Urban Land Institute

ULI Tenant Energy Optimization Program

Case Study:
Rocky Mountain Institute

In 2015, Rocky Mountain Institute (RMI), an international nonprofit organization, had outgrown its office space and wanted to lease space in a hyper-energy-efficient and sustainable net-zero-energy (NZE) office building. As a result, RMI ended up as the anchor tenant in Boulder Commons, an all-electric, aspiring NZE property in Boulder, Colorado. At the time of its completion, Boulder Commons was the largest leased multitenant aspiring NZE mixed-use commercial project in the United States. The NZE process for this project was cost-effective for both the developer and the tenants, and it can serve as a model for the next level of high-performing, sustainable tenant spaces.

RMI, having outgrown its office, needed a larger space that also represented its values. RMI was no stranger to energy-efficient building space: RMI and its landlord, Morgan Creek Ventures, had collaborated on a tenant improvement project to achieve a Leadership in Energy and Environmental Design (LEED) Platinum rating for RMI's previous office space. However, with its new space, RMI wanted to push the envelope even further and truly embody its mission by moving into an NZE space, the gold standard for efficiency. There was one catch: not a single NZE office building existed in the city of Boulder for RMI to rent.

Even though Boulder is known for its high-efficiency building standards and even though the city requires that all buildings be at least 30 percent more efficient than ASHRAE 90.1-2010,[1] in 2015, none of the existing buildings met RMI's ambitious goal of NZE. However, RMI's landlord, Morgan Creek Ventures, was up to the challenge of developing a multitenant NZE office building, and RMI quickly came on board as the anchor tenant.

As one of the first and one of the largest multi-tenant NZE buildings[2] in the United States, Boulder Commons stands out as an example of what is possible in multitenant NZE construction and in landlord/tenant collaboration. And as the anchor tenant of Boulder Commons, RMI saw the value in collaborating with Morgan Creek Ventures to build out an efficient and sustainable tenant space that would demonstrate that advancing energy efficiency and renewable energy in leased offices is possible and replicable for any tenant.

When Morgan Creek Ventures set out to design the base lease for the NZE building, it approached RMI for its assistance in codesigning the accompanying green lease that would eventually serve 10 to 15 other tenants in the two Boulder Commons buildings. RMI not only became the anchor tenant of Boulder Commons, but also became the first tenant to execute the green lease. The unique green lease gives tenants an energy budget allocation to manage plug-load usage, offers options in the form of purchasing renewable energy credits (RECs)[3] in case a tenant uses more energy than is allocated, and requires annual recommissioning of equipment to maximize operating efficiency.

The tenant space itself incorporates sustainable design elements, such as triple-pane fiberglass

1. ASHRAE 90.1-2010 is an industry standard frequently used as a baseline for comparison during energy audits and retrofits. For Boulder to require buildings to be at least 30 percent higher than this standard already sets a higher precedent for baseline Boulder buildings. Going above and beyond this level (as Boulder Commons and any NZE building does) means achieving a very high level of energy efficiency.
2. NZE buildings use as much energy as they can generate on site over the course of a year. Boulder Commons is currently seeking the International Living Future Institutes' Zero Energy Building certification. This certification is widely viewed as the most stringent certification and requires 1) that 100 percent of the energy consumed on site is also generated on site, 2) that a building provides 12 consecutive months of energy data to prove net-zero operating, and 3) that a building has no on-site combustion whatsoever.
3. Renewable energy credits (RECs) are tools that are issued when one megawatt-hour of electricity is generated and delivered to the electricity grid from a renewable energy source. RECs may be purchased by companies as a means to offset energy consumption and promote renewable energy use.

Figure 1: Rocky Mountain Institute Project Information and Projected Performance

Building information	
Tenant name	Rocky Mountain Institute
Building owner	Morgan Creek Ventures
Building name	Boulder Commons
Location	2490 Junction Place, Suite 200, Boulder, CO 80301
Total building size	100,000 square feet over two buildings
Principal use	Class A office
Construction type	Steel construction with combination brick and metal-panel facade

Figure 2: Rocky Mountain Institute Tenant Space Specs

Rocky Mountain Institute tenant space	Projected design
Lease term	5 years
Square footage	14,302 square feet[4]
Modeled energy reduction[5]	36.5%
Energy savings compared with RMI's old space	21 kBtu/square foot/year[6]
Return on investment without incentives	6–9%[7]
Payback period (without incentives)[8]	10- to 15-year payback period

windows; LED lighting and controls; a highly efficient heating, ventilation, and air conditioning (HVAC) system with variable refrigerant flow and energy recovery; and an advanced building envelope design with continuous exterior mineral wool insulation, a low air-infiltration rate, and solar panels covering the entire roof and east facade. Those features provide many benefits, such as increased tenant comfort and added value in the form of energy savings. The LED lighting alone is 50 percent more efficient than code baseline lighting.

Although the construction-to-NZE standards came at a 12 percent premium, the entire Boulder Commons project saves an estimated $146,000 in energy costs every year, which will translate to long-term energy savings throughout the life of the property for both the owner and the tenants. RMI has the added confidence of knowing that its energy bills will remain the same every month—instead of fluctuating unexpectedly—because a lease clause outlines an energy budget and a stable monthly utility charge. After energy modeling and design, RMI's tenant space end-energy use was estimated to be 36 percent more efficient than the baseline ASHRAE 90.1-2010 code. However, usage tends to be even lower than this modeled efficiency, as the ensuing case study outlines.

The Tenant Energy Optimization Program (TEOP) emphasizes the importance of owner and tenant collaboration, particularly because tenant spaces typically account for more than half of a commercial office building's total energy. Overall, this process provides the strongest results and the most significant savings when the building owner engages with the tenant in the process; openly

4. RMI's space was 14,302 square feet upon move-in but has since undergone an expansion and now occupies about 20,000 square feet.
5. As this was a new building, this data point is based on Boulder code.
6. Note that 21 kBtu/square foot/year is kBtu of entire building. RMI's old building used 47 kBtu/square foot/year while Boulder Commons uses 26 kBtu/square foot/year.
7. Because of the expansion of RMI's leased space, an extended lease (eight years) and potentially changing energy prices in coming years, this percentage may fluctuate between 6 and 9 percent. However, even at the low end of 6 percent, this represents an average real estate ROI.
8. Note that RMI represents about 20 percent of the entire Boulder Commons property. The payback period has been calculated with this as a consideration.

shares the building's energy information; and implements building-wide energy saving measures, just as Morgan Creek Ventures did with RMI and the other tenants. With the innovative use of the lease and of advanced renewable energy technology and storage, RMI's work with Boulder Commons is a true example of the industry gold standard for multitenant aspiring NZE buildings. The ensuing case study outlines how RMI applied the TEOP 10 steps to its space and throughout its collaboration with Morgan Creek Ventures.

