Q3 BUILDING INTELLIGENCE INDEX

The Business Case for Comfort

rzero

Executive Summary

Welcome back to the R-Zero quarterly Building Intelligence Index, a resource that empowers buildings to use their data to optimize for people, efficiency, and sustainability.

This quarter, we highlight the value of and share use cases for indoor air quality (IAQ) and indoor environmental quality (IEQ) data. We'll also share examples of how monitoring environmental comfort can support businesses, schools, and healthcare environments to improve efficiency and occupant experience, especially when combined with occupancy insights and smart building controls.

As we do each quarter, we'll provide notable workplace occupancy trends observed across our customers that indicate important shifts in the way that people work and opportunities to drive improved cost and operational savings.

Section 1:

The Importance of Healthy Indoor Air

Clean air and proper ventilation indoors is crucial for the creation of high-performance workplaces, classrooms, and healthcare environments. It's also essential to fostering comfort, productivity, and well-being for your building occupants.

Imagine walking into a building optimized for health and comfort. The air feels fresh and light. There are no musky or overly fragrant smells. The temperature is pleasantly cool and refreshing, and the lighting is neutral and natural. What could you accomplish in a space like this?

In this section, we will build on our understanding of IAQ and IEQ and answer key questions tied to their importance as part of a smart building strategy.

Key Measures of Indoor Air and Environmental Quality

Managing IAQ and IEQ is crucial to enabling optimal occupant comfort and well-being. Below are the essentials to measure, and more importantly, to manage for optimal outcomes.

	What it is	Why it matters
Carbon Dioxide (CO2)	A gas produced by respiration and combustion. Levels up to 1,000 ppm are considered acceptable indoors.	High CO2 levels (1,000 ppm and up) indicate poor ventilation, and can cause drowsiness and reduced concentration. Monitoring for CO2 helps ensure there is sufficient fresh air to maintain cognitive function and overall comfort.
Particulate Matter (PM)	Small to fine particles suspended in the air. PM levels are measured in micrograms per cubic meter ($\mu g/m^3$) and are categorized by size.	Particulate matter can poorly affect respiratory health. Monitoring helps manage indoor air quality and prevents potential health issues.
PM 1	Ultrafine particles from combustion sources like vehicle exhaust, tobacco smoke, and industrial processes.	These ultrafine particles can penetrate deep into the lungs and enter the bloodstream, posing serious health risks. It is ideal to keep levels below 10 $\mu g/m^3$.
PM 2.5	Fine particles from sources like wildfires, residential wood-burning, and power plants.	These fine particles can cause respiratory and cardiovascular issues. It is ideal to keep levels below 15 $\mu g/m^3$.
PM 10	Larger particles like dust, pollen grains, mold spores, and plant fragments.	These larger particles can cause respiratory irritation and exacerbate conditions like asthma. It is ideal to keep levels below 15 $\mu g/m^3$.
Volatile Organic Compounds (VOC)	Chemicals released from paints, cleaning supplies, fragrances, carpets, and furniture.	High levels can cause eye, nose, and throat irritation, headaches, and respiratory issues. It is ideal to keep levels below 300 $\mu g/m^3$. **Formaldehyde (CH20)** is a VOC and carcinogen commonly found in building materials and furniture. Long-term exposure can cause respiratory problems and other serious issues.

	What it is	Why it matters
Temperature	A measure of how hot or cold the indoor environment is. . People are typically comfortable in the low 70s (°F) or low 20s (°C).	An optimal temperature is crucial for comfort, productivity, and well-being. *Research shows a fluctuation of just 4 degrees can have a 9% impact on a company's bottom line. When it comes to temperature, people operate at different core temperatures and metabolic rates, but consistency is key.*
Humidity	The amount of moisture in the air. 40-60% relative humidity is optimal.	High humidity feels muggy, makes it easier for mold, bacteria, and fungi to grow, and increases the severity of allergies and asthma. Low humidity favors viruses, respiratory infections, allergies, and asthma.
Atmospheric Pressure	The force exerted by the weight of the air in the atmosphere.	Drops in atmospheric pressure can affect comfort and health, especially for individuals with certain medical conditions, like migraines, inner ear, and sinus issues.
Light Intensity*	The amount of light in the indoor environment. 300-500 lux is optimal.	Adequate lighting is important for comfort, productivity, and preventing eye strain. It also influences mood and well-being.
Noise Level*	The level of sound in the environment. Normal conversation is about 60 dB.	Noise above 70 dB over a prolonged period may start to damage your hearing. Loud noise above 120 dB can cause immediate harm to your ears. Additionally, high noise levels can cause stress, reduce productivity, and affect overall comfort and concentration.

