Background

Building renovations to meet business needs are a key opportunity to incorporate efficiency measures. Energy efficiency is often implemented as a stand-alone retrofit. However, energy efficiency upgrades can be disruptive if not aligned with the real estate life cycle. To that end, the U.S. Department of Energy (DOE) sponsored an effort with Lawrence Berkeley National Laboratory and kW Engineering to develop a suite of Integrated Systems Packages (ISPs) that can be applied at the time of a tenant fit-out, HVAC equipment replacement, or building renovation. Each ISP includes proven efficiency measures tailored to the scope specific to real estate life cycle events. The ISP toolkit includes specifications and other resources to reduce the required level of effort.

CBRE is the world's largest property and facilities management company, with a long track record of advancing energy efficiency and sustainability in the properties they manage. They were a partner in the development of the ISPs, identifying several potential demonstration sites. This case study describes the implementation of the tenant fit-out ISP to a retail bank branch with office space located in the southeastern U.S.

Interior view of the bank

The Project

CBRE manages numerous sites for a financial institution in the southeastern U.S. Several of these sites were prioritized for facility renovations, such as interior and exterior lighting upgrades and rooftop solar PV. CBRE saw an opportunity to apply ISPs to reduce energy costs and support corporate ESG goals. CBRE selected a site in Birmingham, Alabama, to pilot the tenant fit-out ISP based on its energy use intensity, building size, energy-using system characteristics, and other factors. The tenant fit-out ISP nominally includes LED lighting and daylight dimming controls, HVAC controls based on ASHRAE Guideline 36, and energy monitoring. Optionally and where appropriate, the ISP also recommends ceiling fans, automated interior shades, and plug load controls.

The site was originally slated for a renovation that included upgrading the exterior lighting for security purposes and adding rooftop solar PV.

The scope of the renovation was expanded to include the following energy efficiency measures from the tenant fit-out ISP:

- **Interior Lighting Upgrade**

  LED lighting and daylight-based dimming.

- **HVAC Controls Upgrade Based on ASHRAE Guideline 36**

  Static pressure reset, heating lockout, zone-based scheduling, optimized start, and widening deadband to 4°F

PROJECT DETAILS

- **Facility type:** Bank branch with office
- **Size:** 8,800 sq.ft (4,400 sqft is dedicated to retail banking)
- **Year of construction:** 2006
- **Envelope:** Double pane windows; Brick veneer exterior
- **HVAC:** Packaged rooftop units with direct expansion cooling and electric heat.
- **Lighting:** 2x4 troffer and can lights
- **Savings:** 25% annual energy and GHG

Guideline 36 includes several other features and some were already implemented in the existing system, while others could not be implemented due to system limitations. CBRE also considered two optional ISP measures – automated exterior shades and plug load controls – but determined that these were not suitable for the site. The site does not have energy monitoring software; energy use was assessed via monthly utility data. While the size of the site could not justify a full-featured energy monitoring system as recommended in the ISP specifications, CBRE worked with the utility to obtain interval meter data for load profile analysis.

The project was initiated just as the COVID-19 pandemic restrictions in the U.S. came into effect. Despite limited site access, CBRE staff and contractors were able to conduct site visits and implement the project. A key consideration was whether changes in building operations and occupancy would impact energy use. Subsequent analysis of the energy data showed that the pandemic did not have a significant impact on energy use, which was only 1.6% lower than the pre-COVID.

Energy and Carbon Savings

Energy savings were calculated using metered data for the building with one year of pre-retrofit baseline data and six months of post-retrofit data. The savings calculation method conforms with the International Performance Measurement and Verification Protocol (IPMVP) Option C. Figure 1 shows the annual energy savings normalized to a typical meteorological year (TMY). It shows annual savings of 25% for the entire retrofit with an uncertainty of +/-3% at the 95% confidence level. The exterior lighting upgrade (which was not part of the ISP) was estimated to provide about 6% savings and the ISP measures provided about 19% savings. Note that these savings do not include the additional reductions in grid energy due to the on-site solar PV. Figure 2 shows the GHG emissions reductions for the site, including the additional reductions from the on-site solar PV.

