telkonet®

GREEN ENERGY SOLUTIONS
A Green Way to Save

HOW ENERGY MANAGEMENT SYSTEMS WORK

An Energy Management System (EMS) is a combination of hardware and software, designed to save energy, increase efficiencies, and contribute to user comfort and satisfaction. Occupancy detection and scheduling are the keys to controlling indoor environments without sacrificing comfort.

Introduction

EMS systems, or "platforms", are becoming more and more common in hotels, student housing, multi-dwelling units, senior living facilities, military barracks and office buildings.

At their core, energy-management systems work to reduce energy consumption and related costs by reducing HVAC runtimes, room lighting, and other energy-consuming devices. An average hotel room, for instance, may be unoccupied up to 70% of the time; why heat or cool or light a space when there is no one present to benefit from it? This same logic can apply to dorm rooms, military barracks, office space, apartments, and even multi-dwelling unit properties.

At a minimum, energy management platforms feature the ability for property managers to set in-room temperature limits to control their energy usage and costs. It's common, for example, for an office building EMS to set individual offices to a pre-defined temperature for occupant comfort, and allow the temperature to drift after normal business hours when unoccupied, as an energy savings measure.

"Controlling lighting and heating/air-conditioning based on sensed occupancy provides an opportunity to significantly reduce energy consumptions and costs."

- Michael Brambley, Chief Scientist,
Advanced Building Controls, Pacific Northwest National Laboratory

---

Contents

EMS Platform at Colleges & Universities

A university may use an EMS platform to set their dorm room thermostats to a minimum and maximum temperature range, rather than allowing students to set the temperature themselves and aggressively heat or cool their rooms.

In fact, increasingly, colleges and universities are committed to energy management and sustainability. Robert Franek is the Editor-in-Chief of the Princeton Review, which released its eighth annual guide to the most environmentally responsible "green" colleges in September, 2017. Franek says[1], "Among more than 10,000 teens and parents who participated in our 2017 College Hopes & Worries Survey[2] 64% told us that having information about a school's commitment to the environment would influence their decision to apply to or attend the college."

EMS in the Hospitality Industry

In the hospitality industry, an EMS not only provides significant energy savings, but it contributes to guest satisfaction in a variety of ways. EMS platforms can detect real-time occupancy, thereby avoiding awkward scenarios when housekeeping enters a room while a guest is still in there. An EMS may help identify failing HVAC equipment or low batteries in a room, so the hotel can proactively address them before a guest ever notices it. EMS platforms can also create a "welcome scene": after a guest checks in, she arrives at her room to find a pleasing lighting scene, perhaps a welcome message on the TV and the room temperature already at a comfortable setting.

Let's look at the most common components of an Energy Management System.

---

1 www.princetonreview.com/press/green-guide/press-release
2 www.princetonreview.com/college-rankings/college-hopes-worries

Occupancy Sensors

The biggest opportunity for energy reduction is through occupancy sensing. Occupancy sensing allows the platform to determine whether someone is present in a room, and therefore whether or not to heat, cool or light that room. For example, if a resident at a multi-dwelling residential unit enters a room, the platform could recognize their presence and turn the HVAC on to the desired room temperature, determined by either the resident or the property. Similarly, if the platform senses that the resident has left their room, it can prompt the HVAC to allow the temperature to drift to a preset temperature that's easy to recover from once the resident returns.

There are many technologies and methods for sensing occupancy in a room. Two of the more common technologies include PIR and door contacts. In certain circumstances (large or multi-room spaces, for example) the most effective method for occupancy sensing is through a combination of PIR and entry door events.

PIR Sensors

PIR (passive infrared) sensors are the most common motion sensor type used for occupancy-based control technology. If you've ever seen a motion light turn on in a yard, you've witnessed the result of PIR sensor at work. In indoor spaces, PIR sensors detect occupancy by sensing the infrared radiated by the room's occupants, the infrared radiated by the unoccupied room, and then measuring the differential between the two levels. Upon sensing whether someone is in the room, PIR sensors send occupancy data to the EMS.

When PIR sensors are calibrated to extreme sensitivity, they can detect even slight motion. If the lens sensitivity is optimized for use in spaces such as dormitories or military barracks, it can detect even subtle movement.

PIR sensors may be able to detect moving objects as small as 25 pounds. They tell the thermostat if someone is occupying the room, even

when that person is nearly motionless, and also ignore stationary objects such as lamps because there is no motion.

You can find PIR sensors in occupancy sensors-devices whose sole purpose is to sense occupancy, and also built directly into some smart thermostats.

Light Level Sensors

Sensing light level in the room helps determine whether it is day or night. When the room is dark, there can be longer delays before triggering an unoccupied mode, as the PIR waits to sense subtle motion of a sleeping occupant. This prevents temperature changes in the middle of the night while the occupant is sleeping.

A photo resister light level sensor increases the accuracy of occupant detection in low light conditions. Within a configurable number of minutes after the occupant exits the room, the PIR occupancy sensor notes that the room has become unoccupied. It then waits a programmable delay time. During the day (bright conditions as seen by the light sensor), this delay time is typically 10 minutes. At night (dark conditions), this delay time is typically 45 or 90 minutes. The amount of the night delay time depends on whether or not there have been prior nighttime occupancy detections. During this waiting period, the thermostat works as if it is in the occupied state. Once all (programmable) delays have expired, the thermostat then transitions to the unoccupied state.

Some smart thermostats feature a combination of PIR sensors and photo resister light level sensors.

Door Contacts

The act of opening and closing doors can be used as an indicator of occupancy. Commonly, magnetic door contacts consist of a reed switch and a magnet – the reed switch is open by default and when the magnet is close enough, the reed switch closes. The closing of the switch can trigger the sensor to send a signal to the EMS (Energy Management System).

When integrated with electronic door locks to detect occupancy, the EMS can identify who has entered the room: resident/guest or maintenance or other staff. In the case of hospitality, for example, the temperature and lighting changes if the guest enters the room, but not if maintenance staff enters.