*Neurodiverse individuals, including those with autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), and sensory processing disorders, can be particularly sensitive to noise and light intensity.

Reasons to Improve IAQ & IEQ in Buildings

There are many reasons why building owners, operators, and their tenants should be focusing on IAQ and IEQ.

Influence on Well-being and Productivity

Exposure to high concentrations of indoor air pollutants can lead to "**sick building syndrome**," which is associated with headaches, fatigue, respiratory issues, and impaired cognitive function. The culprit can often be poor ventilation and high CO_2 levels. In newly built and furnished spaces, it may be over-exposure to formaldehyde or in locations that require frequent surface cleaning, the effects of chemical cleaning agents.

Whatever the cause, real-time air quality monitoring is an ideal method to protect occupants by enabling corrective action.

Monitoring for these common pollutants like CO_2, particulate matter, and volatile organic compounds off-gassed from new furniture or cleaning sprays, empowers building owners and operators to proactively identify, mitigate and prevent indoor air quality issues from affecting occupants.

Pursuit of Green and Healthy Buildings

Green and healthy building certification programs like **LEED**, **RESET**, **WELL**, and **fitwel** are becoming standard practice across commercial buildings driven by tenant demand, statewide and federal climate regulations, corporate sustainability goals, and the need to maintain a competitive edge in market. Air quality monitoring and performance benchmarks can be used as an important means to score against and meet applicable certification requirements.

Ensuring compliance with building standards is another important component of meeting green and healthy building standards. Just last year **ASHRAE**, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, released updated ventilation standards intended to drive improvements in indoor air quality and reduce the spread of airborne illness.

These new standards require a significant increase in ventilation. Integrating real-time air quality and occupancy data into smart HVAC controls enables the ability to track and control ventilation levels dynamically, as occupancy changes, to minimize the cost and emissions impact of increased ventilation rates.

Section 2:

IAQ Considerations in Education & Healthcare

IAQ in School Facilities

Children spend a large percentage of their day indoors at school. Ensuring that school facilities, like gyms, classrooms, and multipurpose rooms are well-ventilated and have optimal air quality is critical to supporting the health, well-being, and productivity of students and teachers.

Typically, poor air quality in schools can result from:

▶ Mold growth in locations with humid or damp climates

▶ High concentrations of carbon dioxide when HVAC systems are behind on maintenance (In a 2019 study, researchers found that about **85% of 94 recently installed HVAC systems** in California K-12 classrooms did not provide adequate ventilation)

▶ Chemical cleaning supplies and outdated building materials (lead paint, asbestos, tar and gravel roofing)

▶ Inefficient or malfunctioning HVAC, resulting in poorly ventilated classrooms including allergens and particulate matter. These are also environments that can lead to the spread of illness caused by airborne viruses and microorganisms

By taking proactive steps to improve and maintain air quality, schools can boost student and teacher concentration, cognitive function, and overall academic performance.

How can your school district make IAQ a priority?

A simple and low-cost solution is to develop an IAQ management program and adopt a system for daily environmental monitoring. The Environmental Protection Agency (EPA) offers great resources on how to get started via their **IAQ Tools for Schools** guidance, designed to encourage and sustain effective and comprehensive IAQ management programs. The IAQ Tools for Schools guidance has been implemented successfully in tens of thousands of schools nationwide.

U.S. Schools Committed to Improving Indoor Air Quality

Baltimore City Public Schools *Maryland*	Since 2008, BCPS has implemented a comprehensive IAQ management plan, which includes daily air quality monitoring, routine maintenance of HVAC systems, and using low-emission cleaning supplies. The district reports that these changes have helped curb absenteeism and improved student performance overall.
Oakland Unified School District *California*	In Oakland, thousands of children suffer from chronic asthma. To better understand where Oakland students are being exposed to high levels of air pollution, the EPA recently announced a $1 million grant for the California Department of Public Health to partner with the OUSD to place air quality sensors on campuses to monitor particulate matter in school environments.