Figure 3 shows the average hourly energy use profile before and after the retrofit. Figure 4 shows the 12-month load profile for normalized baseline, post-retrofit performance, and savings. Savings are higher in the summer months and lower in the winter months.

Implementation Costs

The total retrofit cost – including the ISP efficiency measures – was about $131,000:

- $74,000 (56%) for interior lighting,
- $37,000 (28%) for exterior lighting; and
- $20,000 (15%) for the HVAC controls.

The costs for lighting were higher than typical interior retrofits due to a high number of new can light fixtures (vs. troffers) and the hard ceiling (vs. acoustic tile ceiling). A more conventional lighting system (all troffers and acoustic tile ceiling) would result in about 10-15% lower costs. However, it should be noted that this is the cost of the whole renovation, not just the ISP efficiency measures. Due to pandemic-related restrictions, the DOE team was not able to conduct detailed on-site measurement and verification (M&V) to determine the marginal costs and savings of the ISP efficiency measures.

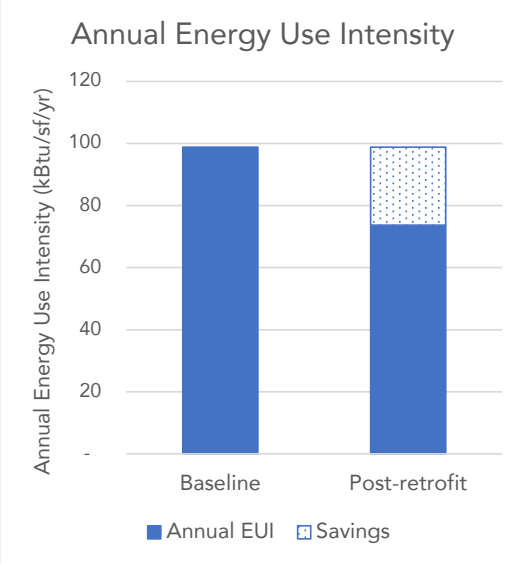

Figure 1: Annual baseline and post-retrofit energy use intensity.

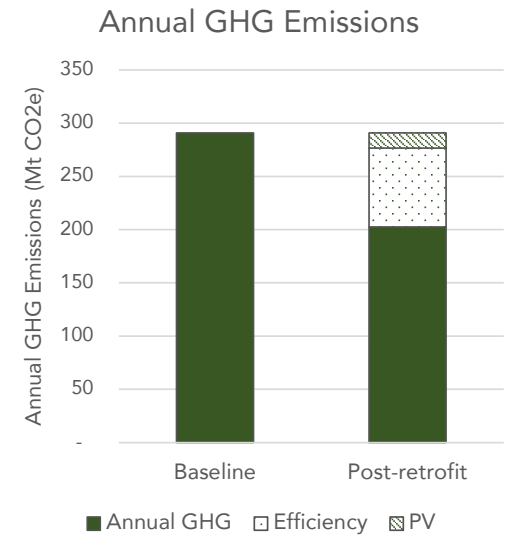

Figure 2: Annual baseline and post-retrofit GHG emissions.

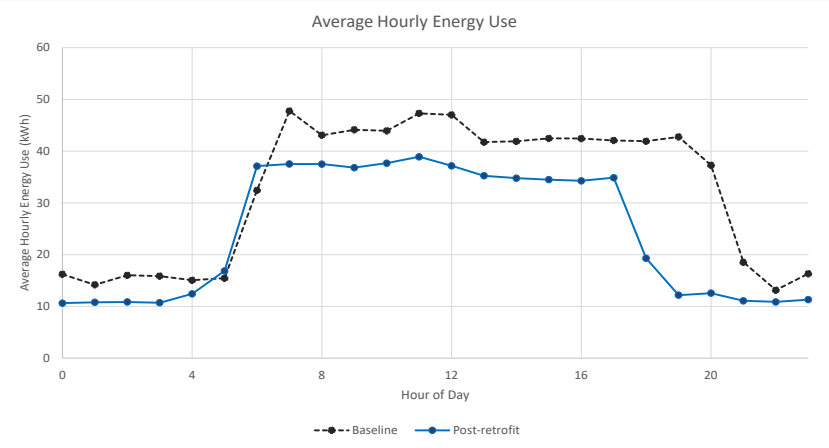

Figure 3: Average daily energy use profile before and after the retrofit, using actual (not normalized) metered energy data.