RMI's case study is part of an ongoing series of TEOP case studies aimed at presenting the energy and cost savings effects of high-performance tenant design. The case studies and companion resource guides provide the market a replicable model to expand the demand for high-performance tenant spaces and supply of market expertise to deliver strong results from such projects. Projects using the step-by-step TEOP process typically demonstrate energy savings 30 to 50 percent, have payback periods of three to five years, and average a 25 percent annual return.

Boulder Commons roof with solar panels. (Morgan Creek Ventures)

Why and How RMI Chose Boulder Commons

RMI, having outgrown its office space, was ready to move into a larger and hyper-energy-efficient leased space in its current city of Boulder, but it was looking for something that did not yet exist—a multitenant net-zero-energy building.

As an international nonprofit focused on the global energy market, RMI intimately understands the need for not only more efficient and sustainable buildings, but also the need for a strong collaborative relationship with landlords to help optimize a leased space. In its search for new building space, RMI found a natural partner in its existing landlord, Morgan Creek Ventures. RMI's collaboration with Morgan Creek Ventures before construction even began on the new space ensured that a smooth landlord/tenant relationship was in place once it moved into the leased space. Because of past conversations with RMI, rapidly increasing energy and sustainability market expectations, and a few other factors, Morgan Creek Ventures decided that NZE construction was a smart business choice. With an NZE building, collaboration between the landlord and tenant must continue throughout the leasing and occupancy phase to ensure the building remains at a net-zero level—RMI found a natural partner in Morgan Creek Ventures to achieve this goal.

When RMI moved into Boulder Commons, the two-building project was not only brand-new but also it was one of the only multitenant aspiring NZE projects in the country.[9] Owner-occupied or single-tenant NZE spaces are becoming increasingly common across many real estate product types, but multitenant or leased NZE buildings add a layer of complexity that deters most developers. Aside from having additional energy users to monitor and manage, multitenant NZE buildings create the need for more collaboration between a landlord and tenants to ensure that the building tenants and owner are managing energy use and generation appropriately. This motivated RMI because it knew there was a high potential for energy and money savings.

Cara Carmichael, a principal at Rocky Mountain Institute, explains why this collaboration was so important: "Net-zero energy is not yet business as usual, particularly for leased, multitenant buildings. We knew the only way to achieve our ideal space was to collaborate with a developer. We wanted to create a model for NZE buildings that was cost effective and replicable, so others could follow our lead. We were lucky to have the opportunity to work with Morgan Creek Ventures—they are one of the most forward-thinking developers in the country. And through strong

Project's Key Stakeholders

Tenant: Rocky Mountain Institute

RMI is a leading nonprofit founded in 1982 that is focused on market-based solutions that help move away from fossil fuels and toward carbon-free solutions. By developing and leading international programs, RMI is able to help move the market toward innovative partnerships and strategies that are aimed at decreasing energy consumption, increasing technological innovation, and decreasing overall dependency on fossil fuels.

Building Owner: Morgan Creek Ventures

Morgan Creek Ventures, founded in 2001, is a medium-sized development firm located in Boulder. The firm specializes in leading-edge sustainability development across offices and mixed-use portfolios. Constantly aware of the effect occupants have on design and construction, Morgan Creek Ventures also specializes in green leasing to ensure sustainably built assets are also operated in an efficient and energy-optimized manner.

9. Note that as of this publication, Boulder Commons is still going through the formal certification process to become an official "net-zero-energy" building. Until certification is received, the building is technically an "aspiring net-zero-energy" building.

landlord/tenant collaboration, we were able to achieve both our lofty energy goals while proving [that] NZE is not only possible but [also] profitable." Already aligned as landlord and tenant, Morgan Creek Ventures and RMI entered the pre-leasing phase with an advantage.

For Morgan Creek Ventures, a development firm based in Boulder, building to NZE standards was not yet its status quo. Morgan Creek had previously built energy-efficient office and mixed-use buildings, but none to NZE standards. However, after realizing the potential success of Boulder Commons as an NZE property, Morgan Creek Ventures Principal Andrew Bush indicated his interest in developing more NZE properties using the same successful model implemented in the building that RMI occupies. Andrew explains that "Boulder Commons was a step out of the ordinary for Morgan Creek Ventures, however, after success meeting energy-use goals and a pending official net-zero certification, this type of design and construction has quickly become ingrained in our practices." Based on market analysis, Morgan Creek Ventures and RMI hope to see 10 percent to 15 percent higher tenant retention in Boulder Commons than in traditional buildings.[10] All of those factors, combined with the growing need to mitigate the influence of the built environment on climate change, pushed Morgan Creek Ventures to adopt NZE construction as a core business practice.

Pre-Leasing Phase: A Collaborative Effort

Step 1: Select a Team

RMI rounded out its team with like-minded sustainability professionals who shared its vision of an energy-optimized space. In a building striving for NZE, it becomes critical to have all of the players on the same page. Figure 3 shows the complete team.

Lesson Learned: Select the Right Team for the Job

Decision-makers should introduce TEOP to all stakeholders responsible for the buildout. Ensuring that they share the owner-tenant vision for an energy-optimized space before buildout will decrease possible issues.

Figure 3: Buildout Team

Company	Role
Boulder Commons core and shell teams	
Morgan Creek Ventures	Building owner
Project One	Project manager
Coburn Architecture	Architect
EHDD	Architectural design consultant
Encore	Lighting designer
Integral Group	Conceptual core and shell energy analysis
Group 14	Commissioning agent
Mortenson	Contractor
RMI tenant space teams	
Huntsman Architectural Group	Tenant fit-out architect
Mazzetti	MEP (mechanical, electrical, and plumbing), lighting engineer
Holland & Hart	RMI legal lease negotiation counsel
CBRE	Broker

10. See Rocky Mountain Institute, "Boulder Commons Sets New Standard for Net-Zero Leases," https://rmi.org/boulder-commons-sets-new-standard-net-zero-leases/.

Step 2: Select a Space

RMI committed to lease 14,302 square feet of office space[11] before Morgan Creek completed construction, and continued to work with Morgan Creek Ventures and the tenant fit-out design and engineering team throughout the construction process. RMI selected the space not only because it was NZE, but also because it had an aligned vision with the landlord and the space was cost competitive with other Boulder properties and it was near mass transit.