IAQ in Healthcare Facilities

Maintaining excellent IAQ and IEQ in healthcare settings is essential for protecting patient health, enhancing clinician well-being, making progress towards sustainability goals, and ensuring a comfortable environment for frontline workers, patients, and their visitors.

Poor IAQ can exacerbate existing health conditions and increase the risk of hospital-acquired infections (HAIs). According to the CDC, HAIs affect 1 in 31 hospital patients on any given day, leading to prolonged hospital stays, increased medical costs, and in severe cases, patient fatalities.

Maintaining optimal IAQ can improve the recovery process for patients. In fact, research has shown that IAQ results in patients experiencing fewer complications and faster recovery times.

The World Health Organization emphasizes that well-maintained HVAC systems are essential in controlling the spread of airborne illness and contaminants such as bacteria, viruses, and fungi where proper ventilation and air filtration reduce their concentration in the air, helping minimize risk within healthcare facilities. This, in turn, protects healthcare workers from occupational hazards, and is crucial in supporting our frontline workers in their critical role of providing continuous patient care.

Healthcare facilities must also ensure they comply with stringent IAQ compliance standards set by regulatory bodies such as the Joint Commission, which provides ventilation, humidity control, and filtration standards that must be met and maintained.

U.S. Healthcare Systems Committed to Improving Indoor Air Quality	
NYU Langone Health *New York*	Since 2018, Langone Health has integrated air quality sensors into their HVAC system design. These sensors monitor air quality continuously, in order to maintain a consistent indoor environment. In addition to air quality monitoring, the hospital uses cleaning materials with lower amounts of volatile organic compounds (VOCs). This includes cleaning products free of antimicrobials, bleach, and other chemicals to reduce potential sources of indoor air pollution.
Clemenceau Medical Center *Dubai*	Since 2021, the Clemenceau Medical Center in Dubai has focused on improving air quality by implementing routine IAQ monitoring. The center's efforts focus on the reduction of particulate matter and VOCs, and in maintaining high filtration efficiency. The use of advanced monitoring and purification technologies ensures that the hospital can respond proactively to any changes in air quality, maintaining high standards of hygiene and safety.

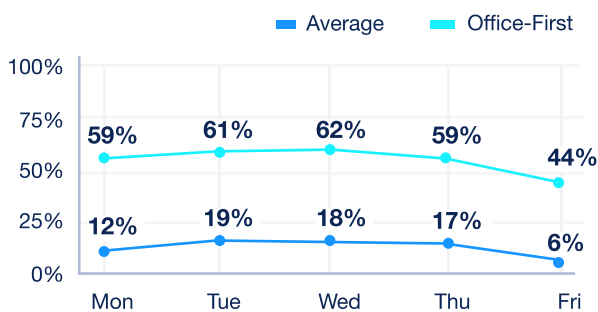# Roadmap to Achieving Optimal IAQ and IEQ in Your Buildings

By following this roadmap, companies, schools, and healthcare systems can enhance their indoor air quality, ensuring healthier environments and achieving sustainability goals.

5 **Analyze Data** Continuously analyze real-time data to identify trends and pinpoint areas that need improvement.

6 **Take Corrective Action** Use insights to make proactive adjustments to HVAC systems, ventilation, and other relevant infrastructure.

4 **Implement Monitoring Systems** Install IAQ sensors in key areas of each property to ensure comprehensive coverage.

7 **Educate Stakeholders** Train the full building operations team on the impact of IAQ and how to use monitoring systems effectively.

3 **Select Monitoring Technology** Choose advanced air quality monitoring systems that provide real-time data and actionable insights.

8 **Maintain and Update Systems** Regularly maintain monitoring systems and update them as necessary to keep up with technological advancements and changing standards.

2 **Define Objectives** Establish clear goals for IAQ improvements, including health, comfort, and sustainability targets.

9 **Measure and Report Progress** Periodically review IAQ data to measure improvements and report progress towards meeting goals.

1 **Assess Current IAQ** Conduct a comprehensive evaluation of current indoor air quality across all properties.

10 **Continuous Improvement** Stay informed about new IAQ standards and technologies, and continuously strive for further improvements.

Q2 Workplace Utilization Trends

These insights represent an analysis of workplace utilization data collected across R-Zero's global portfolio of building intelligence sensors from April - June 2024, across a 5-day workweek of 8-6pm with an analysis of each 15-minute increment of time. The data was aggregated across whole buildings or campuses and coverage may vary based on location.