Door contact sensors can also be used to manage the HVAC system when balcony doors are left open. If a patio door or window remains open for a pre-determined amount of time (60 seconds is common), the door contact can initiate a couple different events: the air conditioning can shut off until the door or window is closed; the thermostat can display a “door open” alert; an alert can appear in the EMS software, a “door open” alert can be issued to staff via text message and/or email.

Smart Door Locks

Smart door locks know from the information on the keycard whether staff or residents/guests enter a room. The energy management system uses that information to adjust default settings for devices like lighting and HVAC in that room, depending whether it’s staff or residents/guests entering the room. The smart locks will send the EMS “door open” and “door closed” messages.

Platform Software

Think of an Energy Management System as a control panel, with your building equipment and status laid out visually before you. A good EMS performs these functions:

1. *Gathers data from deployed devices*
2. *Analyzes data against settings and expected performance*
3. *Presents actionable data*
4. *Allows control of devices in rooms to balance energy savings and resident/guest comfort*

1. Gathering Data

Energy management software continuously gathers hundreds of data points from the wireless devices within a living space, interacting with each other (thermostats, occupancy sensors, door locks, etc.), and ultimately reporting to the EMS.

2. Analyzing Data

The data that an EMS collects can be as granular as:

- The kWh used per day per HVAC
- Occupancy percent of each room
- Runtime (hours per day) of each HVAC system in the EMS network when in cool mode
- Runtime (hours per day) of each HVAC system in the EMS network when in heat mode
- Amount of time the HVAC was in cool mode while the room was occupied
- Amount of time the HVAC was in cool mode while the room was unoccupied
- Amount of time the HVAC was in heat mode while the room was occupied
- Amount of time the HVAC was in heat mode while the room was unoccupied

The value, however, lies in analyzing this raw data to show broader trends and provide meaningful, actionable insights. Not all EMS systems do this, so look for this feature as you are evaluating EMS systems.

An EMS system can provide analysis such as:

- Which HVACs are working the hardest
- How much energy your property is saving while in heat mode and in cool mode
- How much the EMS is saving you monetarily on an annual basis
- Which systems have the highest and lowest runtimes
- What is your overall cooling and heating runtime reduction percentages

Monetary Setback Savings by Mode
(per unit)

Cool: $404.29
Fan: $11.39
Heat: $574.41
Total: $990.62

Annual Cost Comparison
Cost($) / KWh: 0.092
Cost($) / Therm:0.51

Without Telkonet: $602,405.65
With Telkonet: $338,553.57
Savings: 44%

3. Presenting Actionable Data

Dashboard & Insights

Most energy-management platforms have a dashboard to provide insights and reporting for the property managers and owners. The dashboard can show which rooms are occupied, device performance, individual room heating

trends, energy savings in kWh and dollars, and can provide notifications for any trouble that may occur, such as an HVAC that is working too hard, or a non-functioning thermostat. All of this data allows the operator to be proactive in addressing issues, which keeps equipment healthy and minimizes the impact to users. The dashboard can be an ideal daily check-in tool for building operators and managers, but notifications alone may also be helpful enough for the busy operator.

Alerts

An EMS can display alerts and even send email/text alerts. *Example: If the room temperature dips below 55 degrees in winter, send a text alert.*

Low Battery

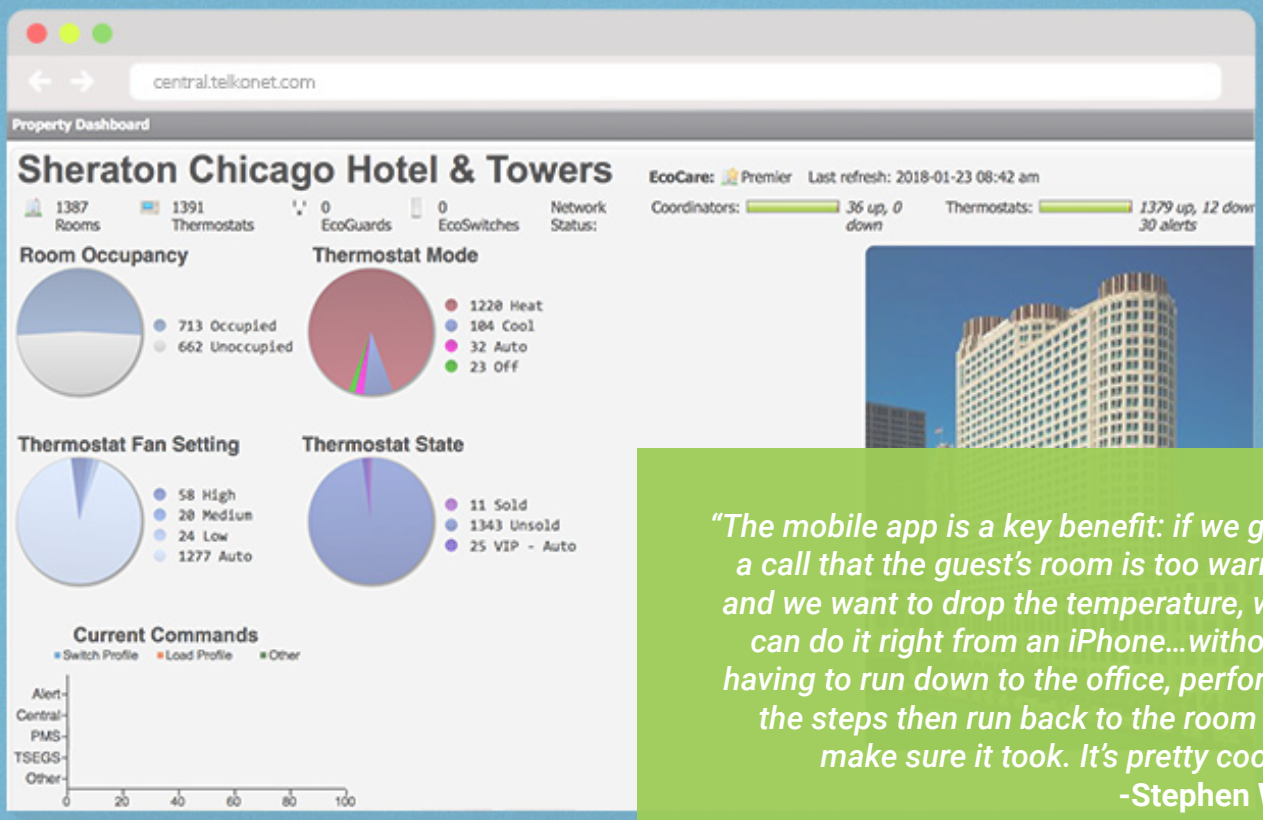
Some smart devices in an EMS, like door contacts and occupancy sensors, run on battery power. The EMS monitors battery life and presents this information, resulting in more proactive and planned maintenance with little disruption to occupants.

