Bottom-Line Sustainability for Business

What's possible – and profitable –
about intelligent building systems

**An industry study commissioned by ESI
from Business Development Directives**

ESI Environmental
Systems, Inc.

Building Solutions. Building Performance.

Introduction

Paul Oswald, *President*
ESI (Environmental Systems, Inc.)

With today's economic pressures, companies of all sizes and types are looking for ways to control operating costs, including energy, personnel, facility and maintenance. At the same time, businesses are seeking the means to make their businesses more sustainable: some because their customers demand it; some because they see it as a way to attract and retain talent; and others simply because it is the right thing to do. The good news is that the benefits derived from reducing operating costs have a direct positive impact on creating a more sustainable business.

The difficulty for many businesses, particularly small and mid-market ones, is a lack of understanding in how to get started on a path to reduce costs and improve their organizations' sustainability. As with many industry trends, a great deal of information is readily available on the subject. However, making sense of it and determining what is relevant is not an easy or straightforward task.

Clearly, this is demonstrated by results from a study conducted by Moskowitz Jacobs, Inc. In interviews conducted with 450 CEOs, CFOs and senior management, it was found that:

- 87% have room to improve on energy management

- 74% do not have a handle on energy cost

- 59% are not well-positioned in house to control energy and improve operational efficiency

- 49% are seeking ways to optimize energy usage

At ESI, we firmly believe that while research into renewable sources of energy is critical to our long-term future, the real potential for significant and impactful cost savings and sustainability improvement lies in enhancing the efficiency of buildings – the largest component of U.S. energy consumption. Energy management is the quickest, cheapest, cleanest way to extend world energy supplies and energy management can provide four times the environmental impact of renewable energy.

In fact, according to a 2009 study by McKinsey & Co., the U.S. could reduce energy costs $1.2 trillion by 2020 by investing $50 billion per year in energy efficiency. Considering that each one dollar of overhead savings is equivalent to three dollars of new revenue, companies clearly need to look at ways to reduce their operating costs, especially given the current economic climate.

ESI commissioned this study to provide business owners, executives and key decision makers with background information that will help them better understand trends, technology and the industry in general. It is designed to assist in sorting through the maze of information and trends, and visualizing what is possible.

This study also confirms for ESI that we are investing in the right aspects of our business – people, education and expanded capabilities – in order to meet the needs of our customers as they work to achieve a more efficient and sustainable operation. We hope you find this research useful and that it serves to provide you with some clarity, while generating discussion and ideas towards achieving greater efficiency and creating a more sustainable organization.

ESI (Environmental Systems, Inc.) has earned a reputation as energy management experts and an industry thought leader. We've been at the forefront in creating practical sustainable building automation systems solutions that generate a fast return on investment and increased profitability over the lifetime of a building.

Contents

Executive Summary

METHODOLOGY

- The purpose of this study is to identify and analyze the key trends shaping the Building Automation Systems (BAS) industry today and looking forward to the future.

- ESI (Environmental Systems, Inc.) commissioned the research team from Business Development Directives (BDD) to conduct more than 60 hours of extensive secondary research to develop an accurate, timely and compelling state-of-the-industry report. Additionally, BDD spent a significant amount of time to analyze and compose the findings in this report.

- To augment and amplify the secondary research, the team conducted interviews with 12 internationally recognized experts in the fields of construction, safety and security, information technology, sustainability, engineering and facilities management.

THE BAS UNIVERSE

- In the simplest terms, a building automation system is a computerized, fully integrated network designed to control the operational functions of a building.

- Today's systems are highly sophisticated and technologically advanced networks.

- Key benefits of BAS include increased efficiency, cost savings and more environmentally friendly operation.

MAJOR INDUSTRY TRENDS

- Three major trends are readily apparent in the BAS industry: there is an increasing focus on innovation and integration; a greater convergence of information technology (IT) and BAS; and a continuing, growing interest in effective energy management.

- Today's BAS users are demanding that providers become more innovative. In practice, this typically means having the ability to manage a system by integrating different components from different manufacturers in order to achieve peak efficiencies and meet the client's needs.

- The convergence of IT and BAS is considered a significant trend by most experts. This convergence is most noticeable in the realm of safety and security, particularly in controlling access to data and facilities.