Even though RMI, Morgan Creek Ventures, and their legal counsel, Holland & Hart LLP, had never negotiated an NZE lease before, all of the parties were able to agree on energy-focused lease clauses through careful communication and understanding of the overall building and tenant space goals. At the end of this process, Morgan Creek Ventures decided to implement a modified gross lease.

The NZE lease between RMI and Morgan Creek Ventures became the first lease for the project and it serves as the base lease for all other tenants in the building.

RMI's lease includes the following components:[12]

- Retro-commissioning of the base building systems shall occur annually to ensure that they continue to operate at peak performance and cost effectively. Retro-commissioning is paid for through the "operating expenses" budget and the landlord passes a share of the costs through to the tenants.
- If tenants go over their allocated plug-load energy budget within their spaces, recommissioning will also be required of that specific space's systems.
- If the building fails to meet the NZE level at the end of the year, Morgan Creek Ventures will purchase RECs to offset the difference. If the shortcoming is a direct result of tenant energy use and activity, the costs will be passed through to that tenant.
- Throughout the process of managing and measuring energy use, Morgan Creek Ventures shares information with tenants through monthly plug-load energy reports and through an annual energy consumption report.

As one tenant in an aspiring NZE building, RMI had to ensure its energy use was in line with the budget allocated by Morgan Creek Ventures. Traditional lease clauses do not typically include an energy use budget or a mitigation plan to handle situations in which tenants use more than an allotted amount of energy in each period. However, Morgan Creek ensured that the standard lease for tenants of Boulder Commons covered many plausible scenarios, all of which include deep landlord/tenant collaboration.

Morgan Creek Ventures gave each tenant a plug-load budget of 7 kBtu per square foot,[13] which is 69 percent less than the average U.S. office space[14] uses; it charges RMI $1.90 per square foot per month for energy use. To ensure that tenants stay on track with this budget,

Landlord/Tenant Collaboration Timeline

Although some landlord/tenant collaborations, such as an existing building tenant improvement, can be done on shorter timelines, long-term collaboration between both parties is possible and it is encouraged when realistic. The timeline of RMI and Morgan Creek Ventures' collaboration illustrates a realistic timeline for this type of collaboration.

2015: Morgan Creek Ventures and RMI brainstormed project possibilities, including NZE.
2015–2017: Morgan Creek Ventures designs NZE solution and starts construction.
Mid-2017: Core and shell construction is complete.
September 2017: RMI moves in.

11. Note that although RMI's initial lease was 14,000 square feet, it later expanded to almost 20,000 square feet.
12. A redacted version of RMI's lease can be found here: https://rmi.org/wp-content/uploads/2017/07/MCI-Boulder-Commons-Lease-RMI-FINAL-00241161xA14B2-1_Redactedv3.pdf.
13. One kBtu is 1,000 British thermal units and is a standard energy use measurement. One Btu equals the amount of heat needed to raise one pound of water 1 degree Fahrenheit. Btu and kBtu are common measurements to include when discussing energy efficiency.
14. See Rocky Mountain Institute, "Boulder Commons Sets New Standard for Net-Zero Leases," https://rmi.org/boulder-commons-sets-new-standard-net-zero-leases/.

Morgan Creek Ventures sends each tenant a monthly energy use report (see figures 10 and 11) that details the energy use. Any tenant going over the allocated budget must offset that extra energy use by purchasing RECs.[15] This formula and this process is written directly into the lease between Morgan Creek Ventures and each tenant to ensure that no energy management decisions are decided haphazardly or without consideration of the overall property's NZE goal. Because of this lease structure, the monthly utility bills are stable and predictable, and they are lower than what most Boulder commercial customers pay (between $1.80 to $2.40 per square foot, according to an informal survey completed by Morgan Creek Ventures).

Morgan Creek Ventures and RMI's green lease also included guidance on retro-commissioning, the process of tuning up and maintaining base building systems to ensure that they are running as efficiently as possible. Retro-commissioning also avoids the premature obsolescence of equipment by monitoring its status and repair needs regularly versus only toward the end of its life. This process ties to step 9 of the TEOP 10-step process, the execution of the post-occupancy plan, and it ensures that the space's efficiency persists throughout occupancy.

Thanks in large part to RMI's collaboration with Morgan Creek Ventures, when new tenants move into Boulder Commons, they will be able to negotiate their lease agreements from a greener, more efficient base lease structure.

Lesson Learned: Start Early in the Process

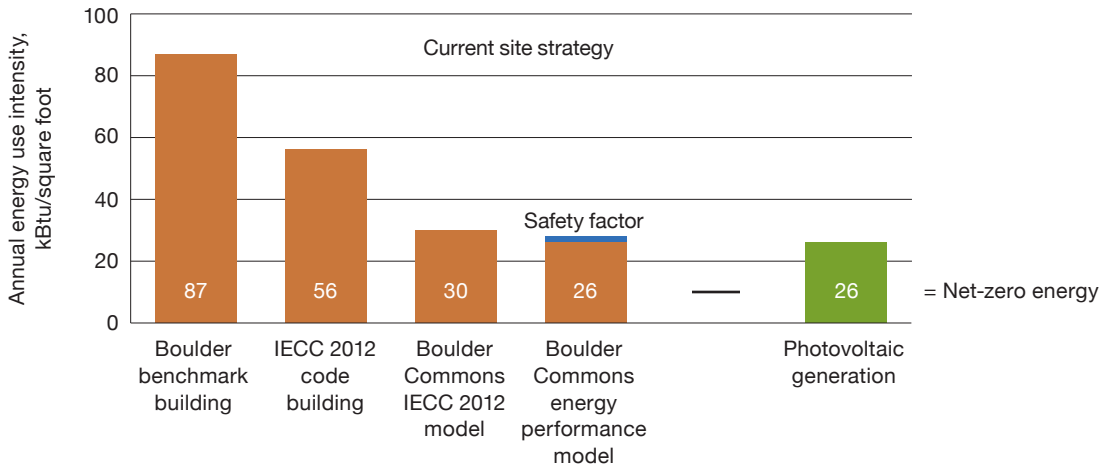
RMI started the energy efficiency and green leasing conversation with Morgan Creek Ventures before construction. This decision gave both parties ample time to plan for and adjust energy and sustainability goals and to ensure design met those criteria.

Design and Construction Phase: Building to Net-Zero-Energy Standards

Step 3: Setting Energy Performance Goals

Setting the energy performance goals of an aspiring NZE building was easy; however, the design and architecture teams still benchmarked and analyzed the prospective development under current code compliance scenarios. Figure 4 demonstrates how Boulder Commons' energy use intensity compares with other buildings' energy use intensity in the same market. Once the goal was set and analyzed, every energy performance measure (EPM) in question had to help the space meet its ambitious energy goals and at a price point in line with the budget.