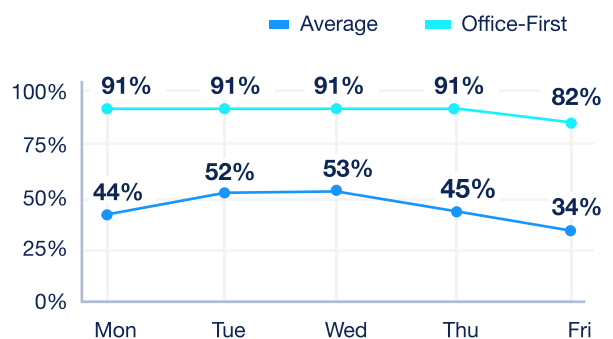### Average Workplace Utilization Monday - Friday Q2 2024

Legend: ● Average ● Office-First

	Mon	Tue	Wed	Thu	Fri
Office-First	59%	61%	62%	59%	44%
Average	12%	19%	18%	17%	6%

High demand on Tuesdays and Wednesdays

In Q2, the highest average utilization during the 5-day work week, across organizations with a variety of return-to-office (RTO) policies, occurred on Tuesdays (19%), with Wednesday and Thursday following at 18% and 17% respectively. Mondays saw 12% average utilization, while Fridays showed the lowest use at 6%. Where companies have a RTO mandate for the majority of the week (three days), utilization rates peaked at 62% on Wednesdays and 61% on Tuesdays.

Large variability in peak use Monday through Friday

In Q2, peak occupancy for office-first workplaces reached as high as 91% on Monday through Thursday (and 82% on Friday); while average peak occupancy across all of R-Zero customers was 51%. Tuesdays saw the highest peak occupancy of about 52%, followed by Wednesdays at 53%, Thursdays at 45%, Mondays at 44%, and Fridays at just 34%.

Peak Workplace Utilization Monday - Friday Q2 2024

Legend: ● Average ● Office-First

|	Mon	Tue	Wed	Thu	Fri
Office-First	91%	91%	91%	91%	82%
Average	44%	52%	53%	45%	34%

Questions to level up:

▶ *Is low utilization impacting productivity?*
▶ *Based on our unique utilization profile, are there opportunities for service efficiencies?*
▶ *Should we consider dimming HVAC and lighting on low utilization days?*
▶ *Is our badge data telling the whole story if national averages are this low?*
▶ *Should we bring teams in for events on low-utilized days to optimize the space and promote collaboration?*
▶ *Can we reconfigure our spaces around daily demands and activities?*

Peak Utilization Q2 2024
Highest percentage of time seats are in use

■ Office-First ■ Average

59%

14%
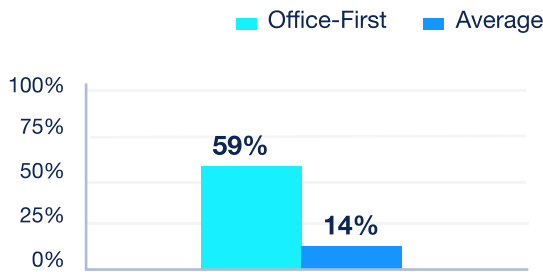
Peak usage points to potential for right-sizing

In Q2, peak workplace utilization (the point at which the most seats were in use) was 14%. Peak occupancy (the highest percentage that workplace seats were in use simultaneously) was 22%. These findings indicate that even during the busiest periods, workplaces were only fully occupied less than 25%, highlighting major inefficiencies in space use and opportunities for optimizing office layouts to better match employee usage patterns and custodial services to the demands of the space.
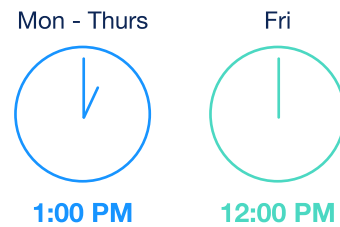
Questions to level up:

▸ *Do we have too much or not enough space?*
▸ *Do we have the right amount of space to meet the needs of our employees Monday through Friday?*
▸ *Is there dead space that needs to be reconfigured? Are teams seeking in-person collaboration or quiet spaces away from home?*
▸ *How do we bring different departments together more often (lunch, happy hours, all hands, etc)?*

## Higher occupancy during the lunch hour

A closer look at peak hour by day of the week reveals that in Q2, peak occupancy occurred most consistently at 1:00 pm from Monday to Thursday. On Friday, the peak hour shifted slightly earlier to 12:00 pm. The data suggests that employees likely start their workday earlier or have staggered start times throughout the morning, leading to peak occupancy in the early afternoon.

