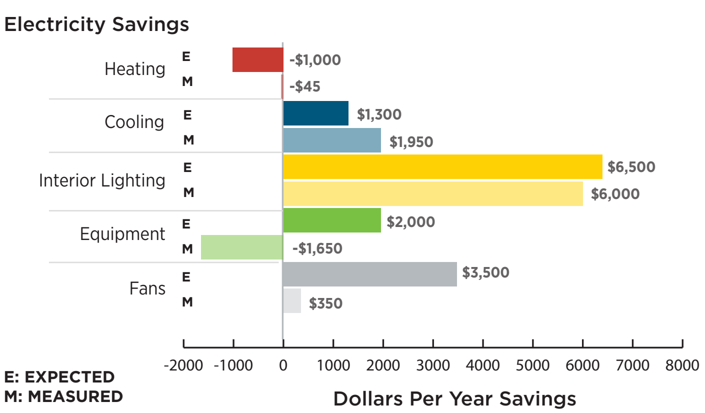
# A Downtown Denver Law Firm Leverages Tenant Improvement Funds To Reduce Energy Consumption

Bryan Cave LLP (formerly Holme Roberts & Owen LLP, headquartered in Denver, Colorado), is an international law firm. It partered with the U.S Department of Energy (DOE) to develop and implement solutions to retrofit existing buildings to reduce annual energy consumption by at least 30% versus pre-retrofit energy use as part of DOE's Commercial Building Partnership (CBP) program.[1] The National Renewable Energy Laboratory (NREL) provided technical expertise. MPG Office Trust (the landlord), Fitzmartin Consulting, and Xcel Energy also collaborated on the project.

Bryan Cave LLP leases more than 100,000 ft$^2$ of office space on five floors in the 52-story Wells Fargo Center, an iconic downtown landmark designed by Philip Johnson and John Burgee, built in 1983. Energy improvements were made to all of the company's floors as part of the lease renewal/office-updating program; this case study presents results for the 42nd floor, which include reception, conferencing, and office areas. By making energy-smart choices in its owner-funded tenant improvement (TI) work, Bryan Cave LLP was able to achieve the desired look and feel for its offices and significantly reduce energy use, all with no direct out-of-pocket expenditures.

Utility bills were not available for the project (utilities in the all-electric building are charged per square foot). Expected and measured cost reductions by end use are shown in the graph below. Measurements from an onsite submetering system showed annual savings of 19% versus pre-retrofit use from May 2012 through April 2013, falling below the project goal because plug loads were higher than expected and fan energy savings lower than expected. Excluding plug loads, savings were 31% versus pre-retrofit. Savings was also benchmarked against the requirements of ASHRAE/ANSI/IESNA Energy Standard 90.1-2004.[2]

## Expected and Measured Energy Cost Reductions




The Bryan Cave LLP office incorporates energy efficiency in a modern design. *Photo by Dennis Schroeder, NREL 19275*

| | |
|---|---|
| Project Type | Office building, retrofit |
| Climate Zone | ASHRAE Zone 5B, cool and dry |
| Owner or Tenant | Tenant |
| Barrier Addressed | Tenant/owner split incentive |
| Square Footage | 24,510 ft$^2$ |
| Measured Energy Savings (Versus Pre-Retrofit) | 19%<br>74,000 kilowatt-hours (kWh)/yr of electricity |
| Cost Reductions (Versus Pre-Retrofit)[3] | $7,000/yr |
| Simple Payback Period | 3.5 yrs |
| Expected Carbon Dioxide Emissions Avoided[4] | 50 metric tons/yr |
| Construction Completion | October 2010 |

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

[2] ASHRAE 90.1: https://www.ashrae.org/resources--publications/bookstore/standard-90-1-document-history#2004

[3] Using $0.09/kWh provided by Bryan Cave LLP

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

## Decision Criteria

The decision by Bryan Cave LLP and the building owner, MPG Office Trust, to pursue dramatic energy savings and the choice of strategies by Bryan Cave LLP reflected economic and noneconomic considerations.

