BUILTWORLDS
INSIGHTS

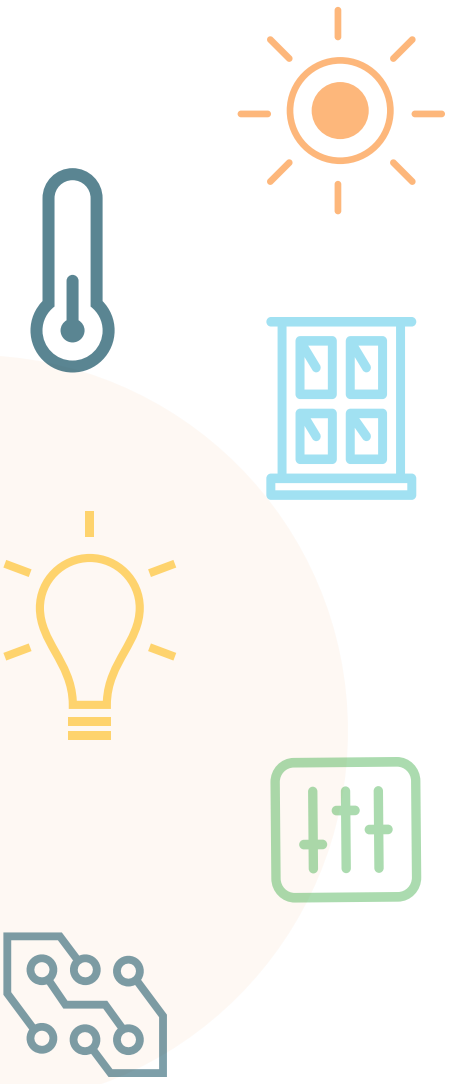
UNLOCK ENERGY EFFICIENCY IN YOUR BUILDING

INTRODUCTION

So far in 2018, roughly 20% of final energy consumption in the United States can be attributed to the commercial sector.[1] What's more, it is estimated that **30% of that energy goes to waste**.[2] Consider hallways, bathrooms, and other common areas: constantly lit and heated or cooled but not in constant use, these spaces are large sources of **wasted energy**. The challenge with powering large commercial buildings like shopping malls, office buildings, schools, and hotels is to appropriately distribute energy resources based on the actual behavior of occupants and tenants rather than their perceived behavior. Unlike in residential buildings, the people who inhabit commercial buildings are often not individually incentivized to be mindful of energy use; lights get left on in conference rooms, thermostats are constantly tinkered with, and water is used liberally. On top of poor energy planning and distribution, many commercial buildings are also powered by fossil fuels, which are inefficient sources of energy and harmful to the environment by and large.

The consequences of poor energy efficiency in commercial buildings are twofold. **First, building owners and property managers suffer from overspending on basic operating expenses.** Among U.S. office buildings, energy and utility spending accounts for 25% of the average operating expense per square foot.[3] With almost a third of that energy going to waste, building owners stand to save a lot of money by implementing energy-saving measures. **Second, the environment suffers from harmful emissions.** In fact, on-site combustion of fossil fuels in U.S. buildings (both commercial and residential) accounts for 39% of total national carbon dioxide emissions.[4] By combining renewable, clean energy sources with optimized energy consumption, the building sector can contribute to a large scale conservation effort while also lowering the cost of building operations.

WASTE NOT, WANT NOT



Information and responsiveness are the keys to unlocking energy efficiency in buildings. Traditionally, electricity bills do not itemize energy use based on source, but simply state the total amount of energy used across the whole building. Without access to system-specific, granular information about energy consumption patterns, it has proven difficult to identify the sources of waste in any given building, preventing operators from taking the proper steps to minimize them. As technology continues to evolve, we now have the ability to track the amount of energy used by each individual building system in **real-time**, enabling IoT-connected control technology to continuously refine energy allocation and **empowering owners and operators to finally take control of their energy bills**. Additionally, new renewable energy technology has made on-site energy generation an affordable option for commercial buildings, working in tandem with remote monitoring and control devices to deliver the diverse benefits associated with improved energy efficiency. **Now is the time to start taking advantage of it**.