- With the increasing cost of energy and growing environmental awareness, it is simply good business for an organization to monitor its HVAC systems for optimum performance. BAS are a critical factor in achieving the best performance and most positive results from energy use.

FUNCTIONS OF BAS

- Two critical functions of BAS include communication and lighting.

- One of the most significant trends in modern building practices is the widespread adoption of digital technologies for both the intra- and inter-building communications.

- Two of the major advances in communication platforms have been Voice Over Internet Protocols (VoIP) and wireless technologies.

- Experts suggest that lighting is a critical, yet often overlooked, function of BAS. Leading authorities in the field suggest that it would be advisable for providers to learn more about the industry in order to more effectively integrate lighting into BAS.

BAS MARKETPLACE

- Recent legislation mandating certain benchmarks for energy use and conservation has split the BAS community. While some believe the government should do more to incentivize environmentally friendly practices, others say legislation is the only effective way to address massive environmental issues.

- American buildings, like those in Europe now, might soon be certified as energy efficient, with a potentially significant impact on builders and operators.

MARKET STRATEGIES

- The BAS market is changing as buyers shop around for the best deals and specific components and systems that meet their unique needs.

- Consolidation has also been an important factor in shaping the competitive landscape.

Methodology

The purpose of this study is to identify and analyze the key trends shaping the BAS industry today and looking forward to the future. Utilizing the firm's seven proprietary super-powered databases and a wealth of professional and technical sources, the experienced team from BDD conducted more than 60 hours of preliminary secondary research using the most authoritative sources available in order to develop an accurate, timely, comprehensive and compelling state-of-the-industry report. These secondary sources include: the U.S. Energy Information Administration, U.S. Census Bureau, Bureau of Labor Statistics and the New Horizons Foundation. Additionally, a significant amount of time was further utilized to analyze and compose the findings in this report.

To validate and extend those findings, the team then took the critical next step of conducting detailed interviews with 12 leading experts in the fields of construction, safety and security, information technology, sustainability, engineering and facilities management. They were asked for their opinions and observations on where the industry is headed, what they consider to be the major issues impacting the industry and which factors will influence the further development of BAS.

Interview subjects comprised a virtual *Who's Who* of leaders in technology and public policy development.

Interview subjects comprised a virtual Who's Who of leaders in technology and public policy development, including Daniel H. Harris, founder and Principal en-terpretor of en-terpret.co and one of the world's foremost authorities on information technology and management; Kerry Malland, Software Consultant; Jim Sinopoli, best-selling author of the book *Smart Buildings*; Chris Curtis, President and CEO of Schneider Electric North American Operating Division; Ken Sinclair, Editor and President of Automated Buildings.com; Bill Mitchell, Executive Director of the Waukesha County (Wisconsin) Economic Development Corporation; and Paul Ehrlich, internationally known writer and speaker on issues related to smart buildings and sustainability, as well as Founder and President of Building Intelligence Group, LLC, among others.

Without exception, the interview subjects were open, unbiased, candid and highly informative in their responses. The individuals on the list (provided by ESI) were glad to hear that ESI was conducting such a study, and the majority of interviews ran well beyond the time the researchers had requested. These individuals, on average, spent twice as much time discussing topics (20 to 30 minutes rather than a brief 10 minute interview). The experts, while not necessarily acquainted with ESI, were even more generous with their time and insights, spending an average of 45 minutes to an hour probing into the issues of the industry and sharing their opinions and perspectives.

The following report is based on the results of this exhaustive secondary and primary research, as well as BDD's highly informed analysis of the findings.

Methodology

Research Resources

Review of over 250 pieces of literature on the industry. Market statistics gathered from the following sample of sources:

- U.S. Energy Information Administration
- U.S. Census Bureau
- Bureau of Labor Statistics
- Hoover's Online
- New Horizon's Foundation
- Frost & Sullivan, Industry Reports
- Thomas.net
- Automatedbuildings.com
- Facilitiesnet.com
- 2008 U.S. Energy Handbook

Interviews Completed

Chris Curtis, President and CEO of Schneider Electric North American Operating Division

Joe Jaskulski, Division Manager, Energy Solutions of Kenny Construction Company

Bill Mitchell, Executive Director of Waukesha County Economic Development Corporation

Steve Fey, President of Tridium, Inc.

