaluated the costs and benefits of each potential energy efficiency measure. The higher upfront cost of high performance measures was analyzed over the life of the lease, and compared against the offset annual energy savings projected to be generated by these measures. NRDC also included energy modeling as part of the build-out process to have a rigorous understanding of the energy use. It is necessary to include the resources/incentives for efficiency before entering the construction phase as once the budget for a project is set it is difficult to change it.

3. Green lease negotiations

Lease terms have a significant influence on the energy choices of tenants and building owners. Many leases do not incentivize high performance build-outs as the base monthly rents include a standard electricity charge for the tenant's premises. NRDC negotiated its lease to provide for an annual base rent excluding charges for the electricity used in the leased premises, which would be sub-metered and paid directly by the tenant. This allowed NRDC to benefit directly from the energy cost savings that its efficient build-out produced and thus incentivized the high performance measures described. It is effective to undertake all negotiations regarding efficiency with the building owner at the time of lease signing itself (for e.g., water efficient restroom fixtures, modifications and upgrades to the existing HVAC system) as once a lease is signed it is difficult to get these at low or no cost from the owner.

4. Commitment at the top

The NRDC Board has expressed a commitment to sustainability, and this helped to shape the project's goals. Having top level buy-in to the efficiency and cost savings goals was critical to the success of the project.

5. Leading by example

NRDC's project serves as a model for other prospective tenants. It demonstrates the possibilities for interior build-out projects, and in working with other tenants to create high performance spaces that maximize strategies such as daylighting and automated lighting controls.

6. Performance Tracking

NRDC is tracking overall project costs, and the results of detailed submetering in the years following the fit-out, will provide a detailed analysis of the business case of the project. The value of continuously monitoring energy use through the submetering results is a robust cost-benefit analysis of each ECM and IEQ measure undertaken, making the process of an efficient fit-out transparent, scalable, and replicable. It also allows tenants to identify if any areas are underperforming, which can thus be fixed to reap the corresponding energy savings.

APPENDIX

Lighting Power Density Details:

These various lighting ECMs result in a system highly responsive to available daylight, occupancy patterns, with local and manual controls.

The average lighting power density of the aggregate office space is 0.75 W / s.f., and for specific areas is:

- Work stations: 0.68 W / s.f.
- Private offices: 0.8 W / s.f.
- Conference rooms: 0.77 W / s.f. (30 to 40 occupancy sensors)
- Storage Areas: 0.64 W / s.f.

Projected 17% Energy Reduction from Energy Star Equipment						
Equipment Type	General Information				Total Wattage	
	Manufacturer	Model	Count	Energy Star	Actual	Allowance
COMPUTERS						
Desktop Computer	Dell	Optiplex SX270	1	Yes	150	120
	Dell	Optiplex SX280	3	Yes	480	360
	Dell	Optiplex GX240	3	Yes	750	360
	Dell	Optiplex GX620	1	Yes	305	120
	Dell	Precision 650	1	Yes	460	120
	HP Compaq	rp5700	35	Yes	2,202	4,200
	HP Compaq	dc7600	3	Yes	216	360
	HP Compaq	dc7700	17	Yes	1,683	2,040
	HP Compaq	dc7800	1	Yes	63	120
	HP Compaq	dx9000 all-in-one	1	Yes	28	120
	Mac Pro	Quad-Core	1	Yes	139	120
Notebook Computer	Toshiba	R200	6	Yes	270	270
	Toshiba	R600	2	Yes	14	90
	HP	2510p	7	Yes	88	315
	HP	2530p	32	Yes	448	1,440
	HP	2540p	4	Yes	44	180
	HP Compaq	nc2400	1	Yes	19	45
	HP Compaq	nc6400	2	Yes	44	90
	HP	6820s	1	Yes	19	45
	HP	8530w	1	Yes	15	45
Display (LCD) 15"	Dell	E151FP	2	Yes	50	90
	Mitsubishi	V50LCD	2	Yes	44	90
	Sony	SDM-X53	2	Yes	36	90