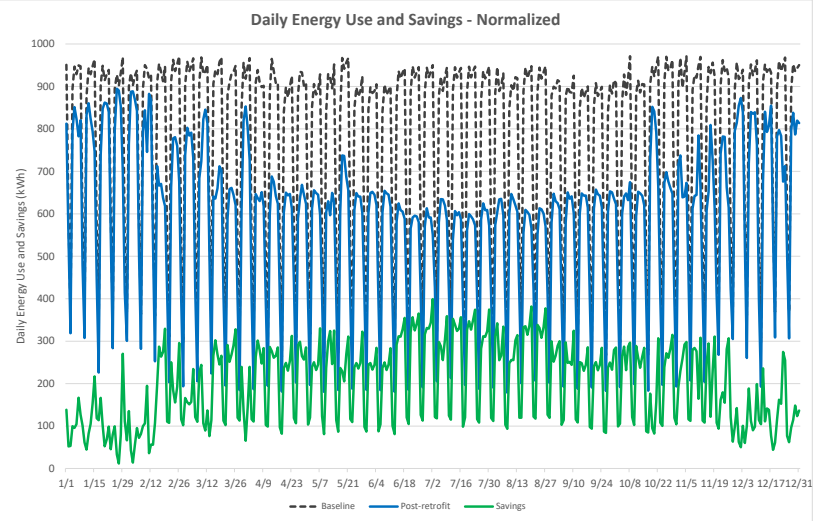

Figure 4: Normalized baseline and post-retrofit daily energy use and savings for a year using TMY weather data.

Ease of Implementation

CBRE provided the lighting contractor and HVAC contractor with the ISP template specifications. The lighting specification was relatively straightforward to use, requiring only a few adjustments and clarifications related to lumen output, daylight sensors on can fixtures, and color temperature. The HVAC controls specification required more engagement and iteration because the applicability of each Guideline 36 measure is highly dependent on the HVAC system and control capabilities. Some aspects of the controls system capability had to be checked and the specification adjusted accordingly. This took one site visit and a follow-up meeting to identify which Guideline 36 measures were applicable for the site's HVAC controls hardware and software capabilities. Since then, we have developed an 'ISP specifications generator' tool that allows users to create a customized ISP specification based on site-specific system characteristics.

ISP toolkits are available at: https://buildings.lbl.gov/cbs/isp

Toolkits include template specifications, applicability checklists, test procedures and O&M template.

KEY TAKEAWAYS

- A package of **routine, proven lighting and HVAC controls measures** can yield substantial site-level savings in the range of **20-25%**.
- **Routine renovations are an opportunity to incorporate these efficiency measures** and energy efficiency projects do not have to be executed as isolated projects. If building owners and operators are already mobilizing facilities staff and contractors to work on their buildings for other business purposes, that opportunity can be leveraged to include efficiency and minimize disruption from one-off projects.
- **The ISP template specifications can be used to help reduce the level of effort.** However, they will almost certainly require some changes to accommodate site-specific considerations.
- The ASHRAE Guideline 36 measures will invariably require customization and not all measures may be applicable depending on the HVAC systems and controls capabilities.
- It is important to ensure whole-building interval metering, at a minimum, to track performance and calculate savings. **Savings calculations based on whole-building metering** (IPMVP option C) **can provide savings with high confidence.**

"The ISP toolkits offer the ability for project developers and planners to easily apply energy efficient standards into the design specifications of the project. The toolkits will not only streamline project execution but will also allow the planner to estimate the energy savings. This will aid in the approval of any potential cost increase due to installing energy-efficient equipment."

Chris Pelrine, Director, Energy Sustainability, CBRE

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