Jim Hunzinger, Executive Vice President of Hunzinger Construction Company

William Harrison, Past President of ASHRAE

Joe Muehlbach, Corporate Director of Facilities and Environmental Policy, Quad/Graphics

Industry Experts Interviewed

Paul Ehrlich, PE, Author, Founder and President of Building Intelligence Group, LLC

Jim Sinopoli, Author of *Smart Buildings*

Ken Sinclair, Editor and President of Automated Buildings.com

Daniel Harris, Principal en-terpretor of en-terpret.co

Kerry Malland, Software Consultant

The BAS Universe

In simplest terms, a building automation system is a computerized, fully integrated network, designed to control the operational functions of a building. At first, most BAS were designed and sold as a unit. All of the components were designed, built, installed and serviced by one manufacturer. Systems were typically comprised of a few air conditioning units and a maintenance plan. In these bygone days, lighting, heating and air conditioning were isolated components in the domain of the plant managers and a few operations personnel.

Some industry insiders caution that BAS has never had a foothold beyond the HVAC arena and that lighting, communication, fire and safety are the next frontier for the industry.

But there is nothing simple about BAS anymore. With the advent of new technologies and an intense focus on environmental concerns and cost savings, the industry has evolved. Some industry insiders caution that BAS has never had a real foothold beyond the HVAC arena and that lighting, communication, fire and security are the next frontier for the industry. Providers have become more innovative and flexible.

In the early days of BAS, systems were typically comprised of a few air conditioning units and a maintenance plan; lighting, heating and air conditioning were isolated components.
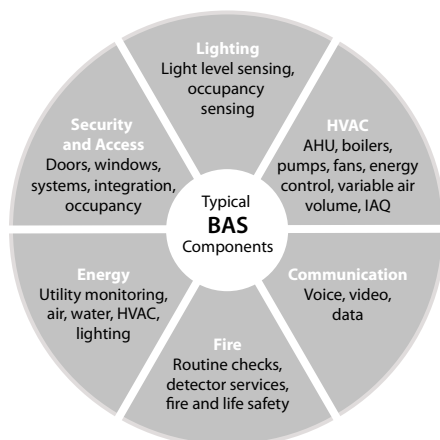
A mechanical industry that was originally developed to serve the HVAC market in plants and facilities throughout the U.S., BAS experienced rapid growth and substantial change over the second half of the last century and is poised for even greater progress in environmental management, energy efficiency and functionality. No longer is BAS the sole concern of the operations staff – the BAS Universe is now populated by individuals in any number of job categories, ranging from automated controls specialists and environmental engineers to experts in electrical engineering and web design, as well as mechanical designers, computer architects and integration specialists. Today's investors, corporate executives and highest-level public policymakers are gaining familiarity with the BAS Universe – not necessarily because they are interested in facilities management, but simply because it makes good business sense and has a significant social impact.

THE LANGUAGE OF BAS

Understanding the transition of the BAS industry requires at least a basic understanding of the technical jargon. The following are a few key terms to keep in mind when reading the following report:

- **ASHRAE,** The American Society of Heating, Refrigerating and Air-Conditioning Engineers, literally "wrote the book" on Heating, Ventilation, Air Conditioning and Refrigeration (HVAC/R) standards. ASHRAE is considered the premier professional and technical organization in its field, much like the American Bar Association is for lawyers and the American Medical Association is for doctors. The organization additionally provides educational resources and actively promotes the interests of the industry through its lobbying efforts.

- **ENERGY STAR** is not just a sticker on an air conditioning unit. It is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy that focuses on energy efficiencies across a wide range of products and industries, including building efficiencies.