### Economic

Bryan Cave LLP did not have hard and fast criteria to screen energy efficiency measures (EEMs). Rather, it had a budget in mind, ranked candidate EEMs by their estimated return on investment, and selected EEMs from the list until the project budget was reached. Bryan Cave LLP did not receive a utility discount from the building owner for reduced consumption.

Investments in energy efficiency in office space can pay back quickly with large long-run cost savings. Even without considering tax benefits, the project presented here was expected to pay back within 3 years when utility rebates were accounted for.

### Branding

The decision-making process was also driven by considerations such as Bryan Cave LLP's desire to attract top clients and talent by openly demonstrating its commitment to sustainability.

### Operational

Bryan Cave LLP's client confidentiality is extremely important, so attorneys' office walls are built from deck to deck. Such walls are expensive to move and may preclude certain EEMs. Although using exterior window glass with a lighter tint could improve the opportunity to use daylighting, it was not an option because the uniformity of the building exterior had to be preserved.

### Policy

National policy issues that impact energy efficiency choices include tax policy that incentivizes efficiency investments such as the EPAct 179D federal energy tax deduction[5] and model building energy codes and standards, which provide a starting point for thinking about energy efficiency.

## Energy Efficiency Measures

Bryan Cave LLP decided to implement the EEMs shown in the table on page 3. The EEMs should be applicable in all climate types. The nighttime lighting loads were reduced as a result of the vacancy sensors, which are similar to occupancy sensors except that they are manual on/automatic off. The plug loads will be reduced as the company replaces computing equipment over time with more energy-efficient items as part of its normal equipment replacement activity. The total cost of the EEMs was equivalent to $1.62/ft$^2$ after accounting for utility rebates.

Several EEMs, such as using lighter tinted window glass to improve access to daylight were considered but not implemented because of architectural limitations such as the need to preserve the uniformity of the building exterior; their impact was not modeled.

"Cost of conserved energy" (CCE, the cost of an efficiency upgrade divided by its discounted kilowatt-hour or therm savings[6]), is included in the business case information. CCE can be compared to the utility rate for electricity to assess whether it is cheaper over the long term to buy energy or to save that energy by retrofitting. The CCE of some measures exceeds the utility rate, but the whole project cost is only $0.07/kWh saved over 5 years. Net present value and CEE in the EEM table were calculated using a 5-year analysis period and 3% nominal discount rate.

Vacancy sensors turn the lights off when a room is unoccupied, helping to reduce daytime and nighttime energy use. These sensors differ from occupancy sensors in that vacancy sensors must be switched on manually, eliminating the problem of lights being switched on unnecessarily, for example where there is sufficient daylight to perform a certain task. Bryan Cave LLP chose to install vacancy sensors on all floors of its Denver headquarters.
*Photo by Dennis Schroeder, NREL 19322*

5 DOE 179D Calculator: http://apps1.eere.energy.gov/buildings/commercial/179d/

6 Meier, A.K. 1984. "The Cost of Conserved Energy as an Investment Statistic." ESL-IE-84-04-109, Lawrence Berkeley Laboratory. Available at http://repository.tamu.edu/bitstream/handle/1969.1/94751/ESL-IE-84-04-109.pdf?sequence=1

| Energy Efficiency Measure | Implemented in This Project | Owner Will Consider for Future Projects | Expected Annual Savings | | Expected Improvement Cost | Net Present Value | Cost of Conserved Energy | Simple Payback |
|---|---|---|---|---|---|---|---|---|
| | | | kWh/yr | $/yr | $ | $ | $/kWh | yr |
| **HVAC: 12% Whole-Project Energy Savings Expected Versus Pre-Retrofit** | | | | | | | | |
| Add variable frequency drives to air handling unit fans. | Yes | Yes | 34,000 | $3,200 | $19,800 | $136,200 | $0.13 | 6.2 |
| Upgrade thermostats and add 3°F to dead band. | Yes | Yes | 11,000 | $1,000 | $4,700 | $44,200 | $0.10 | 4.7 |
| **Lighting: 22% Whole-Project Energy Savings Expected Versus Pre-Retrofit** | | | | | | | | |
| Balance corridor lighting by reducing lighting power density. | Yes | Yes | 18,000 | $1,700 | $4,500 | $79,900 | $0.05 | 2.6 |
| Upgrade downlight lamps. | Yes | Yes | 25,000 | $2,400 | $3,300 | $111,600 | $0.03 | 1.4 |
| Install vacancy sensors. | Yes | Yes | 24,000 | $2,300 | $10,000 | $100,100 | $0.09 | 4.3 |
| Reduce night light and plug loads. | Yes | Yes | 17,000 | $1,600 | $0 | $76,300 | $0.00 | 0 |
| **Subtotals** | | | **129,000** | **$12,200** | **$42,300** | **$548,300** | **$0.07** | **3.5** |