Preventative Maintenance

An Energy Management System continuously collects statistics such as runtime hours for every HVAC system on the property. High runtime could be a symptom of old or failing HVAC systems, or perhaps overworked HVACs because they're on the sunny side of a building. In that case you may want to swap them out with low-runtime HVAC systems on the shady side of the building, prolonging the life of your equipment.

Building Facilities Management Apps

Many Energy Management Systems reside in the cloud so you can monitor your property from anywhere, instead of being tied to your office. Carry your EMS with you by downloading your EMS system's smartphone app. Do you manage multiple facilities? Remotely plan your maintenance schedule using the data your EMS collects for you.



"The mobile app is a key benefit: if we get a call that the guest's room is too warm, and we want to drop the temperature, we can do it right from an iPhone…without having to run down to the office, perform the steps then run back to the room to make sure it took. It's pretty cool."

-Stephen W.
A Waikiki Beach Hotel DOE

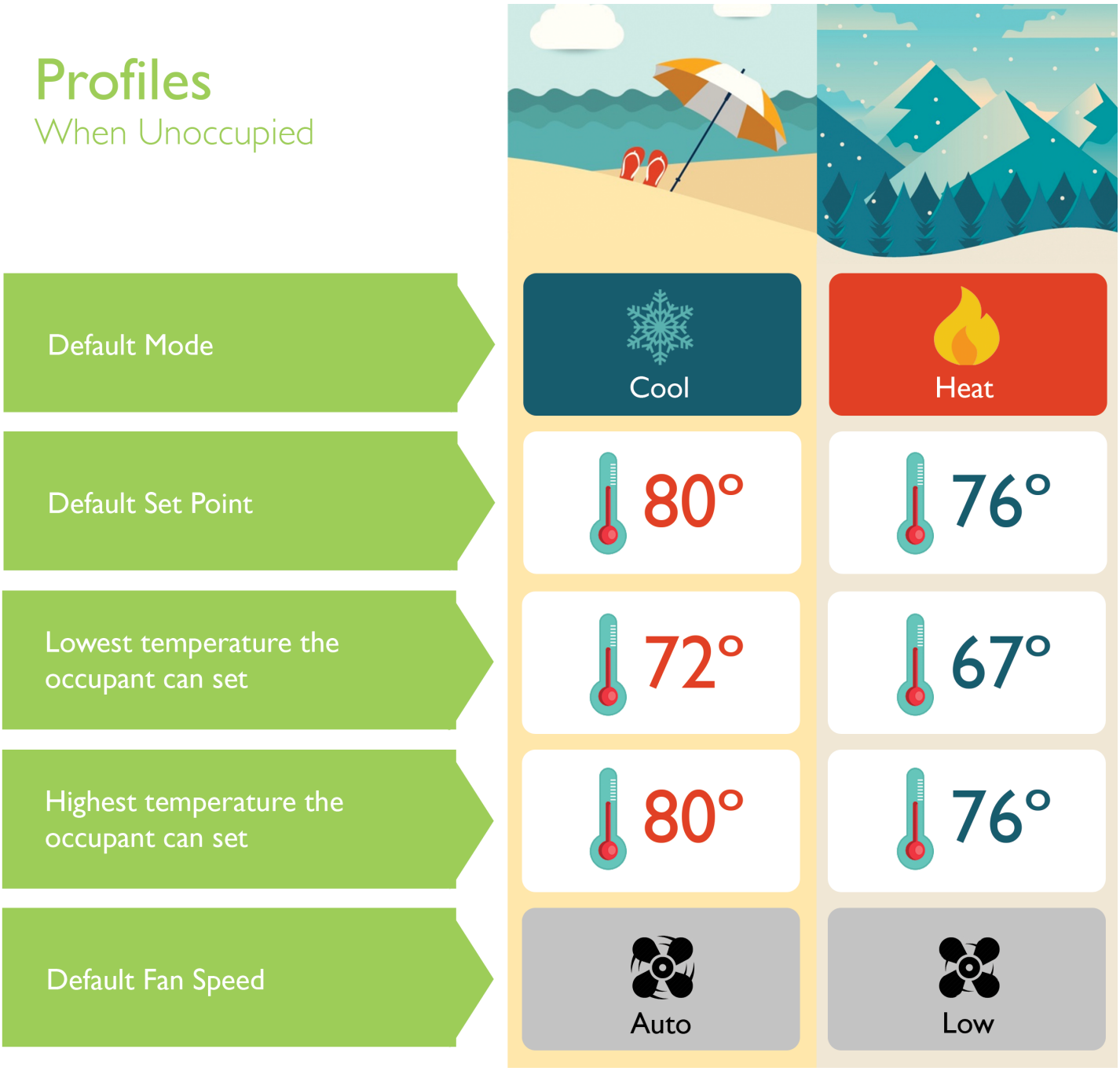
4. Controlling Devices

EMS's offer a number of ways for operators to control their installed devices, both for energy management and for guest comfort.