The BAS Universe

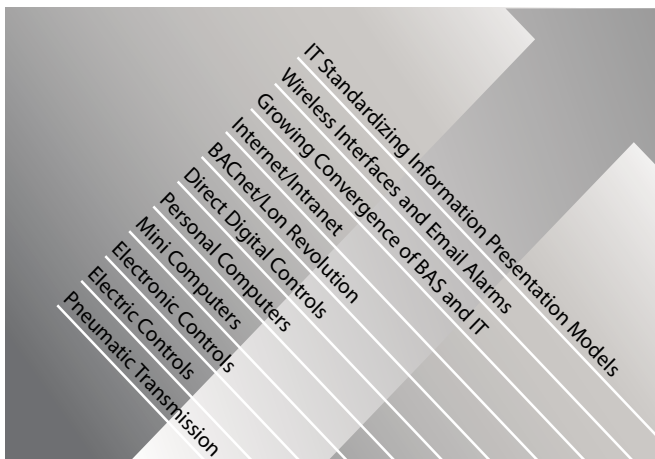- **BACnet** may be just one industry protocol in a jargon-filled universe of industry standards, but it is widely acknowledged as the most important non-proprietary protocol in the industry.[1] [For a more complete list of protocols and standards, along with their definitions, see Appendix 2.]

- The so-called **BACnet revolution** never really ended. As technologies continue to develop, converging automated systems with IT, wireless and Internet protocols, the challenge of making changes to the protocol has been ongoing. (And the BACnet community has struggled to remain awake at the wheel.) As one industry analyst puts it, *"BACnet [will need to] become better adapted to Internet protocols, and not the other way around."*

- When discussing automation in the **HVAC segment**, it is imperative to address energy management. HVAC is such a large segment of building integration that its effects are inextricably linked to Energy Management Systems analysis.

- Also commonly referred to as **Building Energy Management Systems** (BEMS), BAS vary in capability and functionality, but have in common the goal to provide centralized oversight and remote control over building operations.

- **Building Integration** is more than an industry buzzterm – the concept now shapes the majority of the dialogue in the industry. Building integration is all about taking the efficiencies of individual systems (HVAC, lighting, air quality and even security) and managing them as one integrated system through BAS. When this is done, a higher level of efficiencies and savings is realized.

- **Intelligent buildings** will shape the future of BAS (and vice versa). The two terms are becoming more and more interdependent as one does not exist without the other. Intelligent buildings incorporate all of the common building functions, such as environmental control, intrusion detection, access control, lighting and energy management with video.

$$\underset{\text{ENERGY EFFICIENCY}}{EE} + \underset{\text{RENEWABLE ENERGY}}{RE} + \underset{\text{MONITORING AND VISUALIZATION}}{MV} = \underset{\begin{array}{c}\text{NET ZERO}\\\text{Electric}\end{array}}{O}$$
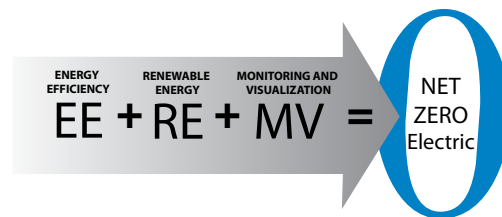
- **Net-Zero** buildings are the long-awaited goal for energy management. In short, net-zero buildings function as their own sources of power, and while most experts believe true Net-Zero buildings are "a long way off," the concept is helping to shape building design today. BAS, of course, plays an increasingly important role in the monitoring and visualization component of the Net-Zero equation.

[1]BACnet is an ANSI, ASHRAE and ISO approved standard. BACnet is a true, non-proprietary open protocol communication standard conceived by a consortium of building management, system users and manufacturers. Also commonly referred to as the ANSI/ASHRAE Standard 135-1995.

Evolution of Systems that may Integrate all Building Services on Standard IT Infrastructure

IT Standardizing Information Presentation Models
Wireless Interfaces and Email Alarms
Growing Convergence of BAS and IT
Internet/Intranet
BACnet/Lon Revolution
Direct Digital Controls
Personal Computers
Mini Computers
Electronic Controls
Electric Controls
Pneumatic Transmission

- **Remote Commissioning** is the BAS tool that allows online web services to be connected to the energy grid and to continually optimize energy use across an entire facility. Remote commissioning is expected to become increasingly important as the smart grid evolves.