Over the past decade, **smart building technology has emerged as a promising solution for the issue of energy waste in commercial spaces**. Buildings function at the intersection of heating, ventilation, and air conditioning (HVAC) systems, lighting systems, roof systems, water systems, window systems, building management systems, security systems, and more. A smart building works on the premise that connectivity and information drive productivity; by linking all of these individual systems using IoT and collecting information about the performance of each using sensors, meters, and cameras, buildings can become more productive as a whole. With smart technology transforming how we design, build, and operate commercial spaces, **people are turning to the built industry to lead the push for innovation**.

Let's explore how developments in **HVAC**, **lighting**, **windows**, and **building management** technology are contributing to energy efficiency, and what needs to be done to fully take advantage of these money and resource-saving strategies.

TAKE CONTROL OF YOUR HVAC

A critical service in any building, **HVAC systems are far and away the largest source of building energy consumption**, averaging nearly **40% of total final energy** but often reaching much more than that.[5] Thus, managing HVAC operations has proven as essential to energy control as it has to comfort and productivity. While occupant comfort and energy savings have traditionally been viewed as conflicting goals, the smart building movement seeks to reconcile the two.

A smart HVAC system relies on a network of sensors that measure a variety of system performance metrics, such as static pressure within air ducts, temperature, humidity, and air quality. Capturing those physical changes and converting them into digital signals, the sensors relay real-time information about the HVAC system to a centralized, cloud-based software platform that is programmed to optimize the conditioning and distribution of air throughout the building. Building-wide smart control over HVAC operations creates the ability to limit airflow to specific parts of a building based on occupancy; on a multi-zone floor, air flow can be increased in one zone while being totally shut off in another, eliminating wasted energy from cooling or heating unoccupied zones. A leader in smart HVAC, **Optimum Energy** offers these solutions and more in a comprehensive platform that **can reduce building energy costs by up to 50%**.[6]

On top of optimized operations and control, smart HVAC sensors also allow building operators to proactively identify faults in system performance. In traditional air systems, these faults would often go undiagnosed for long periods of time, straining energy efficiency and inflating energy bills. Now, with the ability to monitor system performance in real-time, faults such as leaks or blockages in air ducts can be identified and dealt with immediately. Overall, smart HVAC's **optimized performance** and **predictive maintenance** functionalities have proven immensely valuable as energy-saving strategies.

BLINDED BY THE LIGHT

Smart lighting controls are nothing new. Over the past several decades, commercial building owners have begun reaping the rewards of implementing basic sensing, dimming, and timer technology to minimize unnecessary lighting expenses. These well-established systems, however, are far from perfect. Programming and hardware deficiencies have limited the extent of light-sourced energy savings, **driving the continued evolution of smart lighting technology**.

New smart lighting systems are far more efficient and comprehensive in scope than their predecessors. The commercial sector consumes 350 terawatt-hours (TWh) of energy annually, and it is estimated that full implementation of advanced lighting control technology in every commercial building would reduce that by 100 TWh, translating to **savings of more than $10 billion**.[7] While implementation on that scale may not be feasible as of now, the fact remains that individual buildings stand to reduce their own energy consumption on lighting by up to 90% with a fully-integrated smart system.[8]

Advanced smart lighting systems, similarly to smart HVAC systems, consist of a network of sensors and other remote monitoring devices working in tandem with LED lights, all connected by a central lighting management system. Smart light system functionalities include detecting occupancy or vacancy, offsetting the amount of electrical light used in the presence of sufficient daylight, and automatically dimming lights. All of these functions are made possible by data management platforms that can auto-configure lighting parameters based on the real-time input they collect from sensors throughout the building. **The goal of smart lighting is to turn your structure into a responsive and self-correcting machine.**

SPOTLIGHT

Signify

Dutch multi-tenant office building *The Edge* is a marvel of sustainable design, and the first of its kind to implement a fully-realized, large-scale connected lighting system. Using Signify's Interact Lighting platform, 3,000 of the building's LED luminaires were equipped with sensors and connected to a central IT network. When linked to building maps, this network of sensors provides real-time location-based information about how the building is used by its occupants. Facility managers use the integrated Interact Office software to visualize and analyze this data, track energy consumption, and streamline maintenance operations.