Peak Hour by Day Q2 2024

Mon - Thurs | Fri

1:00 PM | **12:00 PM**

Hourly Workplace Utilization Q2 2024
Average percentage of time seats were used by hour

% Utilization — Time of day
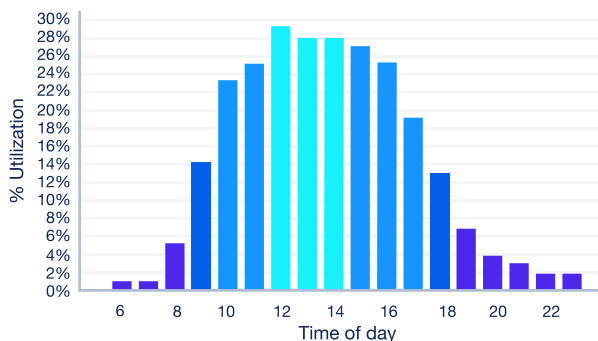
A typical day in the office

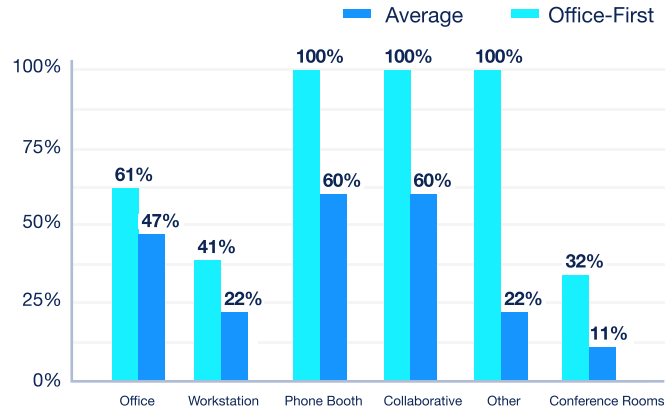Looking at utilization by the hour shows that the majority of people are in the office during the hours of 10-4pm.

Questions to level up:

▸ *What strategies would bring our employees in earlier for a more productive and full day in office?*
▸ *Are there added amenities (breakfast, coffee, wellness stations) we can incorporate that will excite employees?*
▸ *What activities are taking place between 10-4pm? What space types are the most popular during those times?*

High demand for collaborative spaces and phone booths

Q2 utilization by space type shows which areas of the office are popular among occupants, and which are not. Like last quarter, phone booths and open collaborative spaces were the most popular space types, with an average utilization of 61% and 60% respectively. On high occupancy days, these space types reached max capacity. Offices followed with an average use of 48% and utilization as high as 61%. Then, conference rooms with an average use of 35% and utilization as high as 75%. Workstations had the lowest average utilization of 22%, but still saw utilization rise as high as 41%.

Average Daily Utilization by Space Type
Q2 2024

Legend: ■ Average ■ Office-First

Space Type	Office-First	Average
Office	61%	47%
Workstation	41%	22%
Phone Booth	100%	60%
Collaborative	100%	60%
Other	100%	22%
Conference Rooms	32%	11%

Questions to level up:

▸ *Do employees have enough of the space types they prefer most?*
▸ *How can we repurpose and improve spaces that aren't being used to better match employee preferences?*
▸ *Is our space flexible enough to keep up with changing employee preferences?*
▸ *Are our collaborative and meeting spaces being used to capacity?*

Average Dwell Time Q2 2024

Minutes (y-axis: 0, 20, 40, 60, 80)

Dwell Time (dashed line)

- 79 mins
- 54 mins
- 24 mins

Dwell time: A measure of workplace comfort

In Q2, the median dwell time was 54 minutes, indicating that employees typically stayed in their seats for nearly an hour, with times ranging from 24 to 79 minutes. Analyzing dwell time helps employee experience teams optimize workspace design for comfort and ergonomics, allocate space efficiently, and adjust environmental conditions like climate control and lighting. Regular analysis of dwell time data enables understanding if your space is effective in fostering a productive and efficient work environment.