- **Open Systems** (also known as Open Energy Management Systems) will continue to call for more collaboration between energy-related product manufacturers and serve providers. As Bill Mitchell, Executive Director of the Waukesha County (Wisconsin) Economic Development Corporation remarks, *"Open systems give the owner the flexibility to maximize a prior investment in BAS, integrate the existing programming into a new system, or converge multiple systems under a common access."*

> **INSIDERS' NOTES**
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> "Open systems give the owner the flexibility to maximize a prior investment in BAS, integrate the existing programming into a new system, or converge multiple systems under a common access." —*Bill Mitchell, RPA, FMA, CEOE*

- **Energy Management** is no longer simply a cost-containment measure. It has become a strategy adopted by industry and government, quickly translating to both greater profits and a higher standard of living.

- **IAQ** (Indoor Air Quality) is now merging into IEQ (Internal Environmental Quality), an expanded definition incorporating more than HVAC, but also lighting and tenant comfort, health and safety.

- **Information Technology (IT)** is everywhere and functions as both an industry tool and a driver. The newest, and perhaps one of the most promising, IT contributions to the field of BAS is in the realm of Enterprise Computing – what industry insiders now call "operating in the clouds."

- **Convergence** in BAS terms is defined as the complete integration of building automation systems with IT and connected enterprise applications that exist within most buildings – or, on a global basis, a group of networked facilities."[2] True convergence will occur, then, through rapidly expanding **IT development**. The manpower needed to maintain unique interfaces for building automation in the face of new and emerging communications software (IP networking, cloud computing and web access), will make old interface models unsustainable.

- Full realization of the U.S. **Smart Grid**. The electric industry is poised to make the transformation from a centralized, producer-controlled network to one that is less centralized and more consumer-interactive. The move to a "smart grid" promises to change the industry's entire business model and its relationship with all stakeholders, involving and affecting utilities, regulators, energy service providers, technology and automation vendors and all consumers of electric power. The smart grid, most experts say, will be here sooner rather than later. According to William Harrison of Trane Arkansas, Past President of ASHRAE, *"[The] Smart Grid will become a reality in our lifetime. At that point we will be able to merge generation and delivery."*

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[2] An important distinction to observe is that while there has been connectivity between disparate systems in the past, there was not necessarily *integration*. Different systems and applications can communicate basic information, but they usually lack complete data-exchange capabilities. True Convergence is almost synonymous with integration, as it allows for more and more information to be available on a by-request basis and in a manner that is more easily understood by any technology system within the building – or by the people who want to analyze the information.

Major Industry Trends

Intelligent Building

A building that uses both technology and process to create a facility that is safe, healthy and comfortable and enables productivity and well being for its occupants. An intelligent building provides timely, integrated system information for its owners so that they may make intelligent decisions regarding its operation and maintenance … has an implicit logic that effectively evolves with changing user requirements and technology, ensuring continued and improved intelligent operation, maintenance and optimization. It exhibits key attributes of environmental sustainability to benefit present and future generations.

–Continental Automated Buildings Association (CABA)

In a rapidly expanding and evolving industry, three major trends are readily apparent. There is an increasing focus on innovation and the integration of different components and systems; a greater convergence of IT and BAS, especially in the area of safety / security systems; and a continuing interest in energy management. In short, not only is the technology changing, but also the way that technology is used. These major trends, and their impact to business owners, executives and key decision makers are described in greater detail in the following sections.

INNOVATION AND INTEGRATION

Once upon a time, building automation systems were one-size-fits-all. A manufacturer would install whatever system was available, with little thought to the unique needs and circumstances of the building operator. All components in a system had to come from the same provider, otherwise they wouldn't work together. This model left little room for building owners to truly manage their systems. They had to accept whatever parts fit their existing system, whether or not those parts met the operator's needs. Today's BAS consumers are demanding more connectivity, compatibility, scalability, flexibility and interoperability among systems and components. They want parts from different manufacturers to work together at peak efficiency. This kind of sophisticated integration requires a provider to be flexible, knowledgeable and above all else, innovative in finding and implementing solutions.

One corporate-level executive interviewed for this report told researchers that he once monitored his building's operations from a hospital bed.