## Energy Use Intensities by End Use

Energy modeling was an integral part of the design process for the Bryan Cave LLP retrofit project, enabling the design team to assess whether the EEMs selected for the retrofit could achieve the project's energy savings target. Modeled energy cost reductions were also used by Bryan Cave LLP to screen EEMs based on their economic returns. To calculate whole-building energy savings, three energy models were created, as described below.

The graph at the bottom of this page shows a comparison of the end use energy consumption breakdown of the three models and measured energy use using annual energy consumption divided by floor area, also known as energy use intensity (EUI). Tables of energy consumption and energy savings by end use are shown on page 5.

### Code Baseline

The first energy model represented minimal compliance with the requirements of ASHRAE 90.1-2004 for the building envelope properties, installed lighting power, and heating, ventilating, and air-conditioning (HVAC) equipment efficiency, and ASHRAE 62.1-2004 for ventilation for Denver, Colorado. The code baseline model had an EUI of 48 kBtu/ft$^2$.

### Pre-Retrofit

The second model represented the Bryan Cave LLP space as it existed before the retrofit work. The space was served by a constant volume dual-deck distribution system with electric reheat coils in individual zone ducts. Cooling was handled by electric water chillers in a central plant. The pre-retrofit model used 53 kBtu/ft$^2$, which was higher than the code baseline because the building construction predated ASHRAE 90.1-2004.