Questions to level up:

▸ *Are we offering ergonomic setups that enable employees to work comfortably from the office?*
▸ *Are we providing low-stimulation areas where our employees can focus?*
▸ *Does dwell time vary between space type and is this in line with our expectations?*

Daily vacancy rate points to consistent underuse of space

In Q2, daily vacancy rate, the average number of seats not used each day, was 57%. When considering against peak use averages, this consistent underuse of office space points to opportunities for cost savings through the downsizing or reconfiguring of office layouts. For example, implementing flexible workspaces or hot desking could improve utilization rates while creating a more dynamic working environment. Low utilization rates also show a need for strategies to boost in-office attendance and better understand employee preferences for remote work. In addition, optimizing space usage can contribute to sustainability goals by reducing energy consumption and operational costs.

Daily Vacancy Rate Q2 2024

57%

Questions to level up:

▶ *Do employees have enough of the spaces they prefer to do their best work?*
▶ *What space types are most of our vacancies in?*
▶ *Are employees making meaningful connections in the office?*
▶ *Are virtual meetings occurring while people are in the office or are team members connecting in person?*

> " *Occupancy fluctuations are causing a greater need for intentionality about the office. As a result, the way a space is fine-tuned could differ on a weekly, or even daily basis,"* **said Christina Gratrix, Senior Director of Product Management for JLL**. *"To achieve real-time occupancy management, we need to look at sources of data that haven't been traditionally used for space planning but are now relevant for hybrid work.* "

Spotlight:

Integrate IAQ and Occupancy for Efficient Building Management

Combining occupancy data with indoor air quality data allows for smarter, automated building management, HVAC controls, and lighting cycles, which results in improved energy use, operations, and environmental comfort.

The following are a few applications for integrated IAQ and occupancy data insights.

Real-Time Ventilation Controls

By integrating occupancy, IAQ, and IEQ data with your BMS system, you can dynamically adjust ventilation rates based on real-time occupancy, comfort and air quality levels. This ensures that fresh air is supplied where and when it is needed, providing the best conditions possible for productivity while saving energy. This approach also enables buildings to proactively identify and intervene in high-traffic areas that are high-risk. This method can save up to 30% of HVAC energy use through reduced fan power while providing the required ventilation to keep building occupants comfortable.

Energy Efficiency

Occupancy data identifies when and where spaces are in use, allowing HVAC systems to be operated more efficiently based on demand. Layer on IAQ monitoring data to ensure that air quality remains optimal even as energy use is minimized. This can result in significant energy cost avoidance, and carbon reduction without trading off a comfortable indoor environment for occupants.

Predictive Maintenance / Fault Detection

Combining IAQ and IEQ data with occupancy insights can help identify patterns to detect equipment stress or failure. If an HVAC system has a mechanical issue, such as a blocked vent, an air quality monitor will provide an immediate alert and the issue can be resolved, avoiding wasted energy. Additionally, proactive maintenance can be scheduled to prevent malfunctions and ensure continuous and energy-conscious operation of HVAC systems. High PM10 readings help identify when filters need to be replaced. Temperature readings and occupancy patterns help identify where fans may not be operating to specification.

"
Using advanced data analytics, we can turn incomplete commercial real estate observations into useful signals. This allows for better decision-making and more efficient resource allocation, improving overall operational efficiency and boosting ROI.
"

(Source: CBRE Report)

Join us in September for a chance to win a free IAQ Monitor kit

That's a wrap. Now that you've read through the Building Intelligence Index, you should have a better understanding of why it's valuable to track indoor environmental comfort and occupancy to transform our buildings into spaces that are more intentional, comfortable, productive, effective, and sustainable for the people they serve.

Join our live Q&A on Thursday, September 12th to walk through the opportunities that IAQ and IEQ data can unlock for your smart building strategy.

The first 20 qualified participants to ask a question will receive a free R-Zero IAQ Monitor kit and analytics to explore the outcomes IAQ and IEQ data can unlock for you.

JOIN THE Q&A →

Start Planning for Energy-Efficient Outcomes with R-Zero

At R-Zero our goal is to create healthier and more responsive buildings by using intelligent solutions that optimize spaces for the benefit of people, efficiency, and sustainability. For a complete assessment of how our solutions can help you drive reductions in energy costs and GHG emissions, contact us at marketing@rzero.com.

www.rzero.com | marketing@rzero.com