Key Driver

According to Steve Fey, President of Tridium, a global leader in open platforms, today's key market drivers are application software frameworks, automation infrastructure technology, energy management and device-to-enterprise integration solutions, integration and innovation. "Our biggest value is in integration," he says. *"BAS is a mature industry – 30 years old – with dozens of manufacturers with third- and fourth-generation products. Building owners now have very disparate systems, so integration is critical."*

How-To

Integration does not happen on its own. As Fey puts it, *"The first problem to solve is how do you integrate with the different manufacturers? How do you combine all systems? How do you set it up so that customers can have the ability to pick the best-of-breed equipment and still have an integrated system?"* Many experts point out that technological advances are allowing integration of different components and systems to an unprecedented degree. *"The technology for systems is starting to converge,"* says Jim Sinopoli, author of the widely read book *Smart Buildings* and a globally recognized authority on the subject. *"Using similar cables (and) standardized databases, what this means is there can be efficiencies and functionality."*

Knowledge Base

But integration alone is not enough. Being innovative also means being able to provide buyers with the information they need to make the best decisions about their systems. BAS end-users want answers from their provider on how to achieve the greatest efficiencies and cost savings – a solutions-based approach rather than buying off-the-shelf. Information will become just as important as the equipment itself. As one industry leader notes, "In addition to technology, expertise and knowledge to provide the right kind of user-friendly interface for the disparate subsystems will be a key differentiator."

CONVERGENCE OF IT AND BAS

For a long time, IT and BAS were developed in their own separate bell jars, each focusing on their individual technology developments and moving down the path of least resistance to market. But as buildings become "smarter,"
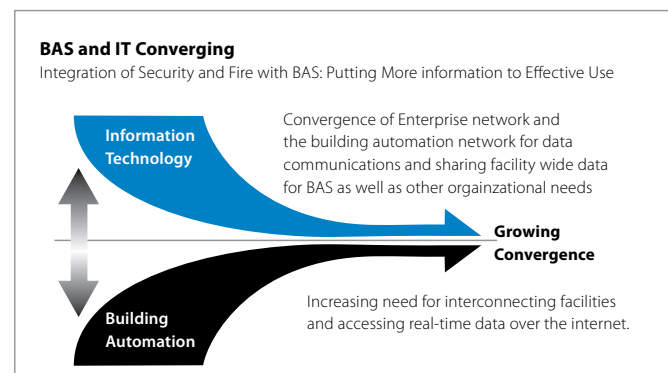
and there continues to be a growing need to interconnect building facilities spread over different geographical locations for remote monitoring / analysis and control, the convergence of the two is inevitable.

Hostile Takeover?

Our expert panel was unanimous in their conclusion that the convergence of BAS and IT is one of the most important trends in the industry. For some, it may be a daunting prospect, but others see convergence as a natural progression. Says Chris Curtis, Executive Vice President, Buildings of Schneider Electric: *"There is a belief by some that the IT industry is going to take over BAS. Our view is that IT is the basic infrastructure – cabling, networks, data gathering, database management and display – of all the systems we use. We certainly see BAS, and for that matter any building system, fully capitalizing on IT technology and trends."*

Safety First

Many of the industry leaders who responded to interviews say the greatest impact associated with the ongoing convergence of IT and BAS has been enabling organizations to enhance safety and security by better controlling who has access to critical data and facilities. With the convergence of BAS and IT, building operators can monitor their buildings 24 hours a day, 7 days a week, they can control access and they can recognize cost savings with the shutdown of non-necessary systems. Controlling access and systems has become such a priority that one corporate-level executive interviewed for this report told researchers that he once monitored his building's operations from a hospital bed.

BAS and IT Converging
Integration of Security and Fire with BAS: Putting More information to Effective Use

Information Technology

Convergence of Enterprise network and the building automation network for data communications and sharing facility wide data for BAS as well as other orgainzational needs

Growing Convergence

Building Automation

Increasing need for interconnecting facilities and accessing real-time data over the internet.

Major Industry Trends

Command and Control

"I think the biggest advantage of the integration of IT and BAS is the overall control of user authentication," says Daniel H. Harris, Founder and Principal en-terpretor of en-terpret.co and one of the world's leading authorities on information technology systems and management.

According to Ken Sinclair, Editor and President of AutomatedBuildings.com, *"We are seeing a smoother approach (to user authentication) develop – face recognition, biometrics. We can buy cameras for everything, from front desk monitoring to checking the belt on a fan. It's a whole new world – radical change."*

Harris notes that having one Smart Card to get in the front door and another to log into the IT system is both inefficient and potentially risky. Merging IT and BAS means one card could be used for both purposes. *"When (the access cards are) unified, this should allow people in the front door and also in the network,"* Harris says. *"And locking someone out of both should happen immediately when an employee is terminated."*

Unfortunately, Smart Cards like car keys, sunglasses and other small, but essential, items – have a tendency to disappear. Anyone can pick up a lost or discarded Smart Card and have immediate access to an organization's most sensitive buildings and computer files. The answer, according to Dan Harris, is an emerging technology right out of a Bond movie: biometrics, such as scanning a fingerprint.

"The ideal solution would have to have some component of biometrics for access and system authentication," Harris says. *"But this has one disadvantage – contact is required."* New technologies, however, may eliminate the need for touch pads and other bulky interfaces, he adds: *"iClass can be read at a distance. This could be useful, for example, to lock a computer automatically when you walk away from it. There is one manufacturer – Privaris – that makes a single device that can be used for door access and system authentication. It also has a biometric capability – a fingerprint scan is required before the device will authenticate to either. This device is really close, but it is still a little expensive. Still, I think the ultimate solution will look something like this."*

Real Concerns

Despite the prevailing and apparently positive trends, there are a number of real concerns about the convergence of IT and BAS:

- While BAS experts acknowledge that the industry itself has implemented the all-important **open standards** and protocols for integration with IT, there remains a number of manufacturers of individual building components that are being criticized for incorporating communications options (BACnet, Modbus or LonTalk generally), that supposedly do not fit the needs of intelligent buildings.

- Peel back the layers of industry marketing hype, and there are a number of real concerns about the need for true IT and BAS integration. It is one thing to have ongoing data collection in the most simple read/write capacity, and yet another to be able to track trends, adjust schedules and incorporate change-of-value reporting[3].

- Integration of physical and digital (IT) security can deliver substantial efficiencies. There is some concern, however, that businesses have not realized the importance of integrating physical and digital security in the workplace. It should be noted that approximately 70 percent of data theft from a company remains in the domain of physical

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[3] Change of Value Reporting – Reporting that only updates when there has been a change, thus freeing up demands on the communications polling devices.

**Revenue Forecast
For Card-Based Electronic Access Systems Control**
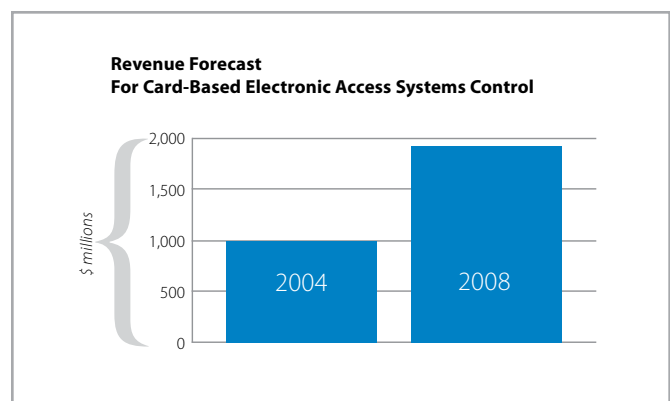
theft – people are stealing more paper folders than computer files.[4] Clearly, there is an opportunity for an organization to promote the integration of fire and safety systems with BAS. The first movement in such a direction will most likely be focused on new construction and retrofit.

ENERGY MANAGEMENT / HVAC

Whether you own one building or a hundred, when you begin to look at operational costs and environmental impact, you will, at some point, look at your HVAC system. It's inevitable. It's common sense. BAS began with the development of control systems to monitor and control HVAC because building owners, corporate officers and facilities managers were looking for a means to run their buildings in a more economically and environmentally sound manner. HVAC in BAS remains important because it is typically still the first place building operators look to cut costs and improve efficiencies. While the HVAC market will continue to change, responding to advances in technology and calling for even more systems integration, it is expected to remain the cornerstone of BAS in the years to come.

The HVAC Market

How important is HVAC and energy management in the BAS industry? The numbers tell the story. The HVAC market exceeded $10 billion in sales in 2006 and has been forecasted to hit $13 billion by 2011. On an annual basis, systems upgrades account for nearly a third of the HVAC market (28%) followed by replacements (25%). HVAC is not an operational function isolated from the energy management and the other major systems of BAS. A savvy solutions provider will recognize that trends in the industry will continue to influence technological and process innovations in coming years.

- With regard to **cooling systems**, industry insiders see continued trends toward packaging of equipment and continued pursuit of smaller size; advances in heat exchanger technology, and a growing response to indoor air quality and control technology.

- Specifically, in **heating equipment** design, there continues to be seen a reduction in equipment size and development of modular heating equipment; continued pressure from non-U.S. (specifically Pacific Rim) suppliers and environmental controls in the EU placing downward pressure on HVAC sales; efficiency improvements in

combustion equipment; development of radiant heating equipment; modulating of low-input heating equipment; and, of course, improved emission controls.

What's going on in the industry? The major nonresidential markets are expected to realize modest growth with the health care, education and power-related markets deemed to have the greatest upside. Some industry insiders suggest looking toward changes in the commercial office with more and more telecommuting office-at-home workers expected in 2018. Declines are expected in the industrial market with a growing amount of manufacturing done offshore. From a business standpoint, the New Horizons Foundation expects a much more **consolidated industry** in 10 years *"as mergers continue through both vertical and horizontal consolidation. The private equity market will continue to provide exit opportunities for HVAC business owners."*

Up and Down

According to Ken Sinclair, Editor and President of AutomatedBuildings.com, the original BAS industry is growing both upward and downward. As for upward growth (which is actually creating a wider base), Sinclair cites the tremendous consolidation in the business: *"Automated Logic was bought by Carrier …. Allerton was bought by Honeywell. Schneider Electric bought Power Measurement and anything else that moved [including Andover Controls]. And, Cisco bought Zeta. Now, THAT's something I hadn't thought would happen a decade ago."*

As for the "downward" growth, Sinclair mentions the increasing adoption of BAS in smaller businesses. As more organizations gain broadband access and greater networking capability, *"It makes more sense for places like schools, hospitals and small retail chains, to be able to immediately recognize efficiencies with integrated BAS,"* Sinclair says.

Energy Savings

Given the turmoil of the recent economic crisis, the growing uncertainty about oil reserves and the fact that energy prices in the U.S. continue to rise, it is not difficult to measure a growing concern among corporations, institutions and facilities managers over the prices associated with just "keeping the lights on" in their buildings across North

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[4] Frost & Sullivan, Integration of Security and Fire with BAS: Putting More Information to Effective Use, 2005.

Major Industry Trends

America. Perhaps "keeping the lights on" is an understatement when it comes to energy use, since energy costs (not only for lighting, but operations including heat, air conditioning, computer use, etc.) represent almost 30 percent of the typical office building's total operating budget. [5] It is estimated that today's office buildings actually use 16 percent more energy per square foot than those built 25 years ago, and the total amount of energy used by commercial buildings has risen significantly since the 1980s. This, according to industry researchers, reflects a 50 percent growth in the total amount of office space available and a 33 percent increase in energy consumption per square foot of space. [6] The result, according the U.S. Energy Information Administration (EIA), is a whopping 70 percent overall increase in the amount of energy used by commercial buildings in most recent decades.

Desperately Seeking Efficiency

In order to combat such increases, both commercial and residential building owners and stakeholders will be looking to squeeze efficiencies out of existing systems, make improvements in the overall performance of their buildings, retrofit – when cost-effective – and design with BAS in mind. With better monitoring and control of energy-intensive systems, Energy Star notes that building managers can reduce energy consumption by up to 35 percent. There are a growing number of more advanced, intelligent and green buildings realizing reduced energy usage by as much as 50 to 70 percent over conventional buildings.

Not convinced? CABA's 2009 industry report on intelligent design cites a number of specific case studies for further exploration. Experienced supplier like ESI also will have case studies of proven results.

Energy Consumption Forecast *by Sector*