Figure 4: Comparison of Boulder Commons' Energy Use



Source: Coburn Architecture.

Boulder's energy code requires a comparison of the proposed design to a standard building designed to the IECC 2012 code. This IECC 2012 model does not allow us to set expected values for lighting or plug loads in tenant improvement spaces; instead it uses conservative values set by IECC and ASHRAE. This model still saves well over 30 percent of energy use required by Boulder's energy code. When expected plug load and lighting densities are applied (based on plug load studies we have done and the lighting design goals), the building energy use drops to only 26 kBtu/square foot/year including a 10 percent safety factor to account for inherent variability in human behavior and weather.

15. RECs or renewable energy credits are market instruments indicating property rights to renewable energy generation. RECs are issued when one megawatt-hour (MWh) of electricity is generated and delivered to the grid from a renewable energy source. Many companies use RECs as a way to meet NZE standards without extensive on-site renewable energy generation.

Step 4: Modeling the Project Energy Performance

Because RMI was a tenant in a new building, it was not able to model energy reduction options against an actual building baseline as it would have done in an existing building.

Coburn Architecture and Integral Group helped Morgan Creek Ventures model projected energy use on the basis of the building envelope design and savings generated from the solar array. Integral Group then analyzed the energy projections of Coburn's design by using OpenStudio, a tool that uses the U.S. Department of Energy's EnergyPlus energy simulation engine. Currently, the office portion of Boulder Commons is on track to achieve NZE. The ground-level space designed as restaurant-ready ended up being leased as office space instead. This change made the NZE goal more attainable because restaurants have a higher energy use than offices.

Lesson Learned: Go Beyond the Status Quo

Selecting LED lighting and efficient HVAC systems is a great early step for energy savings. However, thinking outside the box and including innovative measures, such as a sealant application to the base building or installing triple-pane windows, will help the building and tenant space achieve greater energy savings.

Figure 5 outlines the menu of measures alongside cost savings potential and estimated energy savings. Note that the following menu represents the possible measures considered for the building and tenant spaces, not necessarily the final choices. Final decisions are not made until step 6 in the TEOP process.

Figure 5: RMI's Menu of Measures

Measure	Cost to implement	Savings potential	Target area
LED lights	Low	High	Lighting
Efficient HVAC system: variable refrigerant flow	High	High	HVAC
Plug-load monitoring	Low	Medium	Plug loads
Triple-pane windows	High	Medium	Base building
Samsung SmartThings devices	Medium	Medium	Plug loads
Submetering of HVAC	Low	Medium	HVAC
Submetering of lighting	Low	Medium	Lighting
Continuous thermal envelope/ AeroBarrier	High	Medium	Base building
Geothermal	High	High	Base building
Nighttime air flushing	Medium	Medium	Base building
Automated venting	Medium	High	Base building
Automated window blinds	Medium	Medium	Base building
Alternative wall construction methods	Low	Low	Base building
Fiberglass frames with triple-paned windows	Medium	High	Base building
Redirecting window film	Low	Low	Base building
Renewable energy: solar photovoltaic array	High	High	Renewable energy
Narrow floor plates	Low	Low	Base building
Lighting controls and sensors	Low	Medium	Lighting

Step 5: Calculate Projected Financial Returns

In keeping with the goal of NZE, Morgan Creek Ventures knew it would have to value engineer and make tradeoffs to stay on budget for the development of Boulder Commons. The project as a whole saw a premium of about 12 percent to be built to NZE, but financial paybacks and longevity of the asset made this premium a worthwhile investment. After energy modeling, Coburn Architecture worked with Morgan Creek Ventures and Integral Group to calculate the projected financial returns.

Some noteworthy areas of financial payback to Morgan Creek Ventures include a 6 to 9 percent return on investment (ROI) on the photovoltaic (PV) system (through a low-risk model of fixed tenant energy charges),[16] an anticipated higher sale value due to lower cap rate, less risk during downturned markets, a faster lease up, and a differentiated market offering. Financial benefits to Rocky Mountain Institute and other tenants include rent at or below market rate, predictable energy costs and control of energy expenses, and assistance meeting corporate sustainability objectives.

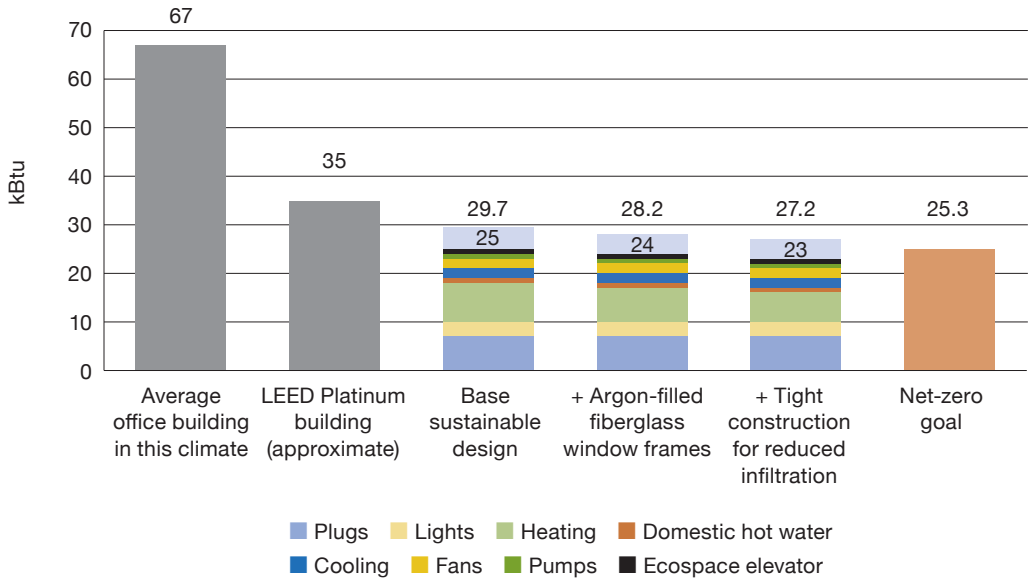
Figure 6 illustrates how the possible packages compare with each other.