Profiles

An EMS can create custom "profiles", groups of settings that pre-define how thermostats, outlets, lights, etc. respond to certain events. For example, you can create summer and winter profiles. Below is a partial sample of summer and winter profile settings for a Chicago property, when a room is unoccupied.

Other profile examples are Occupied / Unoccupied rooms, Sold / Unsold rooms, Sunny / Shady sides of your building, and Load Shed (see below). Get creative! Your EMS provider can help you customize your profiles to best meet your needs, and strike the right balance between occupant comfort and energy savings.



Load Shed
Participate in load shedding. If you have an agreement with your utility company to reduce your power consumption on a regularly scheduled basis, it's a perfect fit for an EMS. Cities with aging electrical grids or high density areas such as New York City require businesses to shut off HVAC systems on a regular schedule to save energy. With an EMS in place, you no longer have to send staff to every room to shut down thermostats.)

VIP Override
Create a VIP override. Enable VIP override if the immediate comfort of your occupant temporarily overrules your long term goal of energy savings. By using a VIP "profile", you can quickly and easily override the preset energy management configuration for their individual space, for the duration of their stay.

An EMS can be as generic or as customized as you choose.

- If you're in Hawaii, shut off the HVAC if the **patio door is left open**.
- If you're in Florida, set more **aggressive humidity control**.
- If guest experience is your priority, create a welcome scene when guests first enter the room (have the TV on, drapes open and certain lights on)
- If your PTACs have no **humidity control**, an EMS may be a good substitute.
- **HVAC damper open/damper close** can be automated. When mechanical dampers are always open—which can be the case for fancoils more than PTACs—it allows fresh air into the rooms, but it presents a major problem in hot humid locations like Miami, FL: similar to leaving the front door wide open for an unwelcome intruder, the humidity finds its way into your rooms through the open vents and contributes to mold and mildew in the walls, furniture, carpeting, etc. The EMS can direct the dampers open and closed based on drive time or specific fresh air requirements.

"Telkonet's EcoSmart platform has proven its ability to not only create an in-room energy management network to enhance energy efficiency, but also to streamline remote equipment monitoring and manage maintenance more efficiently to extend equipment life."

- Steve Brandt, Strategic Account Manager
Trane Hospitality

Smart Devices

EMS equipment is "smart" because it sends data like room occupancy, low battery and "door open" alerts to the EMS, and receives commands from the EMS.

Smart Thermostats

Smart thermostats in an EMS system go well beyond the old "setback" thermostats. Many of us remember this old technology: you can schedule temperature setbacks during defined hours when you are confident that the space will be unoccupied. (The "setback" method is still appropriate in places such as office buildings, which typically have scheduled occupancy).

In contrast to setback states, today's IoT-enabled thermostats can allow temperature to drift based on real-time occupancy. The smart thermostat serves as a ZigBee router, which means it sends and receives its own data to and from the server, and forwards (or "routes") data to and from other smart devices.

The smartest thermostats feature a proprietary algorithm whereby they learn just how far a temperature can drift and still return to setpoint within a stated period of time (such as 10 minutes after the resident/guest returns to the room). Beyond typical thermostat capabilities, these smart thermostats in an EMS system actually process data as a local computer engine and forward relevant pieces of that data to the EMS platform.

The EMS analyzes the data and in turn issues commands to the smart thermostat accordingly, with the goals of energy savings, improved efficiency and an elevated resident/guest experience.
The thermostat can then route these commands to the HVAC unit and to other smart devices within the EMS platform; commands such as: Unoccupied-Reduce Energy Usage, Unsold-Aggressively Reduce Energy Usage, Patio Door/Window Open-Turn Off Air Conditioning, Guest Check-In Activate 'Welcome' Scene.

Smart Outlets

Smart electrical outlets have the ability to monitor and stop the flow of power to one or both outlets, shutting off power to the devices plugged into them (lamps, televisions, appliances, etc.). Smart outlets can combat "energy vampires", devices on standby power when turned off, but that still consume energy. The flood of electronic devices contribute to the problem. Here are some common energy vampires[3]:

- Wall warts and bricks
- Cable/satellite boxes
- Digital TV converters
- DVR, VCR, DVD players
- Mobile/cellular devices
- MP3 players
- Video game consoles
- Standby coffee makers
- Devices that turn on instantly via remote control
- Devices with standby light or clock

In the US, standby power accounts for more than 100 billion kilowatt hours of annual U.S. electricity consumption and more than $10 billion in annual energy costs[4]. Smart outlets completely disconnect devices from the power supply, preventing lights and other in-room electronics from needlessly consuming energy. In fact, smart outlets can provide complete control over any device that consumes electricity.

Some smart outlets now feature built-in power

3 duke-energy.com
4 yosemite.epa.gov/opa/admpress.nsf/0/a9f83e777a975e6d852574ef004e3ca7?OpenDocument

meters, providing energy usage data previously available only from expensive metering devices. Depending on the manufacturer, they can measure cost, voltage, amperage, kWh, and other metrics at regularly scheduled intervals (15 minutes, for instance). To help a property perform a detailed energy usage analysis, some smart outlets can provide detailed, time-stamped data to the EMS, including kWh consumption by time of use price [off-peak, mid-peak, on-peak]; occupancy time by time of use price [off-peak, mid-peak, on-peak]; energy usage separated by occupied and unoccupied states, and occupied/unoccupied time in seconds since installation.

Smart Light Switches

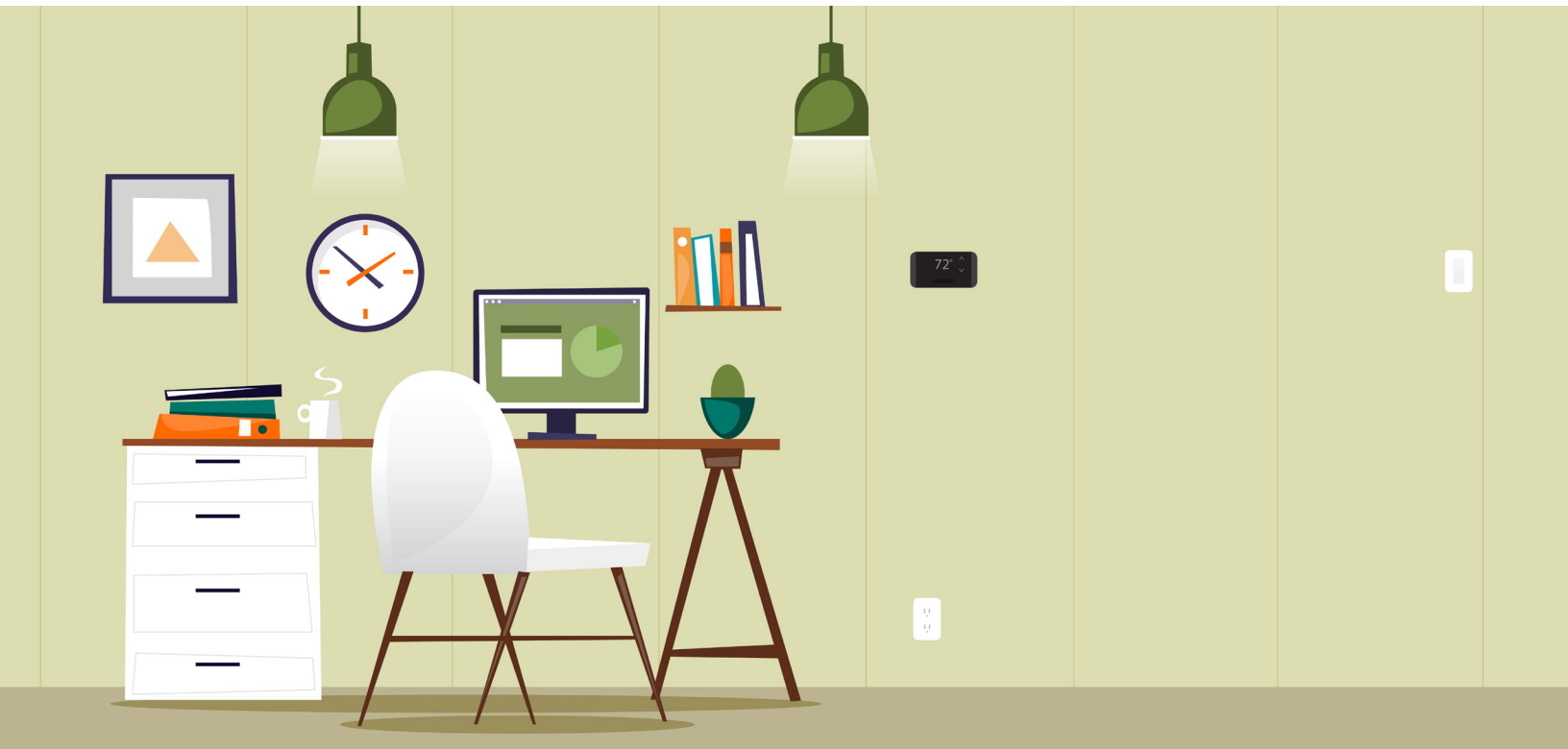
Smart light switches can operate as standard light switches, but also feature sophisticated energy management and reporting capability.

Energy management light switches can control lighting with commands from a smart thermostat or occupancy sensor, a Property Management System, a schedule, or a manual command. Smart light switches have the ability to significantly reduce energy consumption while operating seamlessly as normal light switches. Similar to smart outlets, smart light switches can sometimes report detailed statistics back to the EMS platform to allow the monitoring of accurate energy usage details and real-time savings information. Also similar to smart outlets, smart switches can have built-in true power meters to monitor cost, voltage, amperage, kWh, and other metrics at regularly scheduled intervals. To help a property perform a detailed energy usage analysis, smart light switches can provide detailed, time-stamped data to the EMS platform.

Smart Door Locks

As mentioned previously, smart door locks can serve as occupancy detectors, brands such as Salto, Saflok and VingCard leading the way. They are wireless systems providing 2-way communication between the electronic door locks and-in the case of hospitality-the front desk. The door locks can issue alerts, update keycards, perform room changes and communicate events such as 'room ready', 'door ajar', and 'wandering or standing intruder' as they occur.

Integrating smart door locks into an EMS platform means maintaining and enhancing current electronic door locks by allowing them to communicate within an EMS platform of thermostats, occupancy sensors and light switches over a secure ZigBee network.



ZigBee Communication

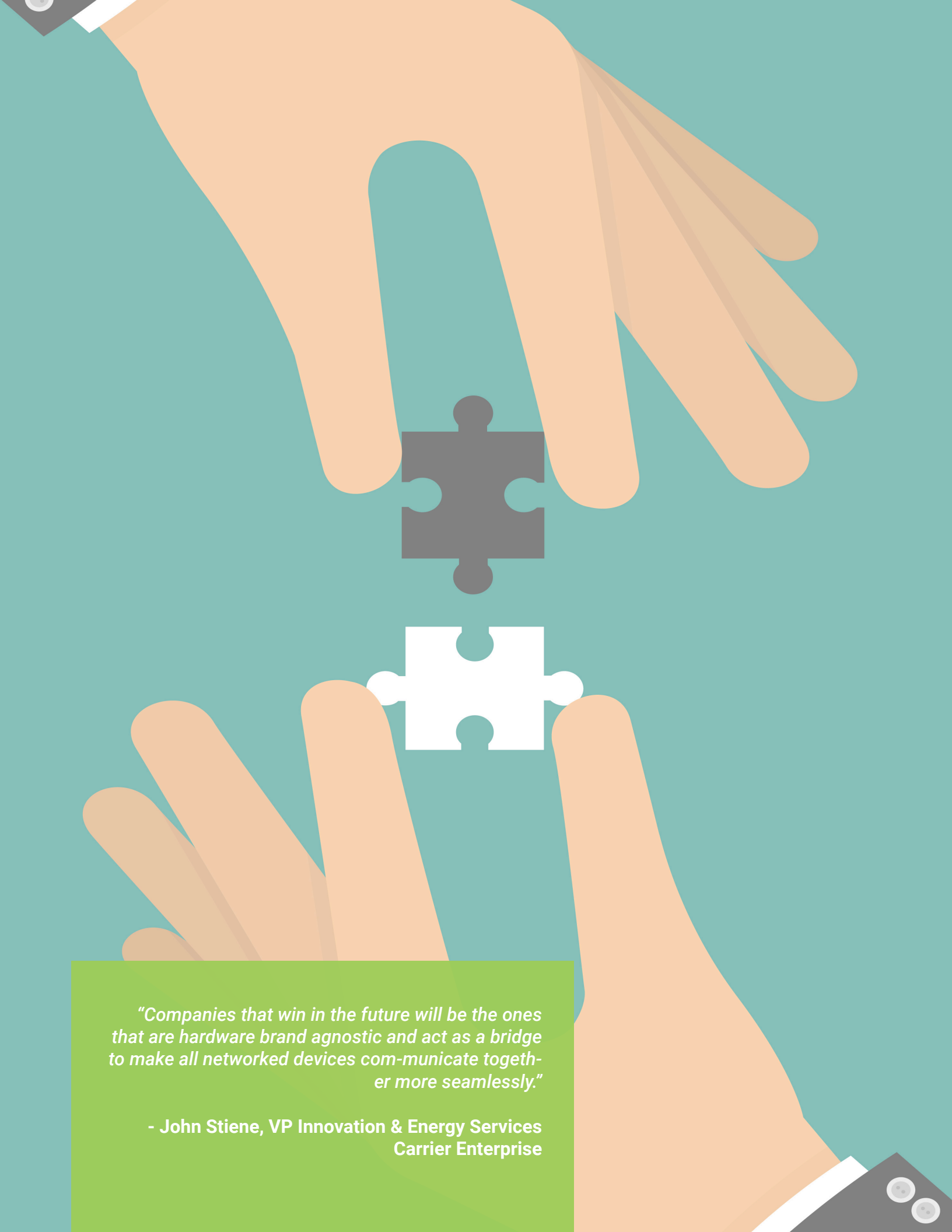
Smart devices are still relatively new and, as such, not yet standardized. Nevertheless, various industries have begun converging their technology decisions. For example, the residential IoT market is slowly replacing Z-Wave with Wi-Fi & ZigBee because Wi-Fi is so common in the residential sector.

Outside the residential market, many EMS devices communicate with each other using ZigBee. ZigBee is a communication protocol: it's a way for devices to communicate with one another. We are all familiar with the term WiFi. ZigBee is similar to WiFi in that they are both wireless communication technologies, but ZigBee is commonly used instead of WiFi in devices like lighting control, door locks, shade controllers and smart power outlets—devices commonly found in homes as well as hotels, dormitories, military bases and multi-dwelling units. Right now you might not control these everyday technologies remotely or automatically, but it's likely you will in the future.

Have you ever noticed how quickly your wireless device loses battery power when you're streaming a movie? It's using WiFi to do that. ZigBee does not use as much power as WiFi, so batteries in ZigBee devices last much longer than batteries in WiFi devices. ZigBee devices communicate in a "mesh" network. That means if one communication path in the ZigBee network happens to fail, a different path within the network is used instead. This is aptly called a "self-healing" network.

You might hear ZigBee referred to as a Mini-WiFi because while ZigBee operates in a PAN (Personal Area Network), WiFi operates in both PAN and the larger WLAN (Wireless Local Area Network). Technically, calling ZigBee a Mini-Wifi not accurate because they were developed under different standards by different alliances.

Devices from different manufacturers (for example, Saflok, Control4, and Telkonet) can work together in the same network when they're all "ZigBee HA Compliant". They're speaking the same language. When shopping for smart devices, look for the "ZigBee HA Complaint" feature. That will help make your investment future-proof.



"Companies that win in the future will be the ones that are hardware brand agnostic and act as a bridge to make all networked devices com-municate togeth-er more seamlessly."

- John Stiene, VP Innovation & Energy Services
Carrier Enterprise

EMS Integration with BMS/BAS and PMS

Sometimes people confuse EMS with BMS or BAS (Building Management Systems or Building Automation Systems), when they are very different technologies.

Both an EMS and BMS can automate building controls such as HVAC, lighting and sometimes metering to varying degrees.

BMS/BAS

Beyond HVAC and lighting, a BMS can automate other systems such as fire, safety and security. Envision how a BMS might be configured: in the event of a fire, a fire alarm panel can shut off dampers in the HVAC system, thereby eliminating the spread of smoke to other parts of the building; it also has the capability to direct all the elevators to return to the ground floor and remain there, eliminating the danger of using elevators during a fire. These technologies are outside the scope of an EMS.

EMS

Building facility managers rely on an EMS to monitor and control energy usage, identify trends, and identify savings opportunities: in other words, to save energy. Energy savings is the primary purpose of an EMS.

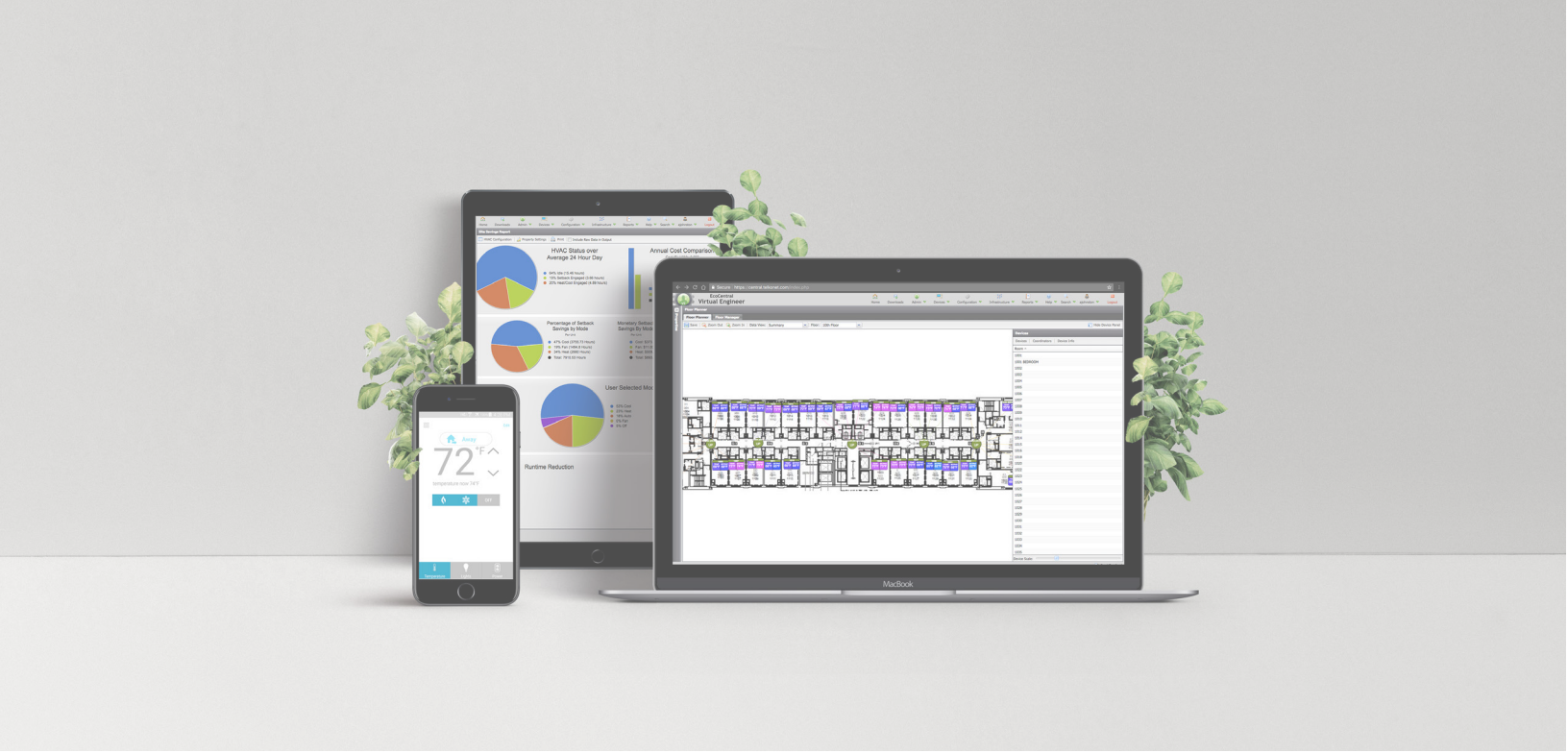
A BMS focuses on the building as a whole; an EMS focuses on individual rooms.

A BMS and an EMS are not competitors. Rather, they can complement each other.

BMS EMS Communication Protocol

BMS and EMS systems can communicate with one another. In order to accomplish this, BMS and EMS systems integrate with a software acting as an intermediary, known as a "communication protocol". It is important to look for EMS platforms that can integrate with BMS systems using open standard software integrations such as BACnet. BACnet is the preferred communication protocol that enables these two systems to communicate with one another. While there are other communication protocols available, BACnet is becoming the most prevalent.

Tridium, Metasys and WebCTRL are some of the largest BMS systems that integrate using BACnet.



Do Energy Management Systems Really Work?

A common complaint about EMS systems is that they shut off while residents/guests are asleep and motionless. A hotel's Director of Engineering, for instance, might get calls in the middle of the night that the air conditioning didn't work, and they'd be forced to override the occupancy detection system so the air conditioning was always on, as if the space was occupied 100% of the time for the duration of the guest's stay.

In fact, there are still building managers who believe EMS platforms in general simply don't work, for that reason alone. This example certainly could be true in the early days of occupancy detection. However, it does not have to be the case today. Occupancy sensors have become infinitely more precise, detecting even the slightest movement.

The ability to reduce the amount of time the HVAC system is running, or the amount of time a light is turned on, or even to utilize blinds to help reduce sunlight and the energy required to cool a room, translates into real reductions in kWh and therefore costs. In fact, it's common for our customers to achieve energy savings of 20% - 40% in their properties. Additionally, the ability to engage their own users, whether hotel guests or students striving to reduce energy usage, is real and translates directly to increased satisfaction and loyalty.

In Hospitality, Engage & Delight Guests

In the hospitality sector, an EMS platform can engage and delight guests in a number of ways. The most obvious is the ability to provide pleasing "welcome scenes" when integrated with the Property Management System. Pleasing lighting, TV messages, music playing can all be activated when a guest enters their room. And incorporating a preferred temperature that's returned to setpoint before the guest enters the room, or shortly thereafter, eliminates an all-too-common guest complaint.

An EMS can even integrate into a hotel's mobile brand application. When a guest downloads your brand's app, the app can potentially automatically know how cool or warm they prefer their room, perhaps their music preferences, etc. These preferences can then be incorporated into the "welcome

scene". In fact, brand apps are even progressing to the point that guests can sometimes bypass the front desk altogether, using electronic check-in and geofencing.

Save Time and Resources

Use an EMS mobile app to remotely adjust room temperature without ever visiting the room, or even returning to your desk. An EMS with mobile device is all it takes. *For example: Plan housekeeping visits by viewing real-time occupancy.*

Identify HVAC systems needing attention and schedule room repairs before they become problems. Or proactively target low in-room device batteries, and then replace those batteries when the guest isn't present.

Prevent Profits from Going Out the Window

Door contacts can sense patio doors and windows that remain open, and because they're integrated into the EMS, the property managers can be alerted. The property has the option of shutting off the air conditioning, and/or displaying a "Door/Window Open" alert on the thermostat. The task of closing them no longer necessarily falls to housekeeping.

Monitoring Set Points

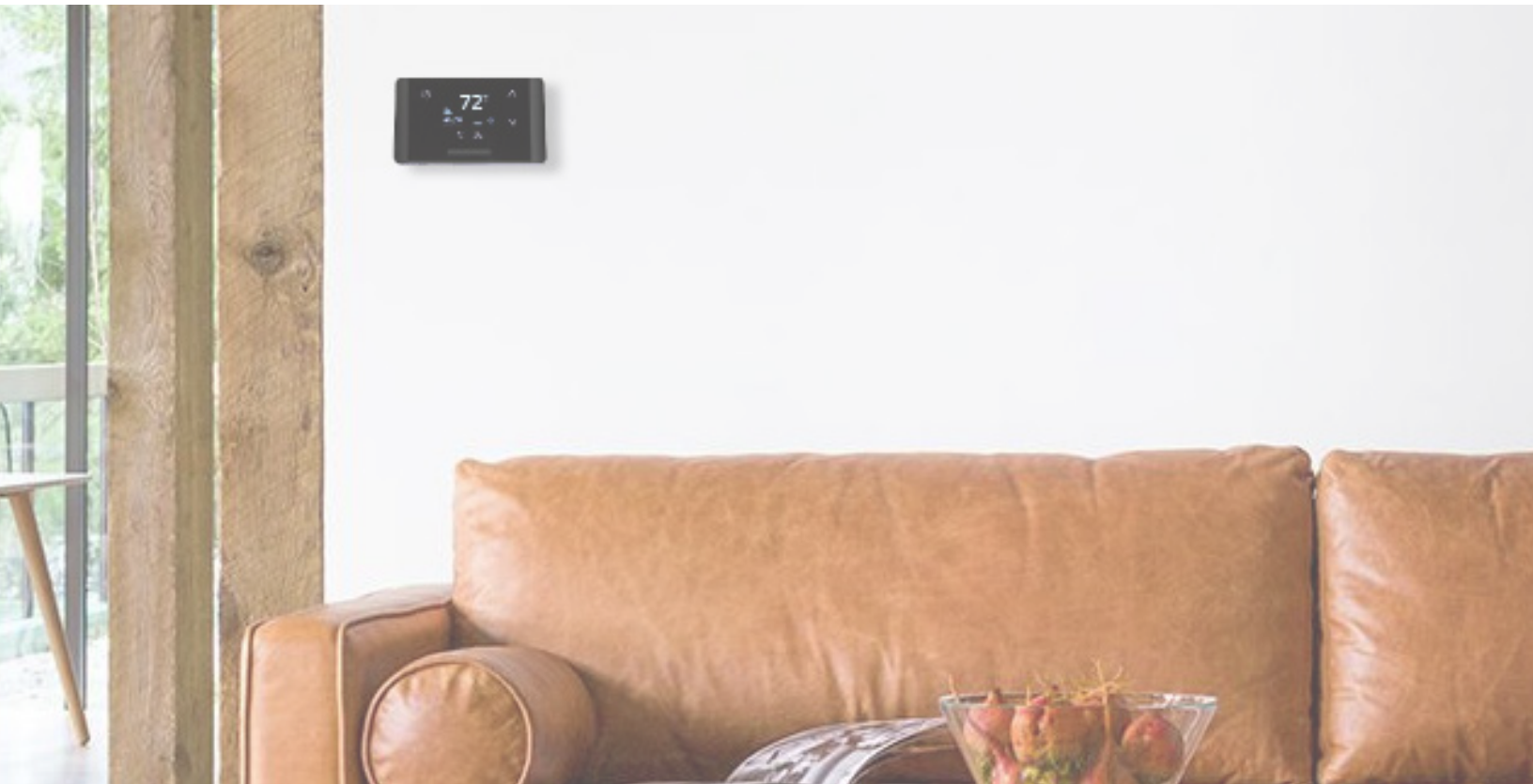
Stephen W, Director of Engineering at a 4-star hotel on the island of Waikiki, uses an EMS to monitor set points. *"I want to ensure there are no set points below 68° with rooms not in VIP mode. I look for discrepancies. I also monitor that VIP status is removed after check-out."*

An EMS can help engineering and facilities managers answer valuable questions about the systems in a facility and how they consume energy. Questions such as:

- How much did my EMS save us this year?
- Which HVACs are working the hardest?
- Which rooms can housekeeping visit right now?
- Which devices have low battery power? How low?

Justifies Itself

When trying to justify an EMS investment, an EMS can inherently provide hard data on the energy it is saving, including the cost of energy with the EMS versus without the EMS.



Conclusion

In commercial buildings, occupants are less concerned about saving energy than they would be in their own homes, where paying utility bills are their responsibility. Energy Management Systems were created to save energy in these environments. Occupant comfort and energy savings: it's not a zero-sum game. An EMS can save energy AND contribute to occupant comfort and satisfaction, ultimately driving brand and property loyalty.

While some occupancy detection devices have been problematic in the past, most of the old pain-points have been addressed, making today's platforms much more reliable and valuable to operators.

Energy Management Systems are investments that pay for themselves. Return on investment, important to all property management and ownership groups, often occurs in less than five years. In fact, Telkonet's EcoSmart Energy Management System typically pays for itself in three to four years.

telkonet®

GREEN ENERGY SOLUTIONS

A Green Way to Save

Green Energy Solutions, LLC
For more information contact a representative
ContactUs.ges@gmail.com or call 708-672-1900
www.GoGreenEnergySolution.com