Projected 17% Energy Reduction from Energy Star Equipment						
Equipment Type	General Information				Total Wattage	
	Manufacturer	Model	Count	Energy Star	Actual	Allowance
Display (LCD) 17"	Viewsonic	VA712B	2	Yes	84	150
	HP	1702	1	Yes	29	75
Display (LCD) 19"	Acer	AL 1916W	2	Yes	100	180
	HP	HP L1906	31	Yes	1,023	2,790
	HP	HP L1910	21	Yes	651	1,890
	HP	HP LE1901WM	12	Yes	240	1,080
	HP	HP LA1951G	10	Yes	210	900
	Planar	PL1910M	25	Yes	1,375	2,250
Display (LCD) 20"	Planar	PE2010	1	Yes	41	120
Display (LCD) 22"	HP	LA2205WG	3	Yes	75	360
OFFICE EQUIPMENT						
Office Laser Printer	HP	LaserJet 2430	10	Yes	110	1,200
Office Plotter	HP	DesignJet 1055CM	1	Yes	45	250
Office Copier/Printer	Xerox	WC5775	1	Yes	320	750
Office Copier/Printer	Xerox	4112	1	Yes	320	750
Office Copier/Printer	Xerox	ColorQube	1	Yes	360	750
Office Copier/Printer	Xerox	ColorQube	1	Yes	360	750
Fax Machine	Xerox	Fax Centre F116	1	Yes	45	45
Scanner	HP	Scanjet 5470c	1	Yes	9	45
Mailing Machines	Hasler	WJS70	1	Not Required	120	120
Postage Machine Printer	Hasler	WJ 150	1	Not Required	19	19
PANTRY EQUIPMENT						
Refrigerator	GE Profile	PDCS1NCZRSS	3	Yes	5,400	3,000
	Sub-Zero	UC-24CI/SS	2	Yes	3,450	1,500
Dishwasher	GE	GLDT696TSS	3	Yes	3,276	3,600
Microwave	GE Profile	PEB2060SMSS	3	Not Required	4,950	4,950
Ice Maker	Hoshizaki	AM-50AE(-AD)	1	Yes	1,725	1,725
Coffee Maker	BUNN	33200	3	Not Required	4,500	4,725
Water Coolers	Quench	720UV	2	Yes	1,100	1,320
AV SYSTEMS						
55" LCD Display	Samsung	550EX	4	Yes	680	680
70" LCD Display	NEC	P701	3	No	1,800	1,800
Video Projector	NEC	NP4100W	1	No	375	375
DM Matrix Switcher	Crestron	DM 8x8 & 16x16	3	No	900	900
Video Conference Codec	Tandberg	C60	3	No	525	525
Integrated Audio Conference System	Biamp	Audia Flex	4	No	600	600
Blu Ray DVD Player	Sony	BDP-470S	3	No	18	66
TOTAL					**42,400**	**51,070**

Endnotes

1 Energy modeling performed using DOE-2 software eQUEST. The baseline consumption and cost information was obtained by modeling the entire building according to ASHRAE 90.1 2007 code compliance. The proposed energy consumption and electricity cost information was obtained by modeling the entire building according to the high performance measures that were implemented on NRDC's floor.

2 Not including the LEED Certification soft costs or submetering costs.

3 In 'The cost and financial benefits of green buildings, a report to California's sustainable building task force' (2003), http://www.usgbc.org/Docs/News/News477.pdf, it is shown that the additional initial cost of a green building - in the range of $3-5 per square foot is more than compensated by the respective NPVs over 20 years of energy savings ($5.8 per square foot), emission savings ($1.2), operating and maintenance savings ($8.5) and productivity and health benefits (which at $36.9 to $55.3 are by far the largest). An important example is that outside views help with high performance lighting and there is evidence to suggest more natural light can increase productivity and reduce sick days, possibly by accommodating people's natural circadian rhythms.

4 From the 2008 Skanska Annual report: 'Being a green builder […] has a positive effect on recruiting and human resource development. Employees are proud of green projects and of being able to contribute to an enhanced environment on our planet'; http://www.skanska.com/upload/Investors/Reports/2008/Annual_report/skanska_annual_report_2008.pdf.

5 This term "hoteling" refers to private phone rooms, team rooms and conference spaces that can be used by employees who otherwise sit in the open floor plan.

6 Peak demand is typically driven by air conditioners running on hot summer afternoons.