Step 6: Make Final Decisions

After vetting options and sustainability considerations, each item's potential effect was analyzed on a per dollar basis—that is, the energy use intensity (EUI) impact was compared to the dollar amount. The following specific areas were analyzed during that process:

- **Shared variable refrigerant flow (VRF) systems.** The building was planned to have four to six independent VRF systems, shared among all tenant spaces. Because heating is the dominant HVAC energy use in Boulder, the fact that this system also allows heat to be moved from one space to another in the building is a critical efficiency feature.
- **Distributed energy recovery ventilators in each tenant space.** Those systems act as dedicated outdoor air units and integrate directly with the VRF system's controls.
- **Garage configuration to serve as a thermal storage mass for condensers.** This configuration required heavy integration with architectural plans to allow for necessary airflow.

Figure 6: Net-Zero Goal and EPM Comparison



Source: Coburn Architecture.

16. This is a direct result of RMI's unique green lease that stipulates an energy budget or allowance. RMI has a standard energy charge rolled into its rent payments and Morgan Creek Ventures can calculate ROI on the basis of that static and consistent revenue.

One system in particular, the VRF,[17] required careful analysis and consideration. If Boulder Commons had been built to the ASHRAE 90.1 code, heating and cooling systems would have accounted for over 2.5 million kBtu of energy consumption annually. However, with the VRF system and efficient design in place, the two buildings instead use just shy of 700,000 kBtu for heating and cooling. The VRF system was selected for four main reasons:

1. In Colorado, buildings can often require simultaneous heating and cooling on opposite sides of the property. When this happens, the VRF can transfer the wasted heat from the side of the building being cooled to the side requiring heating.
2. The system is entirely electric and thus represents one of the more efficient options on the market because it forgoes the need for any natural gas or combustion.
3. The mechanical units can be hidden inside the shell of the building, rather than on the roof. This design element frees up significant rooftop space for more solar panels.
4. The VRF system can be modified fairly easily over time as a tenant space changes. In a multitenant office building in which an average lease lasts five years, this option is a valuable feature.

Some of the options that ultimately did not meet the EUI-to-dollar parameters that were set out by the design team include geothermal systems, nighttime air flushing, automated venting, alternative wall construction methods, automated window blinds, fiberglass storefront windows, photoreactive glass, and other technologies. Although these are all well-functioning systems that may be advantageous to other NZE or energy-efficient buildings and tenant spaces, they did not meet the criteria for Boulder Commons.

The following lists are the final base building parameters and tenant space parameters:

Base building parameters

- Fiberglass frames with triple-paned windows: center of glass U-0.13, solar heat gain coefficient of 0.49 on the north facade, 0.24 on the south, east, and west facades
- Tuned glass percentages on each facade
- Redirecting window film
- Envelope sealing technology[18]
- Efficient HVAC system
  - Features VRF system with energy recovery and ventilation
- Renewable energy: 575 kilowatt solar PV with 71 percent total generation capacity on the roof and 29 percent capacity on the southeast facade (see figures 7, 8, and 9 for detailed solar information)
- Narrow floor plates
- Continuous thermal envelope: exterior mineral wool insulation is applied over the exterior sheathing of the building and structural thermal breaks are employed to reduce thermal bridges.
- Photovoltaic modules

Tenant space parameters

- LED lights: possible power density of 0.35 watts per square foot (61 percent better than required by Boulder energy code)[19]
- Lighting controls: features continuous dimming daylighting controls throughout open office and vacancy sensors throughout open office and conference rooms
- Plug-load monitoring: data communicated between tenants and landlord to ensure that each space is operating within its allocated budget and to help the entire property stay at net-zero energy
- Submetering of all systems including HVAC and lighting using the e-Gauge platform

Establishing efficient base building systems and managing tenants' plug-load use are only two components of the complex systems integration that go into achieving net-zero energy. Renewable energy generation is another critical component.

17. VRFs (also known as variable refrigerant volume or VRV) use a refrigerant as the heating and cooling medium in an HVAC system. A single condensing unit conditions the refrigerant and it is then dispersed throughout the system to various indoor units. VRFs are unique in that they only work at the needed rate of speed, which allows for significant energy savings as opposed to non–VRF systems.
18. Boulder Commons is equipped with AeroBarrier—an innovation that seals and locks spaces or cracks in the envelope and drastically decreases air infiltration into the building. This process includes pressurizing the space and releasing a mist of sealant into the air. The sealant then naturally collects around and fills any small holes or cracks in the building envelope. This process leads to less air leakage and greater energy efficiency in heating and cooling.
19. Once occupied, RMI's space actually ended up operating at around 0.19 watts per square foot because of good daylighting and the use of clerestory windows in the building envelope design.

Morgan Creek Ventures installed a 575-kilowatt solar array mounted on the roof and on the southeast facade. This array is modeled to generate 716,397 kilowatt-hours per year, which is estimated as enough to offset the entire building's electricity use excluding the restaurant. Figures 7, 8, and 9 demonstrate the PV production numbers in more detail including the orientation of PV panels, the shading factor, number of modules, and the energy produced.

Lesson Learned: There Are Many Paths to NZE

For anyone pursuing an NZE building, know that there are many paths to the end goal. Renewable energy must be part of the plan, but it can include on site, off site, or offsets (i.e., RECs) to achieve NZE. However, the first step, before installing renewable energy, is to get deep reductions in EUI with retrofits. The difference can then be covered with renewable energy.

Figure 7: Boulder Commons' Photovoltaic Production Numbers

Roof areas

PV array	PV array description	PV orientation	PV slope (degrees)	Snow + shading loss factor	SunPower modules—high efficiency			
					Number of modules	kW	Energy produced (kWh/kW)	Energy produced (kWh)
RA 1 (north building)	Mounted on "A frame" racking system	East–west	10	0.97	416	143.52	1,382	193,381
RA 2 (south building)	Mounted on "A frame" racking system	North–south	10	0.97	393	135.59	1,383	187,478
RA 3 (north building)	Mounted on "A frame" racking system	North–south	10	0.97	274	94.53	1,383	130,756
				Total	1,083	374	Total kWh	516,614

Figure 8: PV Summary

PV array	Energy produced (kWh)	kWh/sq ft
Roof area—SunPower	516,614	26.6
East facade—SunPower	197,818	19.3
Total	714,433	
Energy use intensity	24.73	

Figure 9: East Facade Metrics

East facade areas

PV array	PV array description	PV orientation	PV slope (degrees)	Snow + shading loss factor	SunPower modules—high efficiency			
					Number of modules	kW	Energy produced (kWh/kW)	Energy produced (kWh)
EF A	Mounted flat on the facade	66 degrees east of south	90	1.00	233	80.39	1,066	85,690
	Mounted on facade with a 45-degree tilt near top of roof		45	0.99	0	—	1,433	—
	Mounted on facade with a 50-degree tilt		50	0.60	29	10.01	853	8,530
	Mounted on facade with a 20-degree tilt near bottom of roof		20	0.60	29	10.01	899	8,998
EF B	Mounted flat on the facade	77 degrees east of south	90	1.00	231	79.70	1,004	80,014
	Mounted on facade with a 45-degree tilt near top of roof		45	0.99	0	—	1,356	—
	Mounted on facade with a 50-degree tilt		50	0.60	20	6.90	805	5,556
	Mounted on facade with a 20-degree tilt near bottom of roof		20	0.60	30	10.35	872	9,029
				Total	572	197.34	Total kWh	197,818