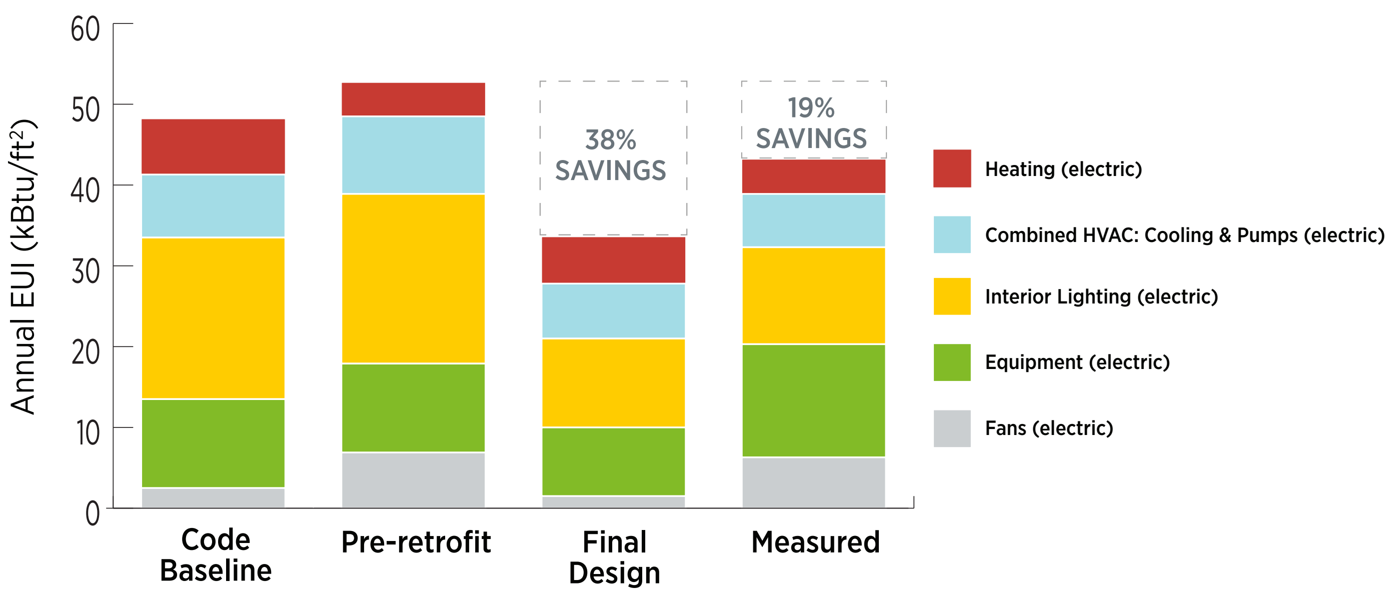
### Final Design

The final model incorporated the EEMs used in the retrofit project. This model had an annual EUI of 33 kBtu/ft$^2$, corresponding to a savings of 38% versus pre-retrofit energy use, due mainly to the retrofit of variable-speed fan drives to the air handling units and lighting power reduction.

### Measured Energy Use

From May 2012 through April 2013 measured energy use was 43 kBtu/ft$^2$, 19% below pre-retrofit levels. However much of the discrepancy between measured and expected savings was due to increased plug loads following the retrofit where they were expected to fall slowly over time as equipment was replaced with more efficient options. When considering only loads regulated by energy code, savings were 31% versus pre-retrofit. At the same time, energy savings from the variable speed fan drives fell below expectations.

### Comparing EUI of Energy Models and Measured Energy Use

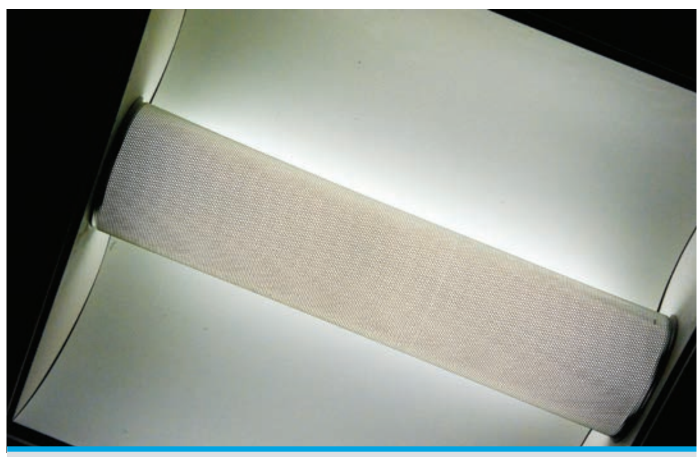


## Annual Energy Use and Percentage Savings by End Use

| | Code Baseline | Pre-Retrofit | Final Design | | Measured | |
|---|---|---|---|---|---|---|
| **End Use Category** | Annual EUI ($kBtu/ft^2$) | Annual EUI ($kBtu/ft^2$) | Annual EUI ($kBtu/ft^2$) | Percent Savings versus Pre-Retrofit | Annual EUI ($kBtu/ft^2$) | Percent Savings versus Pre-Retrofit |
| Heating (electric) | 6.9 | 4.2 | 5.8 | -38 | 4.3 | -2 |
| Combined HVAC: Cooling and Pumps (electric) | 7.8 | 9.6 | 6.8 | 29 | 6.6 | 31 |
| Interior Lighting (electric) | 20 | 21 | 11 | 48 | 12 | 44 |
| Equipment (electric) | 11 | 11 | 8.5 | 23 | 14 | -22 |
| Fans (electric) | 2.5 | 6.9 | 1.5 | 78 | 6.3 | 8 |
| **Total** | **48** | **53** | **33** | **38** | **43** | **19** |