The lighting system also gives employees access to Signify's Personal Control App, allowing for personal control of lighting scenes and room temperature at individual workspaces. The app supports personalization even in open-plan offices, putting employees in control of their working environment.

The benefits to building performance of the Interact Lighting system are multifaceted and significant. Not only does the system prioritize employee comfort, but it also saved €100,000 in annual energy costs. Additionally, the sensing network of LED lights generated occupancy data that helped occupants like Deloitte optimize their use of rented space; after 20 months of operations they reduced the amount of space per employee from 12.6 to 7.6 square meters, cutting out wasted space and adding over 1,000 employees while lowering the average overhead cost per employee by roughly €1,800.

Source: Signify + The Edge

PUT YOUR WINDOWS TO WORK

Windows play a significant role in managing energy consumption in buildings. While window systems are typically thought of as sources of light, they also affect temperature and can strain HVAC systems by slowly heating rooms. It is estimated that in California **roughly 40% of a building's air conditioning consumption is sourced by solar heat gain through windows**.[9] That reality exists in direct conflict with the fact that windows also provide valuable relief to lighting systems by supplementing artificial light with natural daylight. So, how can buildings take advantage of windows as lighting assets without placing undue stress on temperature control?

In theory, manual or remote-controlled shades could solve the problem, but their reliance on human control makes them largely ineffective; it is impossible for us to know exactly when and how much to open or close shades to keep up with the near-constant and often imperceptible changes to natural light, temperature, and radiation over the course of a day. Smart windows take the idea of energy efficiency one step further than manual shades, using **innovative glass and film technology to let in visible light while blocking out solar heat gain and bothersome solar glare**. Additionally, smart windows can use electrochromic technology to self-adjust window tint based on solar intensity and temperature. Companies like **View Dynamic Glass** and **iGlass Technology** make it easy to implement these solutions both in existing buildings and in new construction projects.

The value of smart building technology is perfectly highlighted when considering the intersection of HVAC, lighting, and window systems. With smart windows contributing to temperature control, HVAC sensors will detect the decrease in solar heat gain and the system will adjust accordingly by turning down the AC. In turn, the added daylight will brighten the room and trigger the smart lighting system to automatically dim. In addition to saving money, this responsive technology is helping to **forge a connection between the built and natural environments**, making it more pleasant for us to work inside all day.

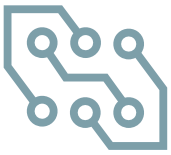
GENERATE ENERGY ON-SITE

One of the most important components of an energy-efficient building is an on-site source of energy generation. **By 2030, the demand for electricity is projected to increase by as much as 40%**, a trend that will further increase electricity prices in the commercial sector.[10] Additionally, the collective strain placed on grid infrastructure makes it prone to productivity-straining power outages. With decentralized energy, companies can generate, store, and consume their own electricity, decreasing direct utility costs and minimizing the cost of power outages. Lastly, the central grid's reliance on fossil fuels carries negative environmental externalities that are well-documented; moving toward on-site renewable energy will help to decrease harmful carbon emissions.

There are multiple ways that buildings can **leverage renewable technology** to generate energy on-site. In general, companies can either install grid-connected systems or microgrid systems that operate independently of the central grid. Connected systems are best suited for smaller buildings and offer the ability to sell excess energy back to the grid, turning the system into a **revenue-generating asset**. Independent microgrids are best implemented on a larger scale, and offer more flexibility and scalability.

Regardless, building managers have already begun using sunlight to generate electricity with roof-mounted photovoltaic (PV) cells developed by **SolarCity**, **Voltaic Systems**, and others. **The cost of PV technology has decreased by 75% since 2009**, making it more feasible for smaller buildings to take advantage of it.[11] Similarly, newer solutions like **Polysolar**'s PV-enabled glass are turning windows and other parts of the building envelope into productive generation assets. Companies are also using excess heat produced by energy generating equipment to contribute to their buildings' HVAC and water heating, further connecting their building systems and cutting out wasted resources.

TIE IT ALL TOGETHER WITH SOFTWARE



Bridging each individual system using advanced data management, analytics, and control software, **building management platforms act as the connective tissue of the smart building**. Implemented on their own, each smart device covered in this report can surely help to improve energy efficiency. However, implemented together and alongside building management software, a building can be transformed into a dynamic and streamlined operating asset.