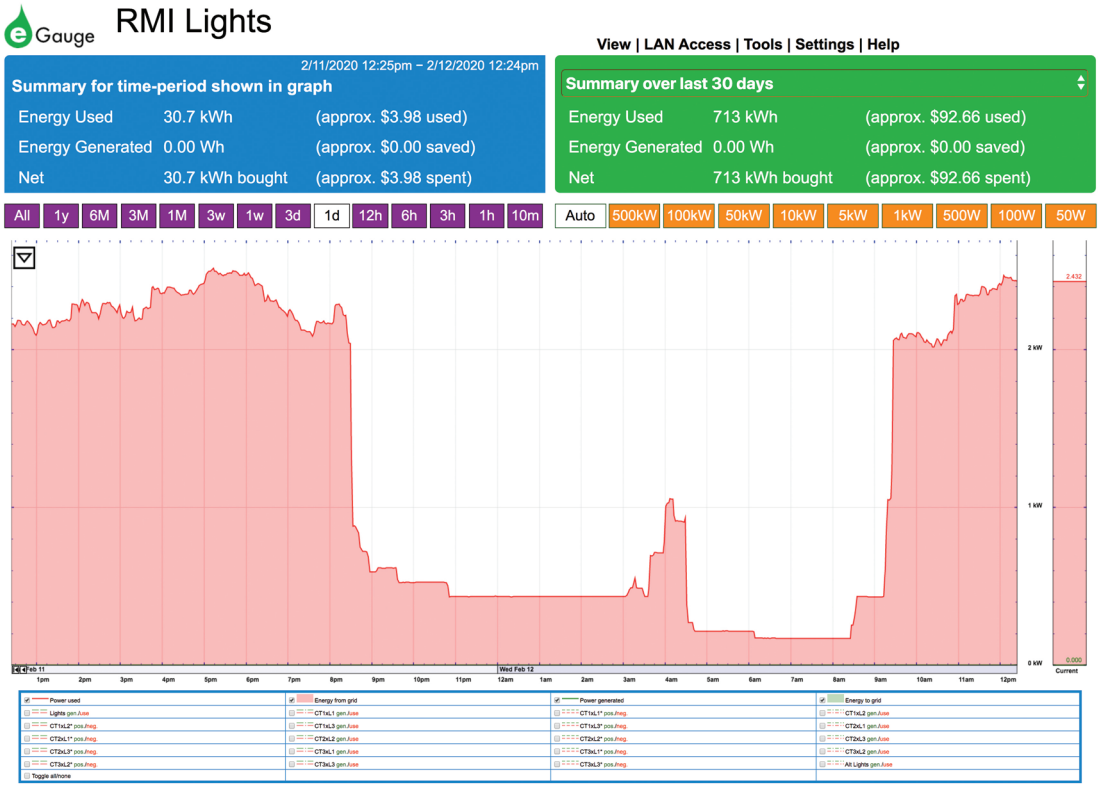
Step 7: Develop a Post-Occupancy Plan

Because Boulder Commons is a new-construction and multitenant property, Morgan Creek Ventures had to balance not only tenant space buildout parameters but also whole-building energy use considerations. In a multitenant, aspiring NZE building, it is imperative that all tenant spaces operate in harmony with the base building systems to achieve net-zero-energy performance. A poorly or erratically functioning HVAC system can result in tenant spaces consuming unnecessary energy, thus requiring the associated renewable energy generation systems to produce more energy to keep the system balanced at net zero. This issue can be avoided when the design and tenant operations are in harmony.

In traditional spaces, energy consumption can differ from the energy model, and installed EPMs can look different from the design scope and from planned EPMs because of challenges with value engineering and scope changes. Although this can still be the case in NZE buildings, every change that influences energy use and consumption must be counterbalanced with an alternative to keep the net-zero harmony.

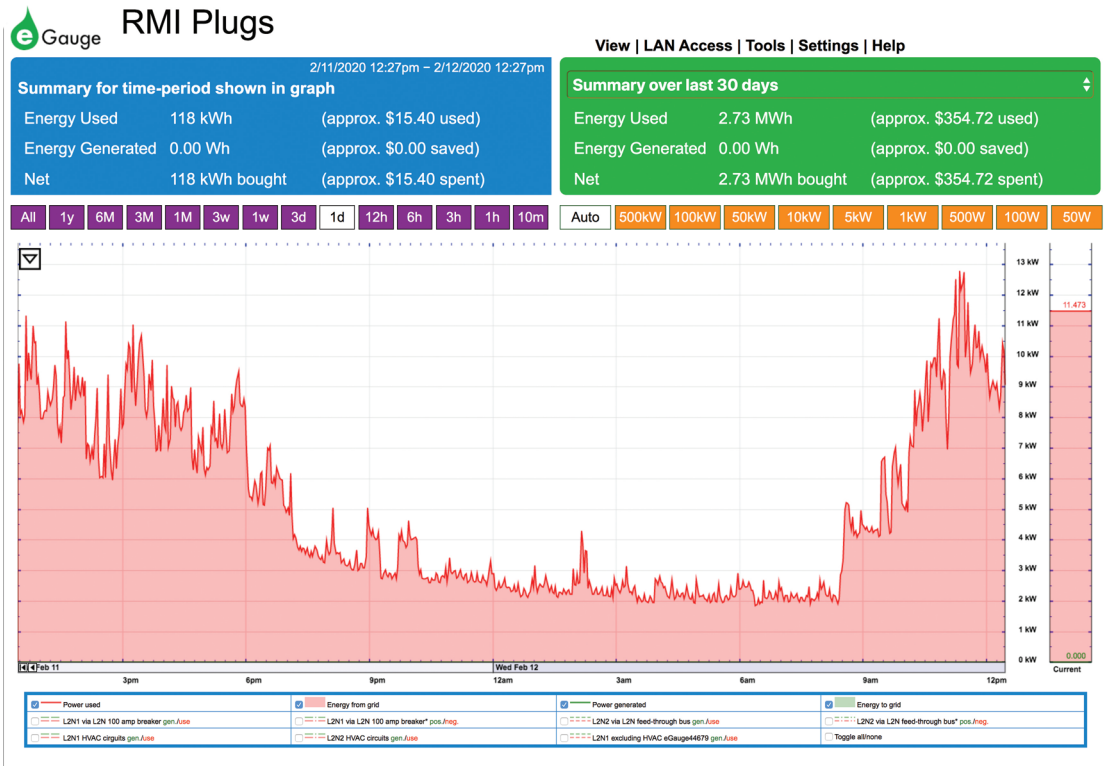
Managing tenants' energy use to achieve the net-zero goal is a challenge, especially when considering multiple tenants with differing missions and occupancy patterns. RMI and Morgan Creek Ventures worked together to develop an energy management and monitoring plan for the whole building upon occupancy, to ensure that the aspiring NZE building achieves its goal once occupied. RMI monitors its space's plug and lighting loads to ensure energy performance is on track toward NZE and it can view results online at any time on the e-Gauge platform (see figures 10 and 11). This tracking helps keep both RMI and Morgan Creek Ventures abreast of energy use to avoid going over the 7 kBtu energy budget stipulated in the lease. Lastly, maintenance and energy awareness does not stop at move-in for NZE building tenants. Ongoing retro-commissioning of base building systems and tenant spaces will continue regularly to ensure that the building remains in top shape and that it meets official net-zero energy every year.