## Energy Savings From Implemented EEMs Versus Pre-Retrofit Use by End Use

| Electricity End Use Category | Expected Savings (kWh/yr) | Measured Savings (kWh/yr) |
|---|---|---|
| Heating | -11,000 | -500 |
| Cooling + Pumps | 14,000 | 21,500 |
| Interior Lighting | 69,000 | 67,500 |
| Equipment | 21,000 | -18,500 |
| Fans | 37,000 | 4,000 |
| **Electricity Total** | **130,000** | **74,000** |



Balancing corridor lighting with workspace lighting is a key aspect of a well-executed lighting design. In the case of Bryan Cave LLP's offices, the corridors were overlit compared to surrounding areas. NREL worked with Bryan Cave LLP's engineering team to develop and implement a lighting plan that provided a pleasing and functional corridor lighting system and also reduced Bryan Cave LLP's energy use by 5%. *Photo by Dennis Schroeder, NREL 19321*

## Lessons Learned

Commercial real estate leases often leave landlords and their tenants puzzled about investing in energy savings. Owners who do not pay energy bills have difficulty justifying investments in energy savings. Tenants question why they would want to invest in someone else's building. One implementation model that helped address this barrier for Bryan Cave LLP was to use part of the owner-supplied TI allowance for energy improvements. This strategy provided Bryan Cave LLP an essentially no-cost way to reduce building operating costs and may increase the property value for owners. Applied throughout a property, TIs that reduce energy use may even prolong the life of the facility by reducing the load on the equipment. Other lessons learned are included below, showing best practices for implementing energy efficiency in TI projects to achieve similar results to those presented here.

Bryan Cave LLP project team from left to right: Greg Stark, NREL; Don Fitzmartin, Fitzmartin Consulting; Nancy Gonzalez, Bryan Cave LLP; Greg Forge, MPG Office Trust; Randy Miller, Bryan Cave LLP; Randall Glardon, MPG Office Trust; Mark Maguire, formerly of Bryan Cave LLP.
*Photo by Dennis Schroeder, NREL 19313*

### Understand the current energy use situation

Key to an effective project is a clear understanding of a property's energy use and savings potential. For most tenants, this means working with outside organizations, architects, engineers, utilities, and federal, state, and local governments. One place to start, if possible, is by analyzing utility bills. Overall energy use can be compared to the performance of comparable buildings, for example by using the ENERGY STAR® Portfolio Manager.[7] By measuring or estimating consumption by different end uses such as lighting, HVAC, and plug loads, the largest opportunities for savings can be identified.

### Energy goals motivate change

Different energy goals can be used to drive the design process. The CBP goals were chosen because they have been shown to be technically achievable for office space using existing technologies, but still push companies beyond business as usual. Regardless of the goal selected, it provides a focal point to motivate the design team. Incentives can be crafted to promote good design and best practices developed to check that the building performs to expectations following occupancy.

Governments sometimes provide energy improvement-based incentives. These vary markedly from area to area and range from tax-based incentives to direct rebates. These incentives can greatly improve the business case for EEMs. Visit the Database of State Incentives for Renewable Energy (DSIRE)[8] to identify opportunities in your area.

> "Investing in energy efficiency provided the best mix of meaningful change. It very much aligned with what we were trying to achieve."
> —Randy Miller
> Office Managing Partner at Bryan Cave LLP, Denver

### Contact your utility company

Utility companies offer incentives ranging from discounted energy audits and cost-shared design assistance programs to rebates for lighting, renewable energy, and custom applications. In some localities, rebates may refund a substantial fraction of the project cost. Even if the local utility's programs are limited, its representatives can help determine where to focus an assessment. In the Bryan Cave LLP retrofit, rebates from the local utility, Xcel Energy, were expected to reduce the cost of the improvements by more than 12%.

### Carefully commission new equipment

During hand-off of the project from the construction team to the tenant, energy-saving equipment must be carefully checked to make sure it is operating properly. For example, during commissioning, a wiring problem was discovered in the vacancy sensors that would have prevented correct operation. Particular attention should be paid to verifying continued proper control and operation of HVAC retrofits such as the variable speed fan drives added to the Bryan Cave LLP air handling units.

[7] Portfolio Manager: http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager
[8] DSIRE: http://www.dsireusa.org

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