Taking raw data from HVAC and lighting sensors, rooftop energy generation systems, and window systems and turning it into actionable business insights for building owners and operators, these platforms provide commercial buildings with a powerful central command center. The software functions by connecting to each point of the building sensor network using cloud-based technology. While data storage has traditionally been seen as expensive and complicated, property managers have removed the need for physical servers by making use of the cloud. Since smart buildings generate a lot of data, this makes it easier than ever to process information quickly and inexpensively. Additionally, building management software providers offer simple and intuitive mobile platforms, providing managers with the insights they need at the tips of their fingers.

By enabling **vertical integration of building systems**, building management software removes waste and uncertainty from building operations and maintenance. Property managers can remotely monitor building-wide energy consumption and equipment condition using a single intuitive interface. In smaller buildings that lack on-site engineering staff, this makes setting energy parameters and keeping pace with equipment maintenance schedules simpler and more cost-effective. With the ability to interpret physical changes detected by sensors and automatically adjust energy consumption accordingly, this effectively **cuts out the middleman from building energy services**.

SPOTLIGHT

Gridium

Office and residential real estate company Douglas Emmett turned to Gridium to provide a more cost-effective way to incorporate analytics, reduce energy spending, and increase energy management capabilities within their portfolio. Gridium's Snapmeter and Billcast tools were deployed across 45 buildings in the portfolio, allowing Douglas Emmett to turn its electric meter data into insights about peak demand charges, anomalous use patterns, and the factors causing monthly utility bill volatility.

Gridium's solution enabled automatic data collection without any additional hardware, regularly scheduled online building report generation for the entire portfolio, and data-driven interpretation of weather, rate, calendar and operational components of monthly energy bills. An example savings opportunity, identified by Snapmeter's machine learning algorithms, was the early startup time of a building on Wilshire Boulevard in Los Angeles. The Chief Engineer suspected the building's electric heating was causing unnecessarily high mid-morning demand charges. Snapmeter flagged the issue, and its weekly load curve graph made it clear where adjustments were needed.

"Gridium's Snapmeter service provides constant feedback and support of our actions as we work to reduce spending across our portfolio," said Robert Lutes, Director of Engineering Services at Douglas Emmett.

Source: Gridium + Douglas Emmett

GREATER THAN THE SUM OF ITS PARTS

As we continue to learn about how the built world impacts the environment, our use of energy as a resource is changing rapidly. The challenge of minimizing energy consumption and prioritizing clean energy sources while still maintaining, and often expanding, business operations has proven to be a complex puzzle. Conveniently, the incentive for building owners to invest in energy efficiency measures serves both private and public interests. The development of integrated smart building technology has not only **reduced the amount of building sector emissions** and **contributed to a shift toward renewable energy**, but it has also **provided significant relief on utilities expenses**. Talk about a win-win.

Construction, architecture, and engineering communities are vital pieces of the energy puzzle. While older buildings can be retrofitted to make use of smart technology, moving forward new construction needs to be designed and constructed with **integrated operations** in mind, because **energy efficiency benefits us all**. The marriage of technology and construction has signaled a shift toward increased collaboration in the industry, and the future of energy efficiency in commercial buildings depends on buy-in from designers, builders, software developers, property managers, tenants, and everyone in between.

REFERENCES:

1 U.S. Energy Information Administration, June 2018 Monthly Energy Review **2** MIT News, Reducing Wasted Energy in Commercial Buildings **3** U.S. Energy Information Administration, Energy Use in Commercial Buildings **4** U.S. Green Building Council, Buildings and Climate Change **5** U.S. Energy Information Administration, Commercial Buildings Energy Consumption Survey **6** Optimum Energy LLC **7** American Council for an Energy-Efficient Economy, Smart Buildings: Using Smart Technology to Save Energy in Existing Buildings **8** American Council for an Energy-Efficient Economy, Smart Buildings: Using Smart Technology to Save Energy in Existing Buildings **9** NGS Films and Graphics, Solar Control Window Film **10** U.S. Energy Information Administration, Electric Power Monthly **11** American Council for an Energy-Efficient Economy, Smart Buildings: Using Smart Technology to Save Energy in Existing Buildings

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