Figure 10: Rocky Mountain Institute's Lighting Loads[20]



20. Real-time chart accessible at https://rmi-lights.egaug.es/5AFDA/.

Figure 11: Rocky Mountain Institute's Plug Loads[21]



Step 8: Build Out the Space

At Boulder Commons, the design and construction teams installed EPMs such as LED lighting, an efficient HVAC system, plug-load monitoring, and triple-paned windows. Unlike conventional construction "value-engineering" out sustainable features, the team also realized they needed to go above and beyond these plans to make achieving net zero easier. The AeroBarrier was added later in the design and construction phase when the teams realized it would help prevent air from leaking through typical cracks and holes in the walls.

The Occupancy Phase: Putting Everything Together

Step 9: Execute the Post-Occupancy Plan

Regular communication between the landlord and tenant was a requirement written into RMI's lease to support persistent, efficient operations of the space. Further, Morgan Creek Ventures completes regular tenant surveys.

Beyond energy and utility data transparency, Morgan Creek Ventures continues to evolve its tenant engagement strategy now that the building is occupied. Community involvement is one pillar of the plan and includes hosted arts shows, shared use of common space for tenant-hosted events, and food trucks in the summer. Morgan Creek Ventures regularly sends out tenant-engagement surveys and uses the feedback to tailor the offerings and programs. In return, RMI regularly checks its energy consumption and communicates performance to its staff members in the office space and to Morgan Creek Ventures. Cara Carmichael explains that "it's very important for transparency to flow both ways between all RMI staff as tenants/occupants and Morgan Creek Ventures as the landlord/developer. The confidence that issues can be collaboratively solved keeps us as very satisfied tenants!"

21. Real-time chart accessible at http://rmi-plugs.egaug.es/5C477/.

Step 10: Communicate the Results

Landlord/tenant communication does not stop with the monthly utility use reports and online platform; Morgan Creek Ventures also periodically surveys tenants to gauge satisfaction and garner new ideas for engagement. Externally, RMI's innovative NZE tenant space story has been widely communicated with the market to demonstrate what is possible in collaborative landlord/tenant spaces. Aside from this case study, RMI published its own analyses and it was also featured in numerous external publications. RMI understands its space in a multitenant NZE building is groundbreaking for the market and it knows how important it is to share its story.

And just as importantly, the landlord/tenant collaboration at Boulder Commons allowed the team to achieve the U.S. Department of Energy's Green Lease Leader Gold Level distinction in 2018, and the Colorado Green Building Guild's Green Building of the Year 2018 award. In addition, the Rocky Mountain Institute's tenant space was recognized as an inaugural Energy Star for Tenant Space recipient in 2018.

U.S. Department of Energy's Green Lease Leaders

The Green Lease Leaders recognition is a program designed to award top landlords, tenants, and brokers who incorporate energy-aligned or sustainability-focused leasing practices. The program was developed by the Institute for Market Transformation and is supported by the U.S. Department of Energy. More information on the program can be found at www.greenleaseleaders.com/.

Energy Star for Tenant Spaces

Energy Star for Tenant Spaces is a recognition program led by the U.S. Environmental Protection Agency to award exemplary tenant spaces achieving high levels of energy efficiency. Parameters were set forth under the Energy Efficiency Act of 2015, and the pilot recipients were recognized in 2018. Learn more about the program at www.energystar.gov/buildings/tenants/about_tenant_space.

RMI continues to look not only for ways to reduce energy use and cost, but also for ways to reduce carbon impact associated with building operations. A big way to do that is by managing peak demand through load flexibility and on-site energy storage. This process would enable Boulder Commons to shift energy loads to periods when the sun is shining or the wind is blowing and there is a greater amount of clean, carbon-free energy fueling the building, either from the PV on the roof/facade or from the grid. Demand management and load flexibility will also enable cost savings by reducing demand charges, which currently make up over half of the building's energy costs.

RMI and Morgan Creek Ventures designed the modified gross lease so that any cost savings from on-site storage installed by the landlord would flow back to the landlord, thereby avoiding the split incentive issue. Plus, as more wind and solar are put on the grid, Boulder Commons could act as a grid interactive building, shifting its load to help with grid stability, which would benefit all energy users.

For Morgan Creek Ventures, NZE development did not stop with one NZE building—in fact it was just the beginning. The next phase of Boulder Commons will include an NZE multifamily residential building and an additional NZE commercial office building; both new developments will officially seek net-zero-energy certification.

Rocky Mountain Institute's office kitchen space. (Morgan Creek Ventures)

Conference room in Boulder Commons. (Morgan Creek Ventures)

What Are the Benefits of the Tenant Energy Optimization Process?

It generates an attractive return on investment (ROI). Tenants using the step-by-step design and construction process typically have experienced 30 percent to 50 percent energy savings, payback in as little as three to five years, and an average internal return rate of 25 percent. Every project and building will be different, but this proven model does generate an ROI.

It provides a competitive edge. Companies with more sustainable, energy-efficient workplaces enhance their ability to attract, retain, and motivate workers who are healthier, happier, and more productive.

It is scalable and replicable. The process can provide energy and financial savings whether the tenant leases 2,500 or 250,000 square feet. Tenants and service providers who have gained expertise through implementation of the process have demonstrated that there is high potential for transferability beyond tenant office space to other property sectors.

