



An Insider's Guide to
Reaching New Heights
in Industrial Efficiency

There are more ways than ever of optimizing industrial efficiency and productivity. Industrial systems are getting smarter, from simple controllability all the way to intelligent, interconnected facilities. But what's best for you is unique to your goals, needs and day-to-day operation. So where to begin? Our Insider's Guide to Reaching New Heights in Industrial Efficiency walks you through the steps, from indexing your needs and goals to potential solutions, and how to implement them with minimal interruption to the smooth operation of your day to day.

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Introduction: The role of “facility manager” can be a nebulous thing to define. You might be in charge of a hydraulic component manufacturing plant in North Dakota; you may lead operations for an aircraft storage facility in California. Each of these roles comes with challenges and responsibilities unique to the activity inside your facility, but the role of facility manager still boils down to one essential goal: to positively impact efficiencies and productivity across all operations.

There are many ways to accomplish this goal, and it can be challenging to pinpoint what fits best with your facility and your managing strategy. Indexing your critical needs is a good place to start: What are my biggest challenges? My biggest demands? And at the end of the day, how does this make a broader impact on the overall goals of the business? How am I creating value for my organization?

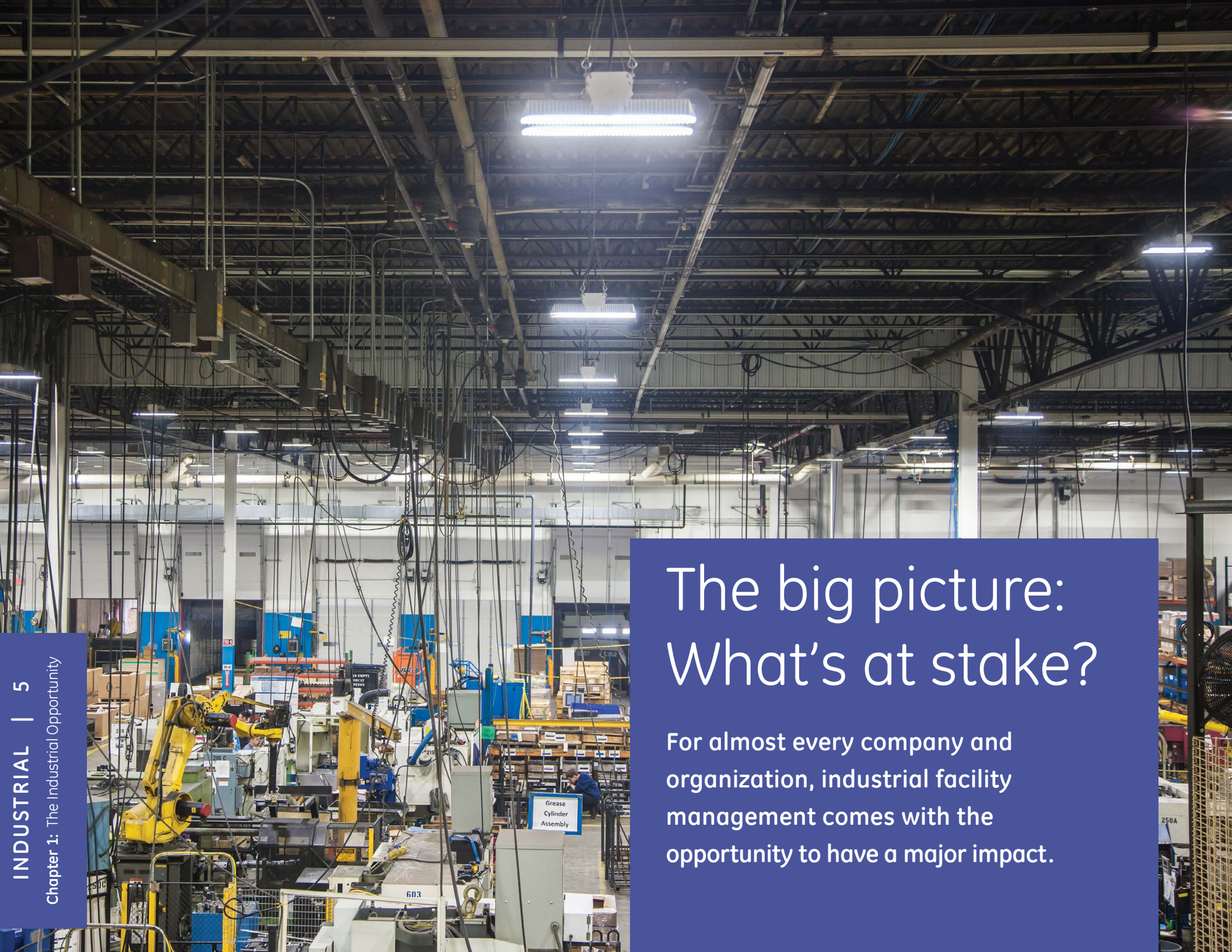
Chances are, you have a good handle on these things, and you’re consistently striving to make improvements—all while maintaining smooth operation and workflow—across all facility operations. It’s why you’re reading this.

An Insider’s Guide to Reaching New Heights in Industrial Efficiency brings together the opportunities you can seize today. Interconnected industrial systems now flourish with the potential to bring untapped efficiencies across your facility, from lighting to HVAC and so much more. Here, you’ll learn what you can do to make this a reality.



Chapter 1:

The Industrial Opportunity



The big picture: What's at stake?

For almost every company and organization, industrial facility management comes with the opportunity to have a major impact.

A Hypothetical: If you were asked to reduce the operating costs of your facility by a percentage, how would you do it?

But what defines impact? Facility managers (FMs) face challenges of all different natures—challenges unique to facility management and challenges specific to that of your given industry. Facility management takes both business intelligence and emotional intelligence; an eye for cool calculation; and excellent people skills. The International Facility Management Association (IFMA) defines facility management as “a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place and process.”

Facility management takes the ability to identify and seize opportunities in order to benefit the company's bottom line. And excellent facility management involves creating opportunities and acting upon them.

When thinking about making an impact, a natural inclination is to focus directly on dollar signs. After all, creating value for shareholders is a major driver for corporations—but even if your facility is privately owned, bringing value to ownership is a primary part of your job. But driving down simple costs is only one piece of a complex puzzle. Indeed, in IFMA's [*2014 Trends Report*](#), Maureen Ehrenberg, global director for FM at CRBE, a global real estate and consulting firm, notes: “As an industry and depending on the scenario, there are opportunities to have a productive conversation within [many] areas, but often it digresses into basically a cost-reduction exercise.”

Excellence in facility management involves identifying and creating opportunities, and acting upon them.

Making a true difference involves adding value, optimizing the day to day of your facility for productivity and efficiency, and bringing new ideas to the table. It also involves thinking holistically across all functionality of your environment. Where should one begin looking for these opportunities? Here are a handful of top-level ideas to get you thinking:

Long-term Solutions

Making a more efficient facility means taking both big and small actions. But the one question you should ask about any fix is this: Are your purchases and solutions forward looking? Strategic facility management involves planning for tomorrow as well as today. Simply put, every decision you make has lasting effects, and each should be viewed as an investment in the future of your company.

The Optimized Workspace

Your facility is complex, involving countless intricacies that all affect the work that can occur within your space. Are all areas optimized for workers to be their most productive? Are you applying the same strategies to each space, or do you have individualized plans to best suit those areas' unique needs? These options range from simple ergonomics (think cushioned mats where line workers may remain stationary on their feet for hours at a time) to major facility infrastructure improvements.

Sustainability

Energy efficiency in industrial facilities can be viewed as a burden—but this shouldn't be the case. Improving the energy efficiency of your facility can lead to a variety of recouped costs, from major savings on energy bills to potential federal energy rebates and incentives. What opportunities exist here that you can be making the most of?

Get Smart

Intelligent controls are becoming ubiquitous, and the average industrial facility is ripe with opportunity to implement these advanced solutions. From simple lighting controls to complete integration of all operational systems, it is worth investigating the possibilities at your facility.

Harness Data

It's probably something you've heard in both your professional and personal life, and there's no escaping it—big data is all around us. And part of optimizing your industrial facility for productivity and efficiency is about harnessing that data. Modern industry is undergoing great transformation, and that's in no small part due to the availability and prevalence of data and the Internet of Things.

What is the "Internet of Things?"

Simply, it collectively refers to all things that can connect to the Internet, and it can help offer unprecedented value by exchanging data between devices, systems and services.





Three Keys to Effective Facility Management



Planning:

It takes long-term vision to keep your facility running at its best—that means planning, strategy and thinking about the big picture. How do today's decisions affect operations and the company's business as a whole?



More than Your Own Job:

It's more than the daily ins and outs of smooth facility operations—it's knowing the business. What are the challenges in your specific industry and in your role as facility manager? How can you contribute to top-level goals?



Leadership:

You're the facility manager—and it's your job to lead. From low-level operations improvement to developing strategic, long-term initiatives, your organization depends on you to take charge. How are you displaying leadership in your role? What are your big ideas?



“Industry”— An American Inspiration and a Catalyst for Energy Efficiency

Think of what it's taken you to get where you are today. Not just your own career—but the history of American industry.

“Industry,” going by a loose definition of the term—simply, the making of things used all over the world, from automobiles to airplanes to machine tools to, well, just about anything you can think of—is part of the fabric of America. It began in the homes of our colonial forefathers, providing for their individual communities, through the turning of centuries, into the high-tech processes that many of us take for granted today. We take pride in it, confident that the things we make are the product of ingenuity and plenty of hard work.

It's also taken a lot of energy. According to the [U.S. Department of Energy \(DOE\)](#), much of the energy consumed by industrial facilities comes from—HVAC, ventilation, lighting and more. The DOE estimates these support functions account for up to 33 percent of all energy consumed by manufacturing subsectors. Further, DOE estimates that annually, “U.S. manufacturing buildings used approximately 2 quadrillion British thermal units (Btu) (including electricity-related losses)—more than the entire U.S. food processing industry and more than 4.4 percent of U.S. manufacturing energy consumption overall.”

Those are significant figures by any measure, and it's a large canvas for all industrial decision makers to make strategic improvements—not only for the benefit of their own bottom line, but to be better corporate citizens and good environmental stewards.

As American industry continues to evolve, one of the most important ways it can do just that is to become more efficient, using energy more intelligently, creating the best possible output with the smartest possible input. The U.S. Department of Energy recognizes this critical part of our future, funding the research,

development and demonstration of highly efficient and innovative manufacturing technologies. It's a work in progress, but make no mistake: It's working. In 2013, the DOE **estimated** that through its Better Buildings, Better Plants Program, over 1,750 manufacturing plants across the United States have saved \$1 billion in energy costs and approximately 190 trillion Btu—the equivalent of around 11 million metric tons of CO₂ emissions.

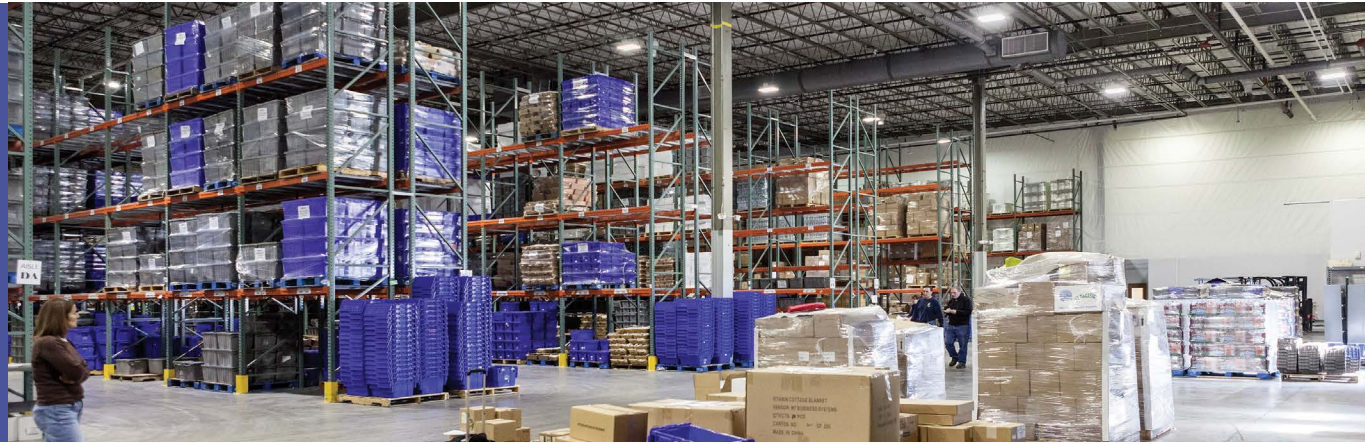
Elsewhere, the DOE's American Manufacturing Office (AMO) offers services to small and medium businesses to help kickstart advanced manufacturing processes and to invest in emerging clean energy technologies. Per the office:

Manufacturing converts a wide range of raw materials, components and parts into finished goods that meet market expectations. Game-changing investments in Advanced Manufacturing—efficient, productive, highly integrated and tightly controlled processes—have the potential to fill the innovation gap between research and full “to scale” industrial production. As an end-user sector, manufacturing is the most diverse in the U.S. economy in terms of its energy sources, foundational technologies and the products manufacturing produces. In 2012 (unless otherwise indicated), U.S. manufacturing was responsible for 12.5 percent [1] of GDP, direct employment for about 12 million people [1], and 70 percent [2] of all business R&D performed (in 2010 and 2011); and close to 75 percent [3] of U.S. exports of goods; production of 17 percent [4] of the world's manufacturing output; and 25 percent [5] of U.S. energy use.

All of which is to say—American industry remains a force to be reckoned with. There's a lot to accomplish, and much of it begins with efficiency.

Big Energy Savings—By Choice or Necessity?

Energy efficiency continues to be a big deal, and there's reason to stay ahead of the curve.



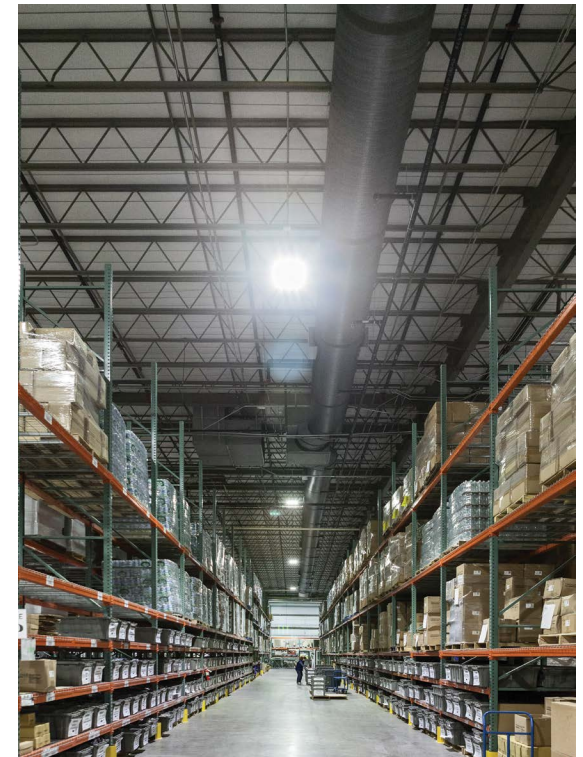
As we've noted earlier in this book, sustainability and energy efficiency concerns are top of mind for organizations around the globe. And you've probably considered undertaking an energy project—either by choice or necessity.

A **2011 study** conducted by the Economist Intelligence Unit, surveying 348 senior executives from North America, Asia-Pacific and Western Europe, found that improving industry energy efficiency was “a clear pre-requisite for long-term financial growth.” The study further notes that firms that continually seek improvement in energy use were poised for greater success.

There's more: Not only can ENERGY STAR® certification lead to lower energy bills, but it's been **mandatory for federal buildings since 2009**. Consider also that **ASHRAE 90.1**, the world's most adopted building energy code, was updated in 2010 to include intelligent lighting control requirements for all new construction adherent to the code. Elsewhere, the California Energy Commission's **Title 24 Energy Efficiency Standards**, effective in 2014, also include the use of advanced lighting controls.

In fact, the way your facility manages its lighting is critical to overall building efficiency, and it's a trend that has been growing in the industrial sector for years. Take the **DesignLights Consortium**, for instance: Operating since 1996, the organization seeks to promote “quality, performance and energy-efficient commercial sector lighting solutions” in the lighting industry from top to bottom. The organization makes available its Qualified Products List, a resource for efficiency seekers that qualifies lighting solutions as dependable.

And that means you, as facility manager, have the power to enact this change in your facility, to better your company's bottom line and lead to greater profitability. You can wait until energy-efficiency upgrades are mandatory, or you can stay ahead of the curve.





The Industrial Internet and Bold Ideas for the Future

The convergence of digital and physical systems in the industrial world is creating a profound transformation in how we think about all systems, not the least of which is our lighting. In today's interconnected world, lights are no longer isolated devices that provide just illumination. Thanks to the Industrial Internet, lights have become part of the business intelligence landscape by capturing data and communicating with other interconnected devices via the Cloud.

The Industrial Internet blends "big data" analytics with the Internet of Things, enabling companies to use sensors, software, machine-to-machine learning, plus other technologies, to gather and analyze data. Businesses then use those analyses to manage operations and offer valuable services.

Lighting systems embedded with sensors and networking capabilities can provide valuable data related to lumens, occupancy levels, environmental conditions, inventory levels and much more. As a result, the Industrial Internet makes lighting considerably more important to large enterprises.

By expanding the sensing capabilities of LED fixtures and enabling connectivity to other devices, GE is moving far beyond energy management to actionable business intelligence. We can imagine a day when lighting fixtures are equipped with cameras and sensors that can help identify and track activity. Fixtures may contain speakers for broadcasting emergency warnings or Wi-Fi capabilities for providing wireless service. And there's plenty more. All of these capabilities are tied back to the interconnected nature of the Industrial Internet to enable data capture, analyses and action.

Chapter 2:

A Reason to Act

It's one thing to identify opportunity.

It's another to act on it.

Committing to a capital investment is no easy task, especially when time is money, and money is tight. But there are plenty of opportunities to take action. And seizing some of these opportunities can make a big difference for your organization.

Smarter, Stronger, Sustainable: The Case for Energy Efficiency

Pursuing heightened energy efficiency is about more than simply cutting your bills and complying with government regulation or building codes. It's a growth market, and you can take advantage.

In its **2015 Annual Energy Outlook**, a comprehensive report forecasting energy consumption and growth through 2040, the U.S. Energy Information Administration (EIA) predicts several trends that will contribute to the ongoing importance of energy efficiency. Among them:

- "Rising costs for electric power generation, transmission and distribution, coupled with relatively slow growth of electricity demand, will produce an 18 percent increase in the average retail price of electricity over the period of 2013 to 2040."
- "Rising long-term natural gas prices, the high capital costs of new coal and nuclear generation capacity, state-level policies and cost reductions for renewable generation in a market characterized by relatively slow electricity demand growth favor increased use of renewables."

In light of these trends, the opportunity exists for companies of all stripes to capitalize on becoming more energy efficient. Industrial facilities in particular are well positioned to take advantage. Says the American Council for an Energy-Efficient Economy: "The industrial sector

offers tremendous opportunity for energy savings and a significant opportunity to instill the tenets of energy efficiency within facilities that, in turn, employ and influence millions of people."

Think about it: As we mentioned earlier, much of the industrial sector is constantly striving to create and maintain value for owners and shareholders, and pursuing energy efficiency can be one of the most reliable ways to meet those goals. Energy efficiency will become a necessity—if not in the very near future, soon after that. Deploying smart energy-efficiency solutions can contribute to innovative business models and help boost competitiveness in an increasingly global economy.

And it's truly about more than simply benefiting your company—efficiency in industrial facilities is good corporate citizenship, and it can have a ripple effect across all facets of the business. The dollars spent to keep the lights on in your plant or facility directly affect the ways the organization spends and conserves dollars. More spent on energy bills can mean less spent on salaries, development, innovation and more.

So what can you do about it?



Energy Efficiency vs. Energy Conservation: They're not the same. Energy conservation refers simply to saving power by using less of it: turning off the lights, unplugging idle electronics and more. Energy efficiency refers to creative and intelligent use of energy via technology, including intelligent controls across various systems—anything that uses power. Energy efficiency has become of particular importance as the world faces rising energy costs and a heightened focus on reducing emissions and greenhouse gases.

Top Projects to Consider

Discover several ways, from simple to state-of-the-art, that you can boost efficiency inside your facility.



Motivated to make a change? There are many ways in which you can pursue energy-efficiency goals, from simple to sophisticated. Here's a quick list of some of the most readily available ways you can add value through efficiency:



Simple Power Management:

Let's start with the basics: It can start with more thoughtful use of your electronic equipment. According to the U.S. Environmental Protection Agency, idle electronics make up for large portions of wasted energy across the United States. Collectively, the EPA estimates that total electricity consumed by electronic devices not in use is equal to the annual output of 12 power plants. You can implement some basic measures to chip away at that figure—ensure your facility is using **power managing energy strips**; and if your facility houses a large computer infrastructure, you can work with the IT department to ensure power settings are optimized among users.



Optimize Controls:

According to **a recent peer-reviewed study** published by Consulting Specifying Engineer magazine, integrated systems have made huge strides in the past few years. Where once it was thought overly complex to link lighting controls with HVAC, recent breakthroughs in control

technology have made this a more attainable and cost-effective strategy to better manage energy use in large facilities. Further, overall intelligent building design is **growing in prominence**. It takes strategy and coordination to successfully implement, so make sure you seek an expert partner to help make this goal a reality.



Evaluate Your Lighting:

Replacing old, inefficient lighting and lamps across your facility is one of the most reliable ways to effect instant change in your facility. If it's been a while since your organization has thought about its lighting needs, it's time you took a closer look at the options.

Aesthetic benefits now frequently dovetail with potential energy savings and ROI. Not to mention, a lighting redesign will make your facility look better and help provide a more pleasing environment for employees, customers and visitors.



Harness the Outdoors:

It may sound too simple, but your landscaping can have a major impact on your energy costs.

Just as humans tend to seek shade on a hot day, your facility can benefit from any natural shade that's provided. **Research shows** that planting

strategically placed trees can be an effective means of combating "heat islands" in urban areas and can have a beneficial impact on cooling costs for large facilities via shading.



Go Solar:

Solar power is increasingly attainable and prominent. According to a **2014 Ernst and Young report** on U.S. capital investment, solar and wind energy installations accounted for \$15 billion of investment in 2013. GE's solutions for on-site solar energy generation can directly benefit commercial and industrial sites. Electricity costs can be slashed, annual energy spending can be rendered more predictable for lower overall operating costs, and sustainability goals can be met and exceeded. **Our solar solutions** are wide ranging, and our experts can help you best determine your facility's unique potential.

Diverting and harnessing natural light works inside your facility, too. Many facilities have taken advantage of industrial shades and window films in order to block the heat of sunlight. And it's not just about keeping the sun out—taking advantage of the natural light via daylight harvesting and smart controls can be another way to manage your lighting and energy costs.

Upkeep and Maintenance: Critical to Overall Efficiency

The day-to-day realities of keeping your facility functional are many. Maintenance projects range in complexity, but the bottom line is the same: Downtime must be minimized in order to keep your business moving forward and operating as efficiently as it should.

Doing what you can to minimize that downtime is directly tied to bringing value to the organization. Scheduling routine maintenance checks is imperative, as is continuous monitoring of all of your facility's systems for potential issues. It's also crucial to consider where items can be upgraded or replaced. Outdated infrastructure can mean big headaches, with breakdowns, outages and more, keeping your business from flourishing when and where it needs to.

Put simply, industrial downtime is the enemy of efficiency—and of your bottom line. Maintenance means in-house personnel are working to fix a problem, rather than production or business goals. Maintenance means potential safety hazards if something's broken. Unscheduled maintenance means that you're less in control of your operations than you should be.

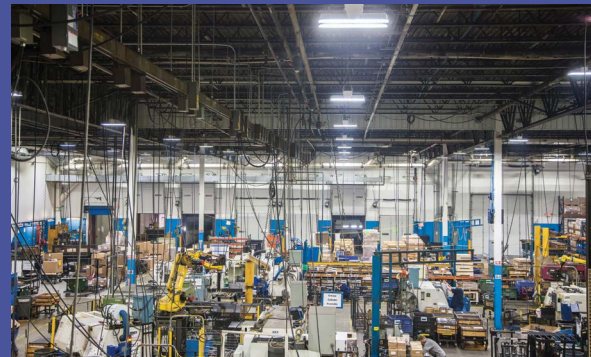
"Downtime" frequently brings to mind a system's failure—a manufacturing line breaks down for one reason or another, halting production. But there's much more that can slow down your facilities, and much of it has to do with the everyday systems that are only thought of when they fail.

Think about it: There's a good chance your facility runs multiple shifts per day, if not 24/7. That means a critical need for reliability in everything that makes your operations flow smoothly.

Take, for instance, your lighting system and how essential it is to keep your facility running smoothly. Flipping on a light switch at home to find an expired bulb might be a minor annoyance, but for an industrial facility, the implications are greater: High ceilings often make lighting a less than a simple fix, requiring specialized equipment.

Situations like a failed bulb highlight the importance of selecting and maintaining reliable equipment. And in recent years, it's one of the reasons that LED lighting systems have come to greater prominence in industrial facilities. LED systems offer a long-lasting solution for this very problem. Rather than burning out, LEDs simply become dimmer over time, and many have an expected lifespan of more than 100,000 hours. Incandescent bulbs last a fraction of that at 1,000 hours while comparable fluorescents top out near 10,000 hours.

This kind of thinking—what works for your facility in the long term—can begin to lead to systems and solutions that can bring a serious impact to your bottom line.



Going Deep to Improve Efficiency

There are plenty of simple, practical measures one can take to improve a facility's energy use, but enacting significant change takes time and effort—not to mention intuition and ingenuity.

We've mentioned how smart controls and sensors can have an impact on energy use. If a room can sense whether or not a human is currently occupying it, the room can know whether to lower the heat, dim the lights or otherwise alter some kind of operation based on a predetermined system.

And the granularity with which sensing technology may soon be able to accomplish these goals might surprise you. Take, for instance, a [2013 study](#) by the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL) that found how commercial facilities could save up to 18 percent of overall annual energy bills by combining sophisticated new sensing technology with ventilation systems.

It worked like this: Ever walk into a room and the light above you turned on in recognition? Well, many modern systems can't distinguish if it was just you who walked into the room or you and 20, 50 or 100 additional people. The implications for large spaces then, are significant: If an HVAC system can't count the bodies in a room, it may be providing enough airflow for 100 people even if it's just you in there.

This study, then, was based on extensive simulations using a device that was able to customize ventilation by sensing the number of people in a given area or zone. ***Per lead author of the report Guopeng Liu:*** "This is the reason you often feel cold when you're in a big space like a conference room or cafeteria without a lot of people. Technology available today doesn't detect how many people are in a room, and so airflow is at maximum capacity nearly constantly. That creates a big demand to reheat the air before it enters the rooms. It takes a lot of energy to keep you comfortable under those circumstances."

The study's results were profound: PNNL estimated that in most U.S. climate regions, these types of sophisticated controls could help save buildings at least \$40,000 per year and up to \$100,000. Much of that 18 percent figure comes from HVAC, and a portion comes from linking the new sensors with lighting.

And while the focus is on commercial office buildings specifically, the implications are there for all manner of facility types—industrial areas especially, in some cases. Many industrial facilities contain large spaces, and the imminent ability to sense and control systems based upon the specific occupancy.

Elsewhere, the challenge of establishing a "zero net energy" (ZNE) facility is gaining traction—a facility that uses the annual energy equivalent of that provided by on-site renewable energy sources, according to the [Alabama Center for Sustainable Energy](#). These types of facilities aren't "off the grid," as they can use energy from outside sources as needed—or conversely, sell off additionally generated energy if possible. It's a big idea, and it's the kind of thinking that is driving a new generation of energy-efficient buildings and facilities across the United States (stay tuned for a case study on how lighting contributed to a [zero net energy facility](#) later on in this book).

So where does that leave us?

Now that you've considered the possibilities, it's time to investigate potential action and which specific solutions can have a big impact on your facility.



Chapter 3:

The Start of a Bright Idea



Once you know what's on the table and have considered the possibilities, it's time to dig into what's right for your facility. How can you best identify what will work for you? What are the proven solutions available today?

QUESTIONNAIRE

Take this brief quiz, and see where you land:

- 1 | Can you reduce energy costs in your facility?
- 2 | Are you able to reduce ongoing maintenance costs?
- 3 | Is proper visibility a challenge in your facility?
Are certain areas difficult to light properly?
- 4 | Have you identified potential capital improvements?
Have you been asked for a recommendation?
- 5 | Can you take advantage of local or state incentives
to help reduce energy consumption at your facility?
- 6 | Have you been recently asked for solutions to improve productivity?
- 7 | Does maintenance for your lighting system present a challenge?
Do you suffer increased downtime when needing to replace bulbs?
- 8 | Is there incentive for your facility to achieve DLC certification?

If you've answered "yes" to more than half of these questions, it's worth your while to seriously consider what a lighting upgrade can accomplish for your facility. If your business goals involve reducing energy, seeking certification and incentive, and improving overall look and feel for optimized visibility and productivity, nowhere in your facility is there a more fitting solution than a comprehensive lighting upgrade.

But a lighting upgrade comes with many important considerations. What will work best for my facility and my specific needs? How should I go about selecting a lighting provider? Which types of lamp will work best? How do I know which types of light and light levels work best for different areas of my facility? Which technologies will best contribute? How can I sell the idea to my superiors?





Catalog of Terms

As we begin to explore how infrastructure and intelligence can impact industrial operations, it's important to speak the language. Take a minute to brush up on these key terms for industrial lighting:

Infrastructure – Lighting

- **Color Rendering Index**

An international system (based on 0-100 scale) used to rate a lamp's ability to render object colors (the higher the CRI, the richer colors generally appear); Numerical comparisons of different lamps are only valid if the lamps are close in color temperature (CRI differences are typically not visible to the eye unless more than five points)

- **Daylight Harvesting**

Using daylight to offset the amount of lighting needed to adequately illuminate a space; Achieved with lighting controls with the purpose of reducing electricity use

- **Dimming**

Adjusting lumen (light) levels over a set (step) or linear (continuous) range with the goal of setting the atmosphere or reducing energy use

- **Efficacy**

A measurement of how effective a light source is in converting electrical energy to lumens of visible light; Expressed in lumens-per-watt (LPW)

- **Fixture**

See Luminaire

- **Lamp**

The term used to refer to the complete light source package, including the inner parts as well as the outer bulb or tube; "Lamp" is also commonly used to refer to a type of small light fixture such as a table lamp

- **LED**

Short for light-emitting diode; As light sources, LEDs act as semiconductors similar to silicon chips; Illumination is achieved by the movement of electrons through a semiconductor material, rather than by sending an electrical discharge through an ionized gas

- **Lumen**

Measures the quantity of light emitted by a source; A dinner candle produces about 12 lumens while the traditional 60-watt incandescent bulb provides about 840 lumens

- **Luminaire**

A complete lighting unit consisting of a lamp (or lamps) and ballast or driver (when applicable) together with the parts to distribute the light, position and protect the lamps, and connect to the power supply

- **L Rating, or rated lumen-maintenance life**

Rated lumen-maintenance life measured in hours with associated percentage of light output; For example, an L70 of 30,000 hours indicates the LEDs produce 70 percent of initial light output at 30,000 hours of use

- **LPW/Lumens Per Watt**

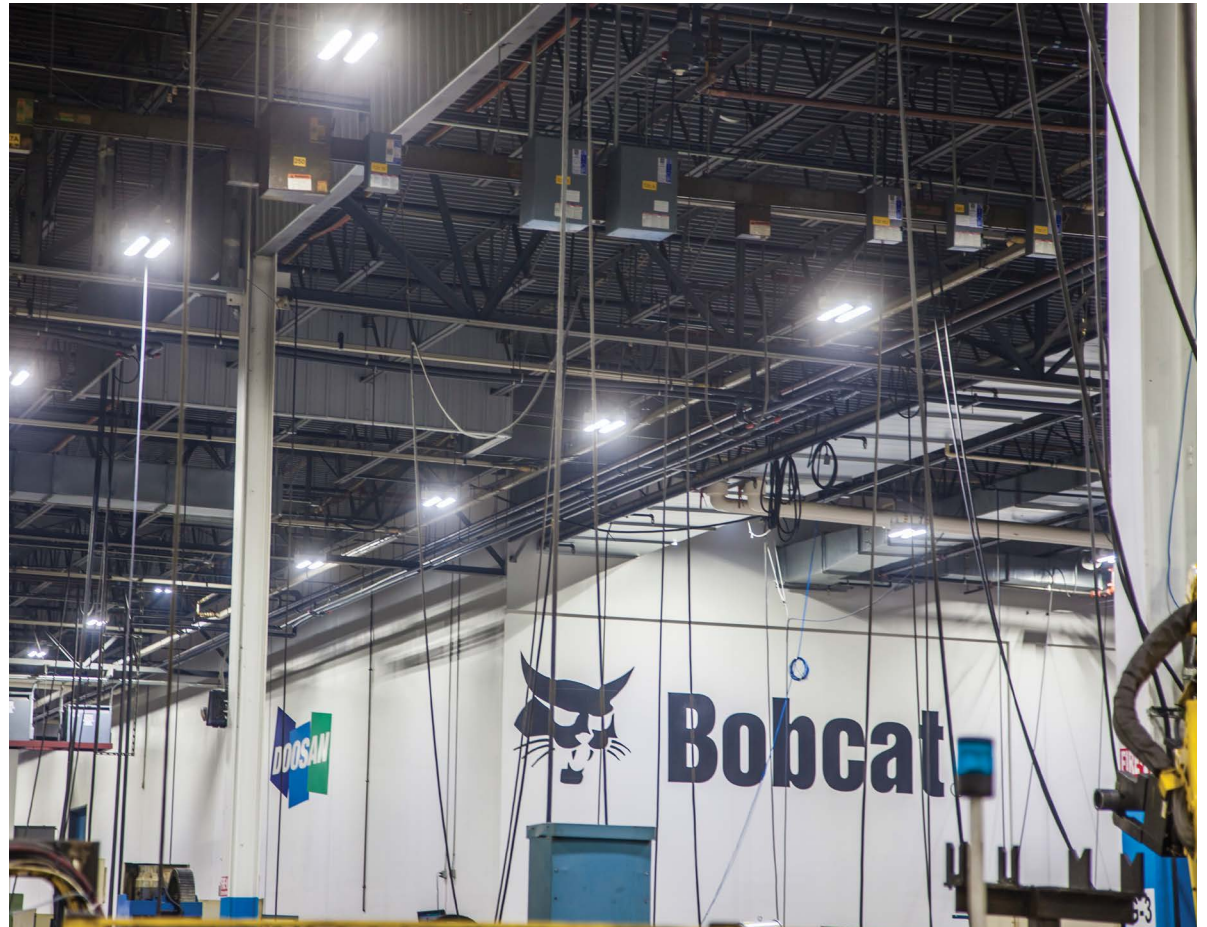
Luminous efficacy, or the measurement of the rate at which a lamp converts electrical power (watts) to light (lumens); Expressed in lumens per watt (LPW)

Infrastructure – HVAC

- **Building Automation System (BAS):**
Automatic central control of lighting, heating, cooling, ventilation and other building systems with the goal of increasing efficiency and ensuring occupant comfort
- **Demand Controlled Ventilation (DCV)**
The automatic adjustment of ventilation needs to meet occupant demand using sensors and controls
- **Variable Frequency Drive (VFD)**
An electronic system that provides infinitely variable speed of three-phase AC induction motors, controlling the flow of air and water in HVAC systems to save energy
- **Variable Air Volume (VAV)**
A system where air delivery volume varies directly with the changing cooling or heating load, thus saving energy at part-load conditions

Intelligence – Operations

- **Big Data**
A broad term for data too large or complex for traditional database management tools; Data sets can be mined for a myriad of information depending on industry
- **Industrial Internet**
The integration of efficient hardware with Internet-enabled software to create powerful outcomes for business; Brings the concept of the Internet of Things and Big Data together; A term coined by GE
- **Integrated (Intelligent) Controls:**
Where lighting and HVAC controls are networked to a single platform/BAS; Allows facility management to be more seamless and strategic



- **Intelligent Environments**
Using LED lighting installations to connect, collect and analyze data being generated by devices in homes and businesses and across cities; Leveraging the power of the Industrial Internet to help cities run better while providing new services and conveniences for residents
- **Internet of Things (IoT)**
Describes a world where machines and computers—including objects like light bulbs, appliances and other electronics—are connected and can interact with each other and their environments
- **Visible Light Communication (VLC)**
Wireless communication technology using lighting; Transmits light pulses opposed to through optical fiber; These light pulses are not visible to humans but can be detected by mobile devices

The Right Light

Industrial facilities present unique challenges for lighting concerns. With ceilings that most commonly exceed 20 feet in height (and often taller), the need for clean, clear, powerful light is priority No. 1. This necessity is compounded by the fact that industrial-classified facilities commonly house massive machinery or equipment, which must be attended to and operated with care—and proper visibility.

In short, lighting an industrial facility is high stakes. The right choice is critical.

For Bobcat® Company, headquartered in West Fargo, North Dakota, the right solution for their recent lighting upgrade came in the form of high bay LED systems throughout its Wahpeton manufacturing plant. Responsible for the manufacture of hydraulics, cylinders and valves for Bobcat loaders, compact excavators and attachments, the lighting needs for the facility present a good case study in how beneficial a lighting upgrade can be.

Much of the high bay space is dedicated to welding, assembly and testing—and prior to the upgrade, workers often found it necessary to supplement the existing light levels (provided by 297 metal halide fixtures throughout the floor) with handheld flashlights. Not only was this a potentially dangerous practice—the use of a flashlight, of course, limits what workers can do with their hands—but it negatively impacted productivity across the plant.

“Operations at our Wahpeton site are critical to the business, so we wanted to be sure we made the best decision,” said Harlan Anderson, Bobcat’s sourcing

specialist who oversaw the lighting project. The Wahpeton facility houses approximately 98,000 square feet of high bay space that is now illuminated with GE’s Albeo™ ABH and ALC4 LED high bay lighting fixtures. The numbers speak for themselves: Yearly energy costs have decreased by more than \$50,000 via a reduction in energy consumption by more than 850,000 kilowatt hours annually. Factor in diminished maintenance needs for these reliable new fixtures and the savings become greater—the plant’s new LED fixtures have a rated lifetime of 100,000 hours compared to the 20,000-hour rated life of metal halides that were replaced.

Nathan Gemar, a Bobcat sourcing specialist, noted that the old metal halide lamps produced a great amount of wasted light and illuminated the ceiling more than was necessary. Previously, the Bobcat team had painted walls, so the space inside the facility would appear brighter. The new LED solution directs light where it’s needed, eliminating the need for flashlights and improving overall working conditions for Bobcat employees.



Integrating Systems:

Energy that Works for You

By Craig Hall, GE Lighting, and Neil Maldeis, Trane

Facility directors looking for ways to improve building performance, reduce energy consumption and shrink their structure's environmental footprint would do well to focus first on their lighting, cooling, space heating and ventilation systems. After all, depending on building type and other factors, these building systems account for 60-70 percent of a typical building's total energy consumption, according to the U.S. Department of Energy (DOE).

An energy audit is a good exercise to start looking for ways to improve building performance. The audit can give the organization the data needed to identify, prioritize and implement energy-efficiency measures, many of which pay for themselves in five years or less.

Energy audits provide vital information about how the building is operating, reveal energy-efficiency opportunities, and make sure heating, ventilation and air conditioning (HVAC), lighting and other building systems are operating effectively and efficiently. Many organizations work with an energy services company (ESCO) or qualified energy engineer to conduct their audits.

Audits often uncover opportunities to reduce energy consumption by upgrading indoor and outdoor lighting technologies. Most often, this includes replacing older-technology lighting fixtures, ballasts and lamps with light-emitting diode (LED) technologies. LED systems use much less energy, require less maintenance, offer better lighting coverage, and enhance the security of buildings, grounds and parking structures. A Lawrence Berkeley National Laboratory (LBNL) study found that implementing various lighting-efficiency measures can reduce lighting costs by up to 38 percent in a typical commercial building.

A lighting audit also may identify opportunities to increase daylight harvesting, which can help reduce energy costs and create a more comfortable and productive indoor environment for employees and other building occupants.

Savings can be equally impressive for HVAC systems. High-performance building technologies and practices can reduce heating, cooling and ventilation costs by 40 percent or more, according to the National Institute of Building Sciences (NIBS). HVAC energy-efficiency opportunities range from "tweaking and tuning" the building's Building Automation System (BAS) to upgrading or replacing the chilled water system, to implementing advanced technologies such as thermal storage systems.

In most buildings, lighting and HVAC systems are operated separately. Advanced BAS technology integrates lighting and HVAC controls into a single automated platform. The result is improved comfort for building occupants and reduced energy consumption for the organization.

The most advanced platforms offer organizations one-system simplicity. Facility teams can manage the integrated system from a single user-friendly dashboard rather than making manual adjustments on multiple platforms. These dashboards can be accessed from any computer or mobile device, which provides the operator with better usability and flexibility.

Integrated lighting and HVAC controls create an optimal indoor environment. They can share the same sensors to determine whether a room is occupied and automatically adjust the lighting and temperature to ideal settings. The BAS can turn off lights and raise or lower the temperature to save energy when the room is empty.

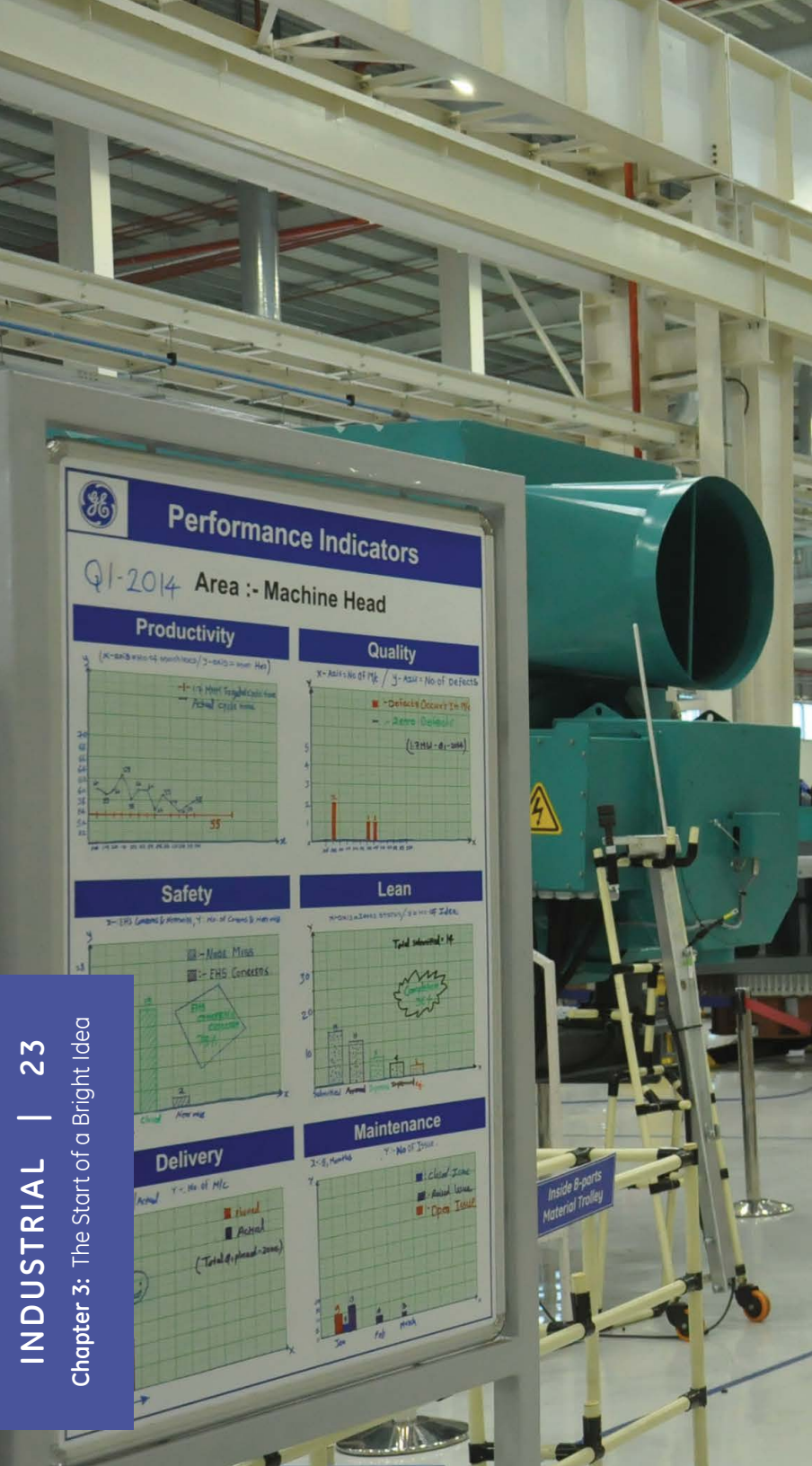
Most buildings already have the technology backbone installed to accommodate the integration of lighting and HVAC controls with their existing BAS or with an upgraded system. Opportunities to improve BAS capabilities are often identified by the ESCO during the energy audit.

Organizations of all kinds continue to look for ways to do more with less—less energy, less staff and lower budgets. Saving energy by improving the efficiency of lighting and HVAC technologies and integrating controls provides an excellent opportunity to reduce energy consumption and costs, improve environmental performance, and create a better indoor environment for building occupants.

Craig Hall is strategic account manager for GE Lighting, which develops energy-efficient solutions that change the way people light their world in commercial, industrial, municipal and residential settings. Hall is responsible for the GE-Trane relationship, which provides lighting and HVAC solutions based on the GE LightSweep™ control solution and the Trane Tracer™ building automation system. Hall has been with GE for 11 years and has nearly 30 years in the automation and control industry.

Neil Maldeis, Professional Engineer and Association of Energy Engineers Certified Energy Manager, is energy solutions engineering leader for **Trane**, a leading global provider of indoor comfort solutions and services and a brand of Ingersoll Rand. He is responsible for the technical development, support and review of performance-based contracting solutions and activities on a national basis. He has more than 32 years of experience as a mechanical/project engineer in the building construction and energy conservation fields.





Seven Reasons

LED Makes Sense for Industrial Applications Lighting

LED lighting has swept the conventional lighting marketplace—and it's doing the same for industrial facilities of all stripes.

Extended lifespans. Reduced energy consumption. Lower maintenance. By 2030, the Department of Energy estimates that LED lighting could save 190 terawatt hours of electricity per year, which is equal to a whopping \$15 billion. And to top it off, purchase prices for lamps and fixtures continue to fall, helping an increasing number of facility managers to upgrade their lighting with LED.

Check out seven reasons you should consider it yourself:

1 | Energy efficiency

LEDs use about 40-70 percent less electricity than traditional incandescent, fluorescent and halogen lighting options, leading to substantial energy cost savings. These savings are compounded within applications where lighting is on for extended periods of time. Further, LED fixtures can aim light hemispherically, or in specific directions, unlike conventional bulbs that emit light (and wasted energy) spherically in all directions. This directional capability reduces wasted light and energy, further contributing to savings.

2 | Extended life

Unlike incandescent lighting, LEDs never “burn out,” they simply become dimmer over time. Quality LEDs have a rated life of 100,000 hours at L70, or at least 70 percent of the initial light output, depending on the lamp and fixture. LED systems can reduce labor spent on replacing bulbs due to their extended life in commercial and industrial environments, helping you achieve reduced overall maintenance costs.

3 | Durability

Further contributing to reduced maintenance costs, LED systems are tough. Without filaments or glass enclosures, LED fixtures are breakage resistant and largely immune to vibration and other impacts, meaning they're perfectly tailored to the industrial environment. Traditional lighting is usually contained in a glass or quartz exterior, while LEDs are instead mounted on a circuit board and connected with soldered leads that can be vulnerable to direct impact—but no more so than your smartphone.

4 | Instant On

Many fluorescent and HID lamps don't provide full brightness immediately, often requiring about three minutes to reach maximum output. LED systems, by contrast, emit 100 percent brightness immediately, with no restrike delay. For industrial facilities, this is critical in the event of a power outage or early morning hours.

5 | Rapid Cycling

Traditional light sources tend to have a shorter lifespan the more they're switched on and off, where LED systems remain unaffected by rapid cycling. If you're considering a system that includes smart controls like occupancy sensing and daylight harvesting in parts of your facility, it makes LED lighting the perfect fit.

6 | Controllability

Fluorescent and HIDs are prohibitive of advanced control systems available today. LED systems, however, are semiconductor devices, meaning they're inherently compatible with advanced control options.

7 | No IR or UV Emissions

Less than 10 percent of the power used by incandescent lamps is actually converted to visible light; the majority of power is converted into infrared (IR) or radiated heat. Excessive heat and ultraviolet radiation (UV) presents a burn hazard to people and materials, which can be doubly concerning if used in an industrial environment that may contain hazardous chemicals, sophisticated machinery and more. LED systems emit virtually no IR or UV. Rapid advancements in LED lighting technologies, with more improvements on the horizon, have resulted in lowered costs and increased reliability

of LEDs. And while it may be tempting to assume LEDs are the right choice for all applications because of their energy efficiency, selection should be based on a combination of factors, including light quality and distribution, dimmability and expected lifetime.

The DOE offers various resources to help guide your decision:

- [Using LEDs to Their Best Advantage](#)
- [What to Ask When Buying LED](#)





A New Look

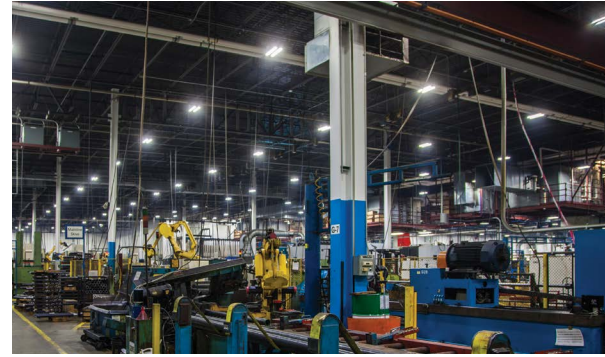
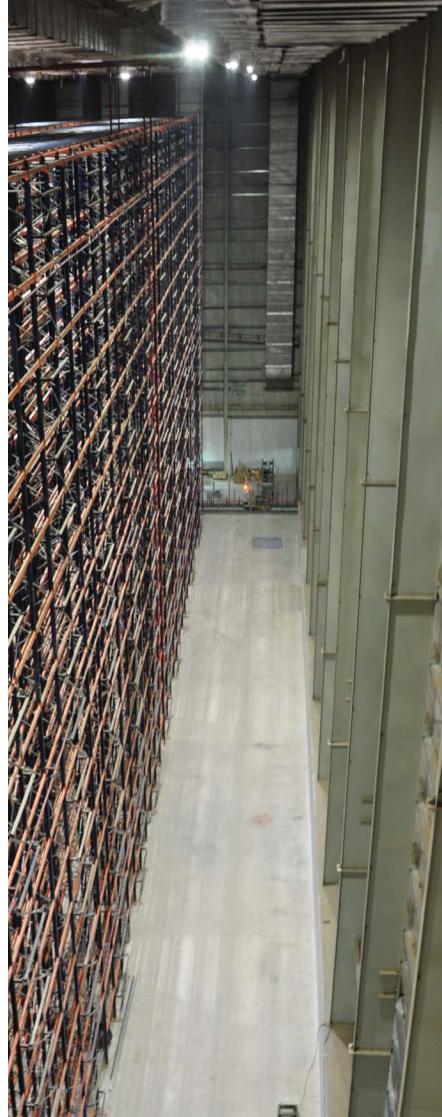
Seeing is believing—so we've compiled the following look book to give you a better idea of the new aesthetic and practical possibilities of a comprehensive lighting upgrade.

Seeing the Light

North Dakota's Bobcat® Company took the time to ensure the right decision was made when it came time to select a supplier for its upcoming lighting upgrade. Engaging their industrial supplier at Grainger, Bobcat was able to test a variety of products from several manufacturers. The search for the right solution ended when discovering GE Lighting's Albeo™ LED high bay fixtures. Producing the best light output, the sought-after durability, and considerable energy savings sealed the deal.

Doug Krick, Bobcat Company strategic business unit manager, was a skeptic early in the process of selecting LED lamps for the Wahpeton facility. "The first LED lighting was set up in our shipping bay, and I wasn't sold," he said. "The team then placed a sample in an area engineered for the best lighting performance in savings and foot-candle power. LED proved to be the best option, with lower maintenance costs as well as the best foot-candle power. I had been a skeptic, but the team proved LED was indeed our best option. I let the data show me the way."

GE's Albeo LED Luminaire fixtures can significantly diminish maintenance needs especially in difficult-to-reach areas where swapping bulbs requires equipment and trained personnel.



GE's Albeo LED high bay fixtures provide quality illumination from high ceilings.



GE's Albeo LED high bay lighting fixtures have reduced annual energy use by more than 850,000 kilowatt hours (kWh) at the Bobcat facility in Wahpeton, N.D.



GE's Albeo LED high bay lighting fixtures increased the facility's foot-candle levels from 22 fc to 40 fc, bettering visibility for floor workers.

GE's Albeo fixtures produce optimal light output, are durable and can help industrial facilities achieve considerable energy savings.

GE's professional lighting assessments have helped facilities across the country save millions of dollars, and it's the best place to start once you're ready to take the first step.

LED... Thriving in Unexpected Locations

"We needed instant-on ability from our new lights to get the team back in action as fast as possible,"

-David Painter,
senior manager of practice
facilities for the Cavaliers.

"We also shoot a lot of video and host media events here too, so it's important our gymnasium looks its best and brightest at all times."



More than 70 of GE's Albeo™ LED lighting fixtures shine over the **Cleveland Clinic Courts** practice space for the Cleveland Cavaliers. Each LED fixture is rated for a 100,000 hour career with no maintenance required.



GE's Albeo LED high bay lighting fixtures instantly illuminate and require no warm-up time.

Chapter 4:

Converging on a Solution



You've decided on a lighting upgrade—but there's more to it than simply staying out of the dark.

Lighting options for industrial facilities are broad, and it can be difficult to know where to begin. If you're looking for a flexible, total solution that will bring operational and monetary benefits to roost, consider some facts:

- If you're anything like the typical industrial facility, **lighting absorbs a significant chunk of all your electrical costs**. This is a tremendous opportunity to save, and **LED technology offers the most energy-efficient form of lighting available**.
- LED is versatile and can be **tailored to many applications**: think manufacturing areas, office space, indoor/outdoor areas and parking lots.
- LED has a long lifespan, **reducing the need for ongoing maintenance and replacement costs**.

Know that selling LED up the chain takes forethought and planning. Think back to Bobcat® for a minute: Strategic Business Manager Doug Krick's initial reticence on LED technology for the Bobcat plant is similar to hurdles that facility managers have faced before. While modern LEDs fit all needs, it's only within recent years that the technology has made the necessary strides to be a suitable solution for high bay applications, and some skepticism remains commonplace.

But believe that LED can make your lighting goals a reality. Here's how:

ROI – Be the Hero

A major LED lighting upgrade is a long-term solution—think of it as a true investment in the optimized operation of your facility. And like all major investments, it's necessary to dig into the numbers to ensure real payback into the future.

By now, you've taken stock of your current lighting scheme and decided it's the right time to upgrade. If your facility is anything like many industrial spaces in the country, you'll likely be replacing traditional high intensity discharge (HID) fixtures. From a financial perspective, HID lighting generally leaves facility managers with two challenges: excessive energy consumption and expensive, time-consuming maintenance needs.

Reduced maintenance needs are a major contributor to overall ROI. Situated high above the working floor, any industrial lighting scheme requires special intention and often specialized equipment—here, the estimated lifespan of LED vs. HID becomes critical. GE Lighting's Albeo™ ABHX-Series LED high bay fixtures, for instance, are rated for 100,000 hours of light at L70 (where the LED lamp maintains at least 70 percent of its original light output at the end of the 100,000 hours). Most HID fixtures are rated for only a fraction of those hours.

Also consider a repair for a high bay lighting fixture is often necessary not because the entire fixture is faulty, but due to the failure of an internal component such as the driver. In cases like this, replacing the driver will allow the fixture to continue producing life for many additional years. Some LED fixture manufacturers will offer standard warranties that cover all internal components should an unexpected, premature failure occur.

When LED lighting was first introduced as a viable option for industrial spaces, a majority of payback was contingent upon those reduced maintenance costs compared to HID fixtures. But as LED prices have steadily decreased over the last several years, and as LED technology has advanced to include highly attractive energy cost savings, LED lighting has become a major contributor to ROI from all angles.

Consider a direct comparison from a real-world example. An indoor sports arena has requirements comparable to many industrial facilities: the need for constant, bright light; high ceilings prohibitive to frequent maintenance; and the need to reduce operation costs. In this environment, a direct comparison based on a yearly energy schedule of 4,500 hours @ \$0.11/kWh shows LED annual

energy costs totaling \$4,366; HID annual energy costs total \$20,108. Combine these figures with maintenance needs: HID necessitates an annual maintenance spend of approximately \$20,000 while LED requires \$0 within its 100,000 hours of rated life.

While reduced energy consumption and maintenance needs stack up to make LED an attractive investment, it doesn't end there. LED inherently lends itself to opportunities that simply aren't possible with HID. As an eminently controllable light source, LED systems can incorporate intelligent controls to ensure light is being used when and where it's needed. Wireless controls allow instant dimming or other modifications and provide instant illumination where HID is inhibited by warm-up time to provide full illumination.

Further, many energy incentive rebates are available, rendering LED even more affordable for your facility. Many local utility providers offer energy incentive rebates that can range from \$100 to \$400 per fixture, depending on funding and burn hours. Often, taking advantage of these incentives requires an on-site lighting audit performed by a local utility company, or a lighting manufacturer or distributor.

Did you know ...

With LED lighting becoming an increasingly popular lighting option for many facilities, many manufacturers make lofty performance claims for their systems.

GE Lighting knows this, and that's why it backs its performance claims with stringent testing. GE's LED systems do what they say: 100,000 hours of light, proven by GE's expert developers.



Tear Sheet:

Five Needs Solved by LED

A lighting upgrade means significant investment—and it might take some convincing up the management chain. Use this page as a one-stop reference for why LED makes sense for your facility.

- 1 | **Increased Efficiency:** Lighting absorbs a significant portion of energy cost in most industrial facilities. LED lighting can help significantly lower this number. Pricing on LED fixtures has steadily decreased while functionality has reached unprecedented levels—fixtures can now generate more lumens per watt, meaning more bang for your buck.
- 2 | **Lower Relamping/Maintenance Costs:** Relamping is costly, and maintenance can account for lost production on your facility floor. Many LED fixtures are rated for lifetimes upward of 100,000 hours, without any need for maintenance.
- 3 | **A Better Work Environment:** LED offers a variety of brightness levels, color temperatures, lens configurations and more—meaning the light you need, when and where you need it. Advanced systems can also provide greater efficiency by eliminating wasted light.
- 4 | **More Storage Space:** Outdated HID system? Chances are you have a large inventory of replacement lamps and fixtures wasting valuable space in your facility. With LED's extended lifespan, you can store fewer (or even no) extra lights.
- 5 | **Seize Rebates:** Many U.S. utility companies and government entities offer rebates for energy-efficient lighting. Details can vary depending upon the utility, but many maintain energy programs for commercial facilities. New York State Electric and Gas, for instance, promotes commercial and industrial energy conservation through its **YES program**, offering prescriptive rebates for a range of specific and predetermined measures.



For US Mat Systems, a Total Solution

US Mat Systems, a company that produces mats for oil rigs and drilling products, moved its manufacturing operations to Leavenworth, Washington, and discovered the lighting in the new 450,000-square-foot facility—formerly a wood mill—needed an upgrade to help ensure workers could efficiently do their jobs.

The facility needed rugged fixtures that could withstand the tough manufacturing process, emitting greater lumen output than the existing HID lighting. So, with the help of the Urban Energy Group,

US Mat Systems seized a GE Lighting solution: Albeo™ LED high bay lighting. In total, GE replaced 167 400-watt metal halide fixtures, increasing the facility's foot-candle (fc) levels from 10 fc to 30 fc, boosting light levels facilitywide and helping US Mat Systems see significant energy savings.

“Our employees do a lot of welding on our manufacturing floor, not to mention woodcutting and heavy machinery use,” said Mike Wold, president, US Mat Systems. “They need the proper light levels to perform those tasks properly.

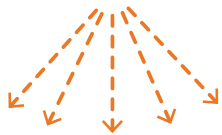
The new Albeo lighting system gave them that—and now many of our employees joke that the prettiest thing in the facility is our lighting system.”

At the time of installation, the new LED lighting system was expected to reduce energy use by nearly 640,000 kilowatt hours each year. And through the reduction in energy use and maintenance needs, US Mat Systems anticipated an annual savings of \$15,000.

Industrial-Sized Savings

By offering a massive savings and performance boost, high bay LED lighting is ready to be your next employee of the month.

High bay lighting must:



Illuminate Vast Spaces from Afar



Minimize Contrast



Manage Glare



Meet Safety and Environment Requirements

On the rise



Adoption of LED lighting is rapidly growing. By 2021, upward of **50%** of all high bay lighting applications will be LED.*

Falling prices



As the prices of **LED luminaires and control systems** fall, high bay applications are set for a rapid shift in lighting technology—**shining straight to LED.**

High bay LED fixtures provide:



Exceptional Quality

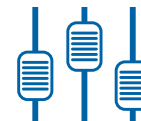


Affordability



Paybacks and Energy Savings

The benefits of LED include:



Controllability



Low Maintenance



Long Lifetime

High bay lighting is crucial in many industrial facilities, including:



Warehouses



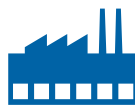
Manufacturing Facilities



Storage and Logistics Spaces



Assembly Spaces

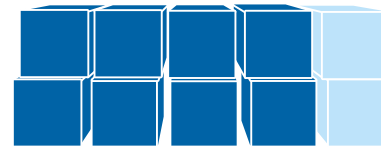


Refining Plants



Distribution Centers

It adds up



Warehouses and industrial facilities account for 52 billion square feet globally—**44 billion square feet** of which require high bay lighting.*

*High-Bay Lighting report by Navigant Consulting

LED for Industrial Facilities:

From Top to Bottom

Industrial High Bay Lighting

Lower the cost of high bay lighting with award-winning solutions for ceilings 20 feet and up, engineered to deliver more lumens with fewer fixtures.

Industrial Low Bay Lighting

For ceilings 20 feet or under, GE offers low bay lighting that works harder with less energy consumption.

Warehouse and Cold Storage Lighting

Deliver the right amount of light, right where it's needed. LED solutions from GE offer enduring performance in open floor plans and racked aisle environments ranging from -31°F to 131°F.

Lighting Control Solutions

From harvesting daylight in order to cut energy use to turning lights on and off as needed, sensors and wireless controls from GE ensure your lighting works as efficiently as possible.

Office and Functional Area Lighting

For workspaces that work smarter, GE has combined the latest technology with stylish designs, creating more welcoming, productive office and functional environments.

Outdoor and Parking Lighting

Poorly lit parking lots or hard-to-see signs represent a risk to employees and send the wrong message to customers and visitors. GE can help you shine in these critical areas.

Demanding Environments

GE provides solutions ideal for settings with high ambient temperatures and wet (IP66) application environments. Utilizing a sealed form factor, GE's rugged design offers exceptional performance and high reliability.



Chapter 5:

Purchase/Demonstrate Core Features and Functionality

You've done your research, you know your needs and you're convinced LED lighting is the solution that will help realize your goals. Now, it's time to choose the right products and the right partner.

As we've noted, your lighting upgrade is a major investment, meaning it needs to be done with the proper care and consideration for the big picture. A new lighting scheme will need to be incorporated into your existing systems. If a facilitywide upgrade is chosen, each area and its unique lighting needs must be accounted for. What specific fixtures will best suit your needs? How long will the upgrade take, and what does that mean for your facilities' operations and production schedule? How will your new lighting system be financed?

For projects big and small, a reliable and informed distributor can help you realize the full potential of a lighting upgrade. It's crucial to select a partner that can bring you through the whole project, from start to finish.



Taking Stock of a Supplier

A lighting upgrade is truly about more than just the lighting—it's about taking a leap toward total facility efficiency. And that means the expertise you require extends beyond just lighting. Across many applications, the process will require careful work and a holistic approach.

Chances are your facility houses more than just high bay space. Office and hallway lighting must be accounted for, for example. Seeking a partner that has broad lighting expertise across all manner of environments can help with making informed decisions for the necessary lighting solutions.

Lighting work has an impact across all systems, including HVAC, electrical wiring and various automation systems. A lighting partner with a broad base of knowledge allows for the best decisions when installation is taking place. And while practicality is ultimately the No. 1 goal for a lighting upgrade, an eye for strategic design can also help your facility look its best while being lit properly.

Convinced it's time to upgrade your systems? Now, it's time to find the right partner to help make your goals a reality. What is the "right" lighting design for your industry facility? How smart should my site be? While there is no singular solution, it's important to have a knowledgeable lighting expert by your side. A professional assessment of your current system will identify lighting technologies that can work smartest for your facility.

Here's what to look for in a lighting advisor:

Has broad lighting expertise

Different manufacturing plants, facilities and the widely varied spaces within them have different lighting needs, and sometimes those differences will be stark. A busy shop floor, for instance, has far different needs than a storage area. An ideal lighting advisor will have broad expertise that can help you make informed decisions for the best lighting.

The experts at GE Lighting have that vast experience and a track record of helping clients make worthwhile capital investments in lighting and a high return on investment that pays dividends well into the future.

Knows more than just lighting

In a lighting upgrade, it is crucial to remember you're not simply replacing fixtures. Across many applications, your lighting upgrade may take more sophisticated and careful work. It requires a holistic approach—one that takes into account the broader impact this sort of work will have throughout your facility. That comprehensive knowledge allows your lighting advisor to help you make the best decisions when installing a new system—and it's the kind of expertise GE Lighting's professionals bring to the table through valuable relationships and extensive experience.

Considers aesthetics

Practicality isn't everything—you also want your new lighting to look good. For this, you'll need a keen eye for strategic design and a good sense of aesthetics to choose which types of light fixtures will work best in a given application. GE Lighting offers a range of industrial lighting solutions that will help accentuate the look of your space.

Offers the total package

A lighting upgrade can hold its own advantages, but as technology has advanced, efficiency and savings can be further improved through advanced control systems, which allow managers to control their lighting like never before. Options like on/off scheduling, automated dimming and real-time performance reporting ensure energy is being consumed at an optimized rate. Additionally, LED lighting fixtures can be incorporated into an intelligent platform, allowing your facility to leverage data and improve services.

Is qualified and verified

If you're looking at LED lighting solutions, you'll want an advisor who knows the ropes of this burgeoning technology. The U.S. Department of Energy (DOE) established its Solid State Lighting Quality Advocates program to help ensure that LED lighting is accurately represented in the marketplace. Visit www.lightingfacts.com to verify that your lighting supplier has taken the Quality Pledge for Solid State Lighting Products and that your supplier is a registered DOE Quality Advocate. Additionally, registered LED lighting products can be found through the site's searchable database.

Provides a comprehensive lighting assessment

A major lighting upgrade has far-reaching implications across your operations, from the look and the light to the costs and your return on investment. That's what makes a lighting audit so valuable. It takes a comprehensive approach to your needs—and not just your lighting requests. A lighting advisor helps evaluate your long-term goals, your standards for energy efficiency and the performance of your current lighting fixtures to provide a qualitative recommendation on how to move forward.

Through the lighting audit process, a good advisor can also help you investigate available rebate programs, which can accelerate your return on investment. A complete audit can identify national and local programs to maximize your savings and recommend customized financing packages to help you reach your goals.



A Long Way to Zero

How LPL Financial achieved a new zero net energy (ZNE) office building through careful strategizing and the right partner.

LPL Financial has plenty on its plate as the nation's largest independent broker/dealer, an RIA custodian and an independent consultant to retirement plans. So creating simplicity, variety and efficiency where they can is important.

When the firm began designs for its new state-of-the-art office building in San Diego, LPL envisioned a **zero net energy (ZNE) site**—that is, a facility that generates as much on-site energy annually as is consumed.

The 13-floor, 415,000-square-foot office tower was driven by four strategies: energy efficiency, health and wellness of employees, connectivity, and flexibility. Architects had a vision, and designers had a desire for an efficient lighting system that felt comfortable for occupants, allowed for added savings through dimming and daylight harvesting, and could easily accommodate the changing needs of a growing business.

Zero net energy isn't an easy thing to accomplish, and it requires a combination of strategies. So prior to a lighting solution, LPL Financial made several significant investments, including fuel cells for a consistent source of clean electricity and an under-floor air-distribution system to reduce heating and cooling loads. A sophisticated, efficient lighting system was next.

"GE Lighting rolled up their sleeves and got to work," said Otto Orr, V.P. of project management, corporate real estate, LPL Financial. "They flew to Charlotte and immediately got engaged with our engineering team—looking at sketches, switching from fluorescent, eliminating fixtures. I've never seen a supplier jump in like this."

By analyzing architectural drawings, GE's experts conceived a new lighting strategy that converted fluorescent fixtures to LED and further eliminated a number of them entirely, reducing total fixture count by nearly 40 percent. Lumination™ BL Series LED luminaires were chosen for common aisles and employee areas—the long, narrow bands of light were integrated within the ceiling to lend a clean, contemporary look to the space.

Orr explained that when it came to office lighting and controls, GE again simplified and streamlined what could have been a messy process. "We were actually looking at a fairly complex lighting control system that added a lot of cost to the project," he said. "That's when GE demonstrated a much simpler solution that met our needs. More importantly, when you have a project this size, typically you have a lighting supplier, a controls manufacturer and a project manager involved."

"With GE, it felt good to have all of that—a full lighting solution and a control package to go with it—all in one bucket."

With GE's LightSweep™ lighting control system and Aware™ occupancy sensors, LPL now enjoys dimming and daylight harvesting capabilities on every floor, zoned to allow individuals to make their own adjustments.

LPL will save an estimated \$38,000 annually in lighting energy costs with LED over fluorescent. Each floor of its San Diego tower is metered to measure HVAC and lighting electrical loads separately. This data, displayed on an LCD monitor in the main lobby helps to make employees more informed about energy savings in the building.

"We believe we are the country's largest net-zero commercial office building," said Orr. "The passion was there, and now our group, including GE, drives it forward. This building shows our dedication to our employees and the environment—we created a net-zero strategy that, when we look back, we'll be proud to say our activities and outreach started here."



Inside a Lighting Audit:

What GE Lighting Professionals Want You to Know

By Jason Brown, PE, CEM, LC



By now you've realized that a lighting upgrade is no small undertaking—and that's part of why it's important to select a reliable team to help you get the most out

of this major investment. I'd like to offer some insight on how to enhance your lighting upgrade and make the process as smooth as possible, with minimal interruption to your daily operations and output. I've been helping facility managers realize the benefits of LED lighting in all manner of environments for many years. These are some key things you can do to optimize the process:

The more we know, the better

Literally and figuratively, lighting touches just about everything in your facility. So in order to obtain the greatest results, GE works with a variety of information to optimize your new lighting scheme—from floor plans to electric bills and more.

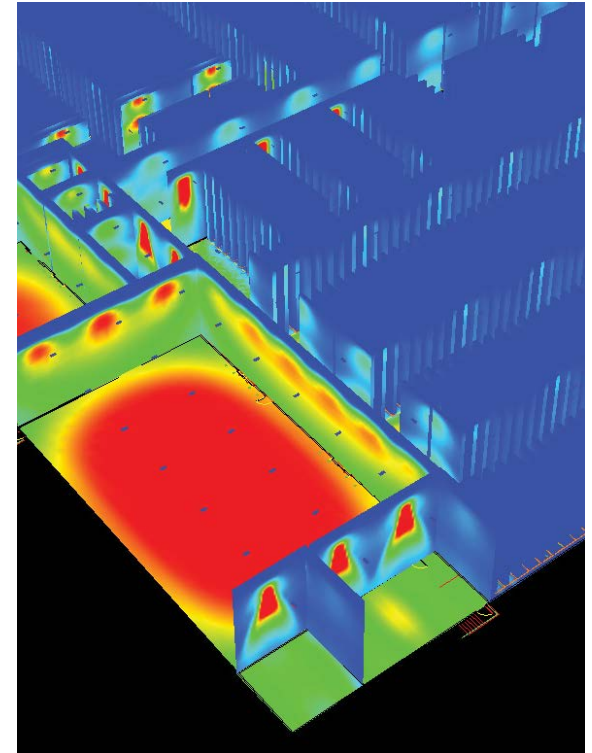
First, if you're considering a lighting upgrade for more than just one facility, we can deploy our data metrics to tell you where exactly you'll benefit from the most immediate payback. Perhaps one particular site has higher utility rates than the others; maybe another has more attractive rebate options. We'll evaluate this data to determine where to strike first.

Next, we need your floor plan. There's a lot we can discern from a simple blueprint of your facility as it gives us the exact dimensions of the spaces that need to be lit. Much of this process involves making calculations based upon GE lighting product specs and your unique space—and your floor plan makes this much easier.

We'll also need to take a look at your 12 most recent monthly electricity bills in order to make an informed prediction on energy savings. The most important figure to calculate is cost per kilowatt hour (kWh), which grants us the most relevant insight into what you stand to save in energy costs.

The on-site audit

There's really nothing better than taking a look at your facility in person, which is why GE Lighting takes the time to perform on-site audits to get the complete picture. While the on-site audit isn't absolutely necessary in every case (there is a LOT we can tell from the information we request, and



From here, you're ready to pull the trigger on your upgrade.



What GE Lighting Professionals Want You to Know (cont'd)

we can sometimes draw up a full recommendation with just that), putting ourselves in the environment allows us to take note of things like current quality of light and other details.

Importantly, we'll be able to evaluate how your current lighting is wired in—most common setups in industrial facilities are either permanent mounts or “cord and plug.” The former means your new lighting will need to be installed in roughly the same locations as existing lighting, while the latter grants more flexibility to optimize new lighting design by placing fixtures in advantageous spots throughout the building.

These on-site audits are performed discreetly, mindful of any potential interruptions to your everyday operations. A key part of this is having access to your floor plan and electric bills, as mentioned, to make the on-site audit smooth and painless. You'll convene with a GE Lighting audit team member before and after the audit is complete to discuss next steps, and you'll receive a Lighting Solution Proposal shortly thereafter. This will include:

- Optimized Lighting Layout
- Product Bill of Material
- ROI Calculation
- Proposed Financial Package
- Next Steps to Construction

Which brings us to the next consideration ...

Know the roles

From the beginning, GE Lighting has been dedicated to being a premium product supplier—and that means we can't necessarily do everything. Namely—we're a product supplier, not a contractor or distributor. And it's beneficial to know up front that you'll need to turn to reliable vendors to install your LED lighting systems after an audit and purchase with GE.

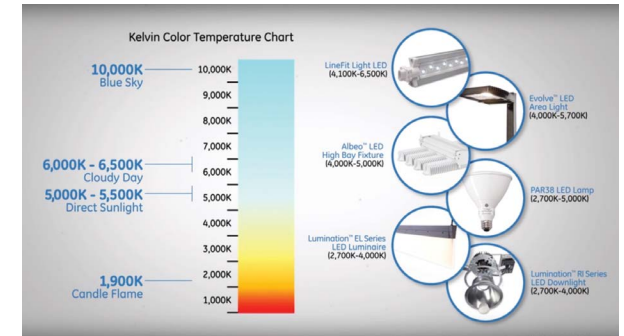
Luckily, we've already done some of this work for you: Through its relationships with contractors across the country, GE is able to offer an extensive, vetted list of contractors and distributors to help your lighting project come to life more simply. Through this process, we can offer an actionable quote to work with a contractor and distributor, offering you a full turnkey service.

Do you have a trusted local contractor you've worked with in the past? That can work just as well. But it's important that expectations on GE's role throughout the entire process are clear up front.

[Click here to schedule a lighting audit.](#)

About the Author:

Jason Brown, PE, CEM, LC, is manager of strategic solutions for GE Lighting. He has more than 15 years in the lighting industry.



Want to learn how you can become an educated lighting buyer?
[Watch this video.](#)



What's the Cost of Entry for a Lighting Upgrade?

LED installations are becoming increasingly more affordable. To make them even more attainable, we're working with customers on unique financing solutions—from funding models that allow customers to pay for our solutions through the energy savings they bring to collaborations with GE Capital as part of our “GE Store,” to the competitive advantage we bring customers by drawing on other GE businesses to exchange knowledge, technology and tools.

Opportunities for savings and efficiencies grow even bigger with intelligent LEDs, which connect the physical world and the digital world. Smart solutions can now use lighting's infrastructure as a conduit to Big Data to reduce overall infrastructure costs.

From our advanced hardware to our sophisticated software, security, privacy, networking, applications and analytics capabilities, GE is uniquely situated to be a trusted provider of the open Industrial Internet platform. We're helping our customers see lighting in a whole new light, so they can use it in better, more effective and efficient ways.

Spec Sheet:

Albeo™ from GE at a Glance

As GE Lighting's premier offering for high bay LED solutions, take a look at what Albeo can provide for your facility:

The award winning Albeo™ ABH-Series LED Luminaire uses innovative heat-sinking and LED technology to deliver a wide range of light outputs that replace 250W–1,500W HID and four- to eight-lamp T5/T8 high intensity fluorescent fixtures in high bay applications. The ABH2-Series offers higher efficacy than previous generations and can be matched with motion, daylight and wireless controls for increased energy savings, lower maintenance costs and shorter paybacks.

Features include:

- Modular design: 1, 2, 3, 4 and 6 modules
- Lumen output: 6,900–57,600 lm
- Optics: 20°, 30°, 40°, 80°, 120°, 120° diffuse, 30° diffuse
- Cable/chain, rod, indirect or pendant mount
- 4000K or 5000K CCT
- 70 or 80 CRI
- Daylight, motion and wireless controls
- 0–10V dimming
- Lifetime: L70 at 100,000 hours
- 5-year limited system warranty

Applications:

- High and low bay lighting
- Racked aisles or open floor plan
- Warehouse, cold storage, industrial, gymnasiums, sports arenas, retail high-ceiling spaces
- Designed to meet recommended luminance and illuminance requirements for high and low bay lighting applications in industrial and commercial buildings





Celebrating the Win and Sharing Your Story

Congratulations! You've done the hard work of researching the benefits of a lighting upgrade, the installation has been complete and you're ready to watch the benefits manifest enterprisewide. So why not share your story?

Think back to yourself a few months ago: investigating potential solutions for the improved operation of your facility, soaking up all available information and getting down to brass tacks when it comes to ROI. Your lighting upgrade has been a success by any measure, and there are many facility managers out there for whom a success story would provide value as they're beginning to undergo the same process.

While your facility is unique, the methods you applied for your lighting upgrade can be applied in industrial facilities around the world. What are some unexpected circumstances you've come across while maintaining productivity?

If you're thrilled with the results, you can contact your GE Lighting representative to learn how to share your story with facility managers like yourself. GE is always seeking satisfied lighting customers to develop informative case studies and success stories for those who want and need them—and you can help.

Now that you've realized the benefits of an LED lighting upgrade in your own facility, consider what the future holds. Here's a hint: It's big, and its implications extend far beyond lighting.

Chapter 6:

What Does the Future Hold?



Earlier in this book, you read a short piece about the Industrial Internet, the Connected Future and its implications for not just the industrial landscape, but the entire way we think about infrastructure in the future.

This means that for you, and for facilities like yours, there exists an opportunity to lead when it comes to overall energy efficiency. And as you've learned with your recent upgrade to LED lighting, it's a challenge that can be seized for the betterment of your facility and for the more efficient operation of your business overall. Your role doesn't stop with lighting, and it doesn't stop with today's technology. As the rapid evolution of LED has demonstrated, new technologies for efficiency are perpetually cropping up. So what's on the horizon?

Five Things to Know About the Connected Future

By Jim Carroll

When it comes to acceleration, we live in one of the most fascinating periods in history, where the rate of technology change is absolutely staggering.

So what trends are driving this acceleration, and how are smart businesses adapting to not only survive but thrive in an ever-connected world? Read on to learn five things to know about the connected future—and how you can stay ahead.

Five Things to Know About the Connected Future (cont'd)

1 | Acceleration: Today is the slowest day of technology change for the rest of your life.

Bill Gates once observed that most people tend to overestimate the rate of change that's going to occur in a two-year basis, but underestimate the rate of change that will occur in a 10-year basis. A few years ago I used to speak about 3D printing as if it were science fiction. Now it's part of many businesses day-to-day operations.

In the not-so-distant future, we will likely have connectivity in cars that researches 3-bedroom, 2-bath homes for sale in your neighborhood, and then drives you directly to each house for a tour. We already have augmented reality displays built into ski visors and goggles that tell you, in real-time, how fast and far you've skied—this same technology will be integrated into automobiles in the not-too-distant future.

It's important to be ready for this acceleration. Your opportunity in dealing with this is continuing to ingest new ideas, new technologies and new methodologies to solve problems.

2 | Hyper-Connectivity.... and endless possibilities.

Every industry is set to be transformed as an era of hyper-connectivity becomes the new norm. The result? Massive business model disruption; industries in which customers empowered with mobile devices control a wide variety of other devices that are a part of their daily lives; unique opportunities for deep analytical insight into trends and opportunities emerging in industries; and a reinvention of manufacturing, logistics, retail, healthcare and other industries because of consumers who are empowered, connected and enabled with a new form of lifestyle management that we've never witnessed before.

Every device that is part of our daily life is becoming plugged into the Internet. We are becoming aware of its location and its status. And while this has been a trend for a while, it is today's businesses that are primed to turn this momentum into big wins.

By the year 2020, there will be more than 50 billion devices connected to the Internet. That's roughly six devices per person.

The Internet of Things is happening everywhere; it is real, and it is unfolding at a blistering pace. We're in the era of connected thermostats that link to an intelligent energy grid; autonomous vehicle technology that is self-aware and networked into sophisticated, intelligent highway flow control systems; a connected trucking fleet that is self-diagnostic, predictive and built for zero downtime.

We have scales that record our body mass index, transmit it to a password-protected website and create custom charts on our health. We have ceiling fans that will slow down when owners go to sleep. We have barbeques that send us text messages when the meat needs to be flipped.

These are staggering trends, and what it means is the possibilities are endless for growth and innovation.

3 | Momentum and the potential for big wins.

When it comes to lighting, we're in the era of revolutionary new opportunities. The potential for significant efficiency and cost savings through deep analytical insight into usage patterns and detailed, specific-spot addressability and management is real.

New LED technologies change our very concept of lighting and individual addressability as the level of the light bulb leads us to an era that is unlike anything we've ever known. Consider these statistics:

- Right now, lighting accounts for 12–15 percent of annual global power consumption, creating 1.7 billion tons of CO₂ emissions per year.
- According to the International Energy Agency, improving lighting efficiency by 20 percent can reduce total power consumption by 3.8 percent and cut total CO₂ emissions by 0.8 percent.
- According to industry reports, the global LED lighting market is expected to grow from \$7 billion in 2010 to \$40 billion in 2016.

There is so much momentum behind these changes because the potential for big wins is huge.

4 | The next generation.

Today's younger generation—those under age 25—have never known a world without a mobile device that lets them access incredible amounts of information at their fingertips. They are globally wired, entrepreneurial, collaborative... and they thrive on change.

Gone are the days of MS DOS copy and computer courses like COBOL. This generational trend is crucial to businesses that need to communicate with customers and employees who are used to receiving information in vastly different ways. Additionally, this generation is starting to drive rapid business model change and industry transformation as they move into executive positions.

According to author Cathy Davidson, 65 percent of children today will work in a career that doesn't yet exist. Think about titles like "water usage audit analysts," "energy usage audit architects" and "location intelligence professionals." We are at the forefront of a remarkable time in history as the next generation uses connectivity to advance some of the biggest energy successes.

5 | The future belongs to those who are fast.

As new technology, intelligent lighting and infrastructure emerge, the key phrase businesses need to remember is to Think Big, Start Small and Scale Fast. Take on a small-scale, experimental project in your municipality, industrial location or retail store. Test out a new technology with a target group of customers.

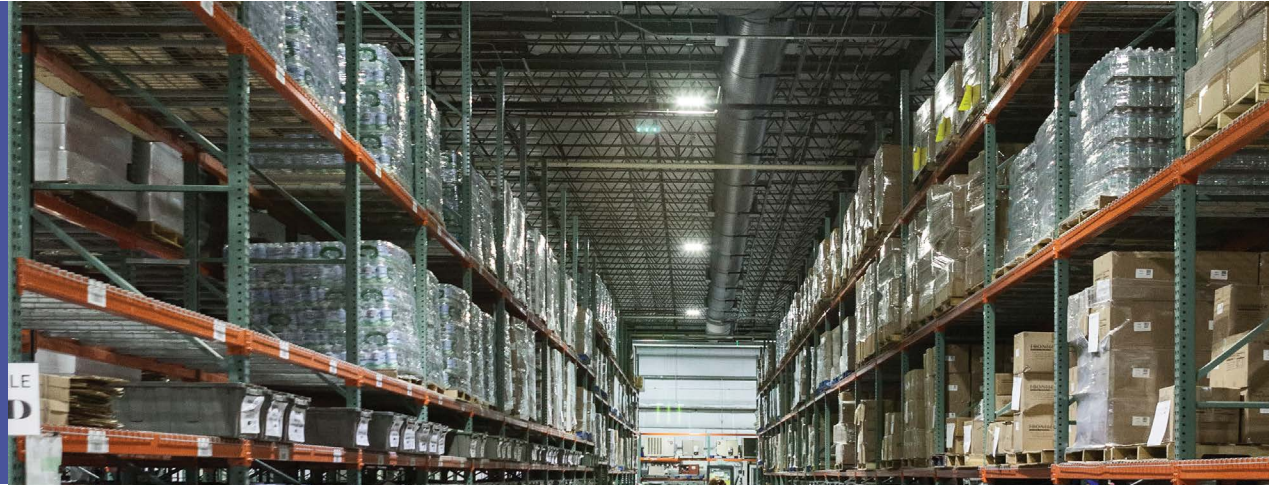
By starting small and learning to scale fast, you can adopt an innovation mantra and build a business plan that leads to success.

About the Author:

Jim Carroll is one of the world's leading international futurists, trends and innovation experts, with a client list that ranges from Northrop Grumman to Johnson & Johnson; the Swiss Innovation Forum to the National Australia Bank; the Walt Disney Organization to NASA. His focus is on helping to transform growth-oriented organizations into high-velocity innovation heroes. Jim has operated J.A. Carroll Consulting since October 1990 and has authored numerous books, including "The Future Belongs to Those Who Are Fast". For more information, visit www.jimcarroll.com.

Facility Intelligence and Connectivity

As you know, if you've implemented smart controls for your lighting, the use of intelligent controls for all systems is a powerful way to double-down on energy savings. Available systems are now smart enough to learn how you're using energy, and they can deploy that energy in ways that make the most of it.

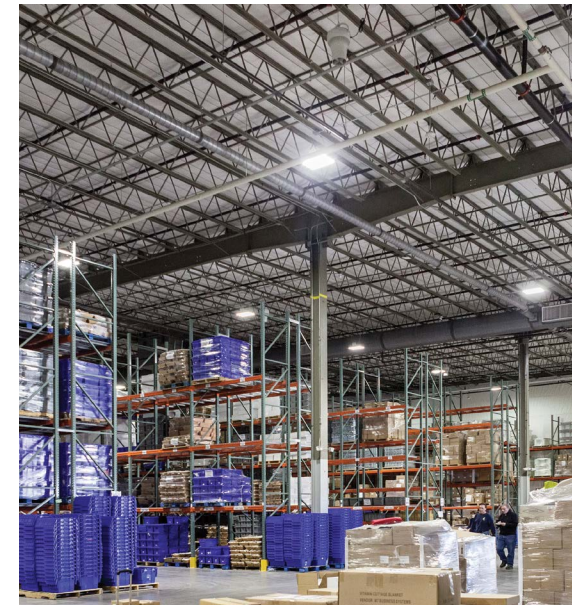


DOE defines "smart buildings" as "buildings with technologies and control systems that can not only optimize energy performance and comfort, but also support energy-related transactions outside the building envelope." This is made possible through the use of transactional networks that connect facilities with the utilities themselves—or "**building-to-grid**" integration.

The possibilities opened by the integration of buildings with the power grid is a critical step in increasing energy efficiency on a broad scale, according to the DOE. "The introduction of smart sensing, metering and control technology is transforming the nature of our power system from end to end," writes Joe Hagerman,

senior policy advisor, Building Technologies Office, U.S. DOE in an introduction to a **recent report** on building-to-grid opportunities. These advances have allowed decision makers to "see and understand the operation of their systems with unprecedented levels of granularity and detail," leading to previously unavailable insights on energy usage.

Critical to the realization of the possibilities afforded by building-to-grid integration is widespread adoption of these smart systems. Hagerman notes that currently, many buildings across the country are "sleeping," untapped assets. As these technologies advance and generally become more affordable, your facility can truly be an asset in heightened energy efficiency.



The Industrial Internet Welcomes the Future of Lighting

A Q&A with Maryrose Sylvester, president and CEO of GE Lighting



Q: What are the Industrial Internet's implications on the lighting industry?

A: The convergence of digital and physical systems in the industrial world is creating a profound transformation in how we think about lighting. In today's interconnected world, lights are no longer isolated devices that provide just illumination. Thanks to the Industrial Internet, lights have become part of the business intelligence landscape by capturing data and

communicating with other interconnected devices via the Cloud.

The Industrial Internet blends "Big Data" analytics with the **Internet of Things**, enabling companies to use sensors, software, machine-to-machine learning, plus other technologies to gather and analyze data. Businesses then use those analyses to manage operations and offer value-added services.

Lighting systems embedded with sensors and networking capabilities can provide valuable data related to lumens, occupancy levels, environmental conditions, inventory levels and much more. As a result, the Industrial Internet makes lighting considerably more important to enterprises.

Q: What capabilities does the Industrial Internet bring to lighting systems?

A: By expanding the sensing capabilities of LED fixtures and enabling connectivity to other devices, GE is moving far beyond energy management to actionable business intelligence.

We can easily envision a day when **street lights are equipped** with cameras and sensors that allow city managers to monitor traffic and identify roads that need to be plowed. Sensors may monitor weather conditions, pollution levels and pollen counts. Lighting fixtures may contain speakers for broadcasting

emergency warnings or Wi-Fi capabilities for providing wireless service. In a parking lot, a consumer may be able to launch an app tied to the lighting system to find an open space. Within retail stores, location-based technology embedded in LED lighting fixtures can give retailers the ability to push targeted offers to shoppers' smartphones.

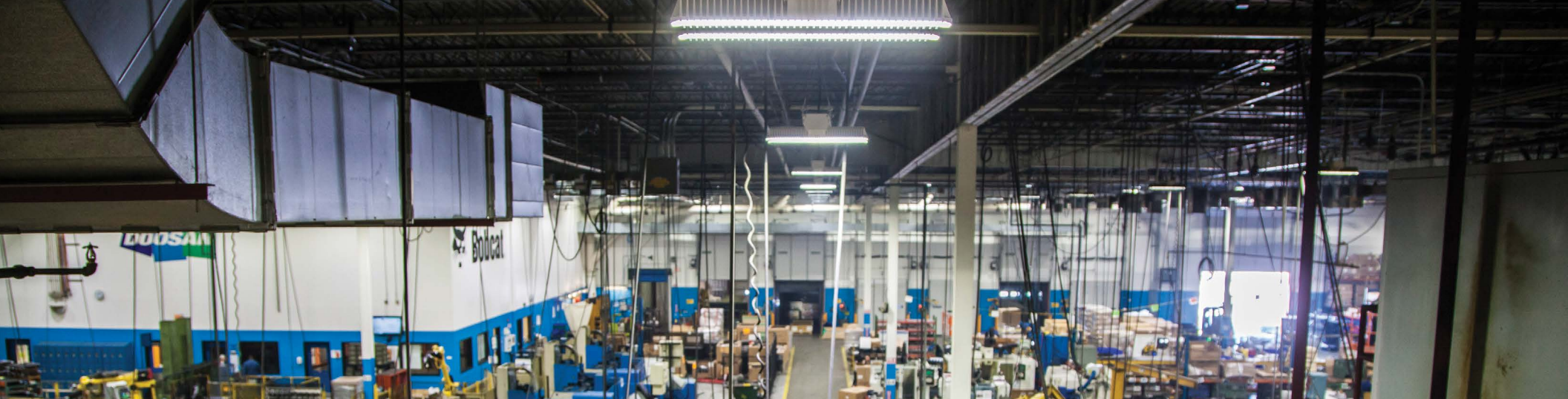
Each of the above capabilities is tied back to the interconnected nature of the Industrial Internet to enable data capture, analyses and action.

Q: What's the cost of entry to implement smarter lighting?

A: LED installations are becoming increasingly more affordable. To make them even more attainable, we're working with customers on unique financing solutions—from funding models that allow customers to pay for our solutions through the energy savings they bring to collaborations with **GE Capital** as part of our "GE Store," the competitive advantage we bring customers by drawing on other GE businesses to exchange knowledge, technology and tools.

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Intelligent Buildings

Facilities such as offices and high-rises can also capitalize on the digital nature of LED to connect lights and sensors to each other and to a building's IT network. As the U.S. General Services Administration explains, the result can be a rich array of location-specific data on room occupancy, amount of daylight, temperature, humidity and other variables. Using this data, the technology mediates environmental, user and building information to both save energy and maintain occupant comfort.

As with sensors and transmitters, lighting controls are becoming more sophisticated and less costly, and widespread commercial adoption remains only a matter of time. In fact, Title 24 of the California Energy Commission's efficiency standards mandates the use of lighting controls in some new buildings. Enacted in 2013, it is among the first pieces of legislation of its kind, and, undoubtedly, an indication of things to come.

Integrated controls—where lighting control is interfaced with a building automation system (BAS) to simultaneously manage heating, ventilation and cooling (HVAC)—have

the greatest potential to elevate operations to new levels of efficiency and effectiveness. For instance, an intelligent office might know to automatically dim lights on a sunny day to limit wasteful energy use or turn down the heat in a crowded conference room to keep occupants comfortable.

Light is even changing the way we experience retail stores. Indoor location technology—a form of Visible Light Communication (VLC)—is making it possible for **lights to "talk"** to shoppers by leveraging LED modulation (the "pulse pattern" produced by an LED light source, which is unique, like a fingerprint).

This pattern, while imperceptible to the human eye, can be detected by the cameras on smartphones and tablets, meaning LED fixtures with embedded sensors can pinpoint a customer's exact location in a store—provided that customer is currently using the retailer's app on their mobile device.

For store owners, this creates a tremendous opportunity to deliver **new value to customers**, from personalized shopping lists and easy-to-follow maps to product info

and special offers or coupons based on where a person is standing in a particular aisle, relative to specific goods or merchandise.

And not a moment too soon, say many. To better understand the impact of smartphones and online information on in-store shopping, Google recently partnered with Ipsos MediaCT and Sterling Brands for an online survey. The study revealed that **consumers want more information and customized experiences during their shopping journey**: Two in three shoppers who tried to find information within a store say they didn't find what they needed, and 43 percent of them left frustrated. Meanwhile, 71 percent of shoppers who use smartphones for online research say their device has become more important to their in-store experience.

Beyond the retail industry, lighting-based indoor positioning systems could also see application in airports, hotels, hospitals and many other environments where it is beneficial to know one's exact location.

2015: A Big Year for Big Data

GE Reports – Ideas Lab Staff

By now, most people with an Internet connection have probably heard of Big Data. But is it really such a big deal?

If you're in an information-rich field, the answer is most likely yes—or it soon will be. Seeking to differentiate themselves from competitors, early adopters are bringing dark data into the light and crunching reams of IT to boost business efficiencies, monitor far-flung industrial machinery connected to the **Industrial Internet**, and avert equipment failures through predictive analytics.

More than two-thirds of executives around the world who participated in GE's latest **Global Innovation Barometer** said Big Data was critical for optimizing business operational efficiency, with just 6 percent calling it more of a buzzword than a reality.

It's no wonder analytics software providers like Matt Davies of Splunk are calling 2015 "**the year of Big Data**." "In 2015, the conversation around (the Internet of Things) will extend beyond consumer devices to the disruption in traditional "bricks & mortar" industries like building, manufacturing and transportation," says Davies.

Fueled by the digitization of everything from medical records to 3D models, as well as rapidly expanding networks of connected machines, the amount of data being generated worldwide is exploding. The digital universe is expected to double every year to reach **44 trillion gigabytes by 2020**—enough memory to stretch a stack of tablets between the earth and the moon more than six and a half times, according to research firm IDC. About a tenth of that data will come from connected devices on the Internet of Things.

The fact is, data is being generated so rapidly, and in such large datasets, that traditional analytical methods are not capable of making sense of it.

As recently as 1992, global Internet traffic was creating about 100 gigabytes (GB) of data a day. Two decades later, data generation had exploded to 28,875 GB of data per second in 2013, including 204 million emails sent across the globe—each carrying a vast framework of data. By 2018, traffic is expected to reach 50,000 GB per second.

Given such eye-popping figures, it's no surprise that executives across sectors are viewing data analytic capabilities with a greater sense of urgency. About nine out of 10 executives from a range of sectors surveyed by GE and Accenture warn that **companies who don't adopt a Big Data analytics strategy in the next year risk**

losing market share and momentum. Three-quarters of them plan to boost investment in Big Data over the next year.

All this data also generates new policy questions such as how to balance privacy and security with public good, and how to most securely and effectively return government to the people through the open data movement.

The fact remains; Big Data has become incredibly useful, improving decision-making capabilities by monitoring and analyzing activities to generate predictions. The impacts will surely be far-reaching for both society and industry.

This infographic by **voucher cloud** illustrates how the massive amount of data we produce every day is improving our everyday lives.



Rethinking Business in the Industrial Internet Age

As we progress through the Information Era, machines are just beginning to tell us what they're like inside. We are able to endow hardware with intelligence and, by imbedding sensors and controls, usher in a host of new means of achieving productivity.

Companies worldwide, including GE, are investing in what we call the Industrial Internet—the idea of taking big machines (some that we have known about for 100 years) and overlaying them with software that conveys data and performs analytics.

Why is this a big deal? We've all seen in the past decade or two the transformative power of 3 billion people coming online. We've all connected with people we haven't seen in years, people maybe we've never met, people in the most remote parts of the world. Now imagine what happens when 50 billion machines come online in the next couple of years—five times the number of connected machines that exist today.

They'll be talking to one another; they'll be talking to us. We'll be interacting with people and machines in ways we never thought possible. We'll see devices shipping off this continuous stream of data originating from sensors—data that has seemingly limitless potential for analysis and subsequent action. The sensors are getting smaller, they're getting cheaper and they're getting more ubiquitous. You may find this very exciting, very scary or both. Regardless, you should care.

The best innovations focus on a need. The Industrial Internet has the potential productivity we need to help save significant time and resources. It will allow us to more comprehensively connect data to outcomes that matter.

Start to think like this about sensing, data and analytics. Our machines have this incredibly rich inner life. Let's look at a few examples.

Think of a wind turbine, out in the middle of a wind farm somewhere, powering a machine that is able to react to changes in the wind and the weather. Now, one wind turbine is able to talk to another and say, "Hey, I have better wind velocity here; change the pitch of your turbine blades to accommodate." Cumulatively, the whole wind farm is able to ping the utility and say, "We are capturing a lot of energy from the wind today; you don't need gas, and you don't need coal because the wind farm is running so optimally." And all of this is achieved without adding any new hardware—just by putting the right software in place and allowing one part of the machine to talk to another. You are able to optimize the output sometimes as much as 30 percent without any new capital expenditure!

Locomotives will be able to run much more efficiently on railroad tracks than they do today. If you are not in the rail business, you may find this hard to believe, but the average locomotive only moves about 21 miles per hour. It's not because they can't move faster; it's because there's so much congestion. People don't know where a lot of the locomotives are sometimes because of backlog. However, when you start to imbed sensors and controls—a basic tenet of the Industrial Internet—this problem goes away since assets are connected. The same theory applies in hospitals where nurses spend something like 20 percent of their time looking for things that they need to take care of patients. With sensors, they are able to be much more productive.

It's not just about the "thing." It's about the thing connected to another thing, so eventually entire ecosystems—whether air traffic control, hospitals, railroads or otherwise—all start to function much more efficiently to create better outcomes. When large numbers of interconnected nodes in a network all work together, the resulting intelligent environment can deliver an unprecedented amount of power. We are standing on this threshold today.

"We've known for a while that lighting is much more than illumination; it's much more than you can see. It's intelligent infrastructure. We are redefining perceptions of lighting to be seen as an integral part of intelligent environments. We've recognized for some time that not only does light allow us to see in darkness; it gives us a host of additional benefits, including feelings of security, clarity and warmth. Now, with sensors and the right software, we are finding all kinds of new tasks for lighting—we are creating the MENSA for lumens as part of our push for more brilliant lighting."

- Beth Comstock, vice chair at General Electric who oversees GE Business Innovations



Lighting the Way Forward

Lighting has always played an important role in how humans live their lives. When carbon arc lamp “moonlight towers” were constructed in the pre-electric light days, people could suddenly go outside and socialize after dark, shifting the paradigm of daily life. When Edison invented that first incandescent bulb, the transformation was even greater: He not only changed the way people lit their homes and businesses, but he further altered the way they could live. With this new technology, people could begin their days before the sun rose, walk and drive the streets more safely, and enjoy their families later in the evening. Recognizing technology’s incredible potential to create change, product innovation has remained a focus for GE Lighting since the company was founded more than 130 years ago.

Lighting technology still continues to evolve, with LEDs leading the way to more efficient, bright and sustainable solutions for every need. GE has continued to drive LED advancement over the last 50 years, ever since a GE engineer invented the industry-changing technology in 1963. Today, from televisions and phone screens, to roadway and outdoor lighting, to the familiar lamps in our homes and offices, LED technology is everywhere. Whereas Edison’s first test bulbs with carbon filaments lasted for 13.5 hours, the LEDs installed today last 20 years. Also, these LEDs are going to cut electricity usage anywhere from 50–70 percent over alternative lighting options.

When Edison invented electric light, his challenge didn’t end there—he next had to figure out how to scale and optimize his creation. Well over a century later, we’re revisiting this challenge with LEDs as we enter the era of the Internet of Things. Tapping into the power of LED light waves has allowed us to explore the possibilities of the connected future and how GE can help cities, businesses and consumers not only adapt to, but thrive in this changing world. We are excited to be a leader in the technology transformation taking place, and we look forward to once again helping people live, work and grow smarter.

Today, light is intelligent. It does more than illuminate—it listens, learns and sees. Light connects data to people to things, creating intelligent environments that change the way people work, live and play. GE's Intelligent Environment solutions are driving this unprecedented shift in the lighting industry as it transforms from simply lights to a software-based ecosystem.

Cities



Direct drivers



to available downtown parking spaces via LED street lights

Reduce congestion through real-time traffic routing

based on weather, construction and signal timing



Cities can monitor air quality and ground conditions

to understand trends better and take action when needed to benefit citizens



Give emergency responders
incident information and deploy them faster

Buildings



Shoppers can easily find everything on their lists,



resulting in higher cart rings and more enjoyable shopping experiences

\$1 OFF

Shoppers can receive coupons on their smartphones while in-aisle, as retailers can promote special offers or highlight certain products

Retailers can better manage inventory,



so shoppers can get what they need

and also spend less time in line at the register

Homes



Wash the dishes, start the dryer and dim the lights



all from the comfort of your couch



Save energy & money

by switching off forgotten lights by smartphone (from the office, the gym, the beach)



Vacation smarter:

Remotely turn specific lights on to give the appearance that you're at home

Program your lights to sense and turn on when you arrive home



Imagine never having to flip a switch because your lights are fully automated and synced to your schedule to come on and off whenever you want





A Look Back at the Lighting Industry

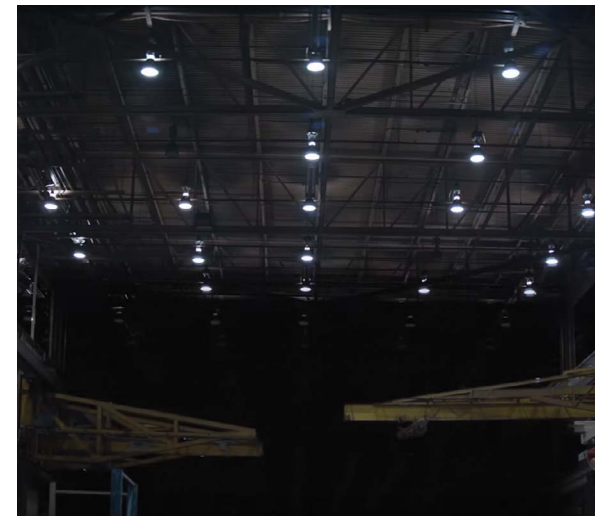
Light has remained essentially the same for a century, you might say. So, how can we make a leap forward now? The answer is two-fold: better light-emitting diodes and lower-cost sensors, transmitters and controls. LED lighting technology has actually made major strides in recent years. Early products struggled to produce a “pleasing” light or simply, enough of it. This is important, as people want light that is not only cost effective, but is aesthetically pleasing—good lighting is the number one driver of positive perceptions in a hospitality environment, and it is equally important in a hospital for utilitarian reasons. Today, we’ve overcome hurdles that faced early LED lights—the quality and light output of LED lamps and fixtures is now comparable, if not superior to, traditional incandescent, fluorescent and halogen sources.

The result is rapidly increasing adoption, particularly in the commercial sector where LED installations and refits are taking place in supermarkets and department stores, banks, office buildings, hotels, restaurants, arenas, warehouses and many other types of facilities. In fact, according to a report by global management

consulting firm McKinsey & Company, LED usage will reach about 70 percent in commercial environments by 2020, up dramatically from just between 10 to 20 percent today.

At the same time, advances in electronics and manufacturing have ushered in a new generation of much smaller, more powerful, less expensive wireless sensors, transmitters and controls that easily integrate with LED lights, which operate as semiconductors (where illumination is achieved by movement of electrons through a semiconductor material, as opposed to sending an electrical discharge through an ionized gas).

It all has the industry excited, and rightly so. This convergence of intelligence and infrastructure has far-ranging implications and the potential to create realities limited only by imagination. LED lights that leverage the latest intelligent hardware and software can talk, listen and even learn. And it’s already happening.



Today’s light not only illuminates. Today’s light is bright. [Watch this video to learn more.](#)



www.gelighting.com/industrial