It is proven. Through measurement and verification, tenants are able to demonstrate and communicate energy and financial savings.

It is critical for the environment. Energy use in buildings is the largest source of climate-changing carbon pollution. Also, tenant spaces generally account for more than half of a building's total energy consumption, which makes this process essential to improving the environmental performance of buildings and addressing global climate change.

Who Is Involved in the Tenant Energy Optimization Process?

It is collaborative. The process connects the dots between tenants, building owners, real estate brokers, project managers, architects, engineers, and other consultants to create energy-efficient workplaces. In this regard, the process reflects ULI's longstanding tradition of bringing together professionals from a variety of real estate disciplines to improve the built environment.

Tenants

Building Owners

Real Estate Brokers

Project Managers

Architects, Engineers, and Contractors

Energy Consultants

Supply and Demand: The Role of the Broker, Tenant, Building Owner, and Consultants

Leasing brokers are influential tenant advisers during the pre-lease phase. If experienced in energy efficiency conversations, brokers can help tenants demand and understand building energy performance information during the site-selection process. Brokers who highlight case studies or examples of work representing tenants in the selection of high-performance spaces may gain additional clients.

Tenants create demand for energy-efficient, high-performing space. Tenants also create demand for consultants who can advise them on how to reach their sustainability goals through the design and construction of energy-efficient space. By prioritizing energy-efficient space and working closely with their advisers, tenants can develop better workplaces to attract and motivate employees, attain recognition for sustainability leadership, and manage costs.

Building owners supply high-performance buildings that help tenants meet their energy performance and financial goals. Real estate owners can gain competitive advantages by marketing energy-efficient buildings' cost-saving energy and operations improvements to attract high-quality tenants. Tenants may prefer longer lease periods in highly efficient buildings that better align with their corporate environmental and social responsibility goals, provide financial benefits, and add recognition value.

Consultants (e.g., architects, engineers, project managers, energy consultants, and contractors) provide the expertise to optimize energy performance and present the technical options and economic case for a comprehensive, cost-effective, and high-performance space while meeting the tenant's schedule and budget. Consultants offering these services may attract additional clients by demonstrating cost savings and other benefits to a tenant's business goals.

Key steps for choosing a high-performing space include the following:

1. Select a leasing broker experienced in energy efficiency.
2. Convene a workplace strategy and energy performance optimization workshop.
3. Perform a financial analysis.
4. Assess high-performance space feasibility.
5. Meet with the building owner to discuss collaboration to improve energy performance.

Selecting an Efficient Base Building

Good:

- Building that reports an Energy Star score
- Ongoing tenant/landlord energy efficiency coordination
- Landlord willing to allow submetered tenant space

Better—includes all of Good, plus:

- Building that reports an Energy Star score of 75 or higher
- Central building management system with tie-in of tenant heating, ventilating, and air conditioning (HVAC) and lighting
- Building energy audit, ongoing commissioning activities, and energy capital projects completed
- Submetered tenant space with energy billed on actual use

Best—includes all of Better, plus:

- Subpanels to measure tenant lighting, HVAC, and plug load separately
- Tenant energy management program (such as a dashboard)
- All electric
- Net-zero energy
- Recommissioned annually or biannually

Questions to Ask the Building Owner

What is the building's Energy Star score? The EPA recognizes top-performing buildings that meet or exceed a score of 75. Even if a building has not achieved Energy Star recognition, an owner that tracks and reports the building's score may be more willing to collaborate on energy efficiency than an owner who does not currently monitor energy performance.

Is the space submetered, and is the utility billing structure based on actual use? What is the utility rate and average energy cost per square foot? Studies have found that submetered spaces save as much as 21 percent in energy compared with spaces without energy-use information.[22]

What has the building done to improve and maintain energy efficiency and conservation and when were the improvements installed? Buildings with excellent natural daylight, energy-efficient windows and lighting, envelope walls, advanced equipment controls, and efficient HVAC equipment reduce energy costs.

Does the building have resources or programs to help with the design, construction, and ongoing management of energy-efficient spaces? Request from ownership any design and energy efficiency criteria for the buildout of tenant spaces, recommended cost-effective energy measures with financial value analysis, or a building energy model for reference. Owner-provided resources are a starting point for sensible energy strategies and they promote a collaborative relationship between the building owner and the tenant. An existing energy model will reduce the upfront cost and effort of implementing the process. Experts can help identify opportunities for cost-saving lighting, outlet plug load, and HVAC opportunities throughout the lease term.

22. See U.S. General Services Administration, "Submetering Business Case: How to Calculate Cost-Effective Solutions in the Building Context," https://www.gsa.gov/cdnstatic/Submetering_Business_Case_How_to_calculate_cost-effective_solutions_in_the_building_context.pdf.

About the Urban Land Institute

The Urban Land Institute is a global, member-driven organization comprising more than 45,000 real estate and urban development professionals dedicated to advancing the Institute's mission of providing leadership in the responsible use of land and in creating and sustaining thriving communities worldwide.

ULI's interdisciplinary membership represents all aspects of the industry, including developers, property owners, investors, architects, urban planners, public officials, real estate brokers, appraisers, attorneys, engineers, financiers, and academics. Established in 1936, the Institute has a presence in the Americas, Europe, and Asia Pacific regions, with members in 80 countries.

About the ULI Greenprint Center for Building Performance

The ULI Greenprint Center for Building Performance is a worldwide alliance of leading real estate owners, investors, and strategic partners committed to improving the environmental performance of the global real estate industry. Through measurement, benchmarking, knowledge sharing, and implementation of best practices, Greenprint and its members strive to reduce greenhouse gas emissions 50 percent by 2030.

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Case Study Participants

- Rocky Mountain Institute: Cara Carmichael and Alisa Peterson
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- Coburn Architecture: Bill Holicky and David Stanek
- Integral Group

Project Director

The Tenant Energy Optimization Program builds on the energy efficiency retrofit project conducted at the Empire State Building. Today, the program is housed under ULI's Center for Sustainability and Economic Performance and is led by Emily McLaughlin. Through collaboration and work with landlords, tenants, architects, and engineers the program continues to grow and expand with the hopes of aiding leased spaces across the country with the knowledge and resources needed to build out their spaces in an energy-efficient and sustainable manner.

Funders

Funding to run the Tenant Energy Optimization Program (TEOP) was generously provided by the Malkin Fund.

For More Information

Interested in implementing the TEOP process?
ULI provides tools such as technical resource guides, how-to documents, case studies, and other training materials. These materials and others can be found at **tenantenergy.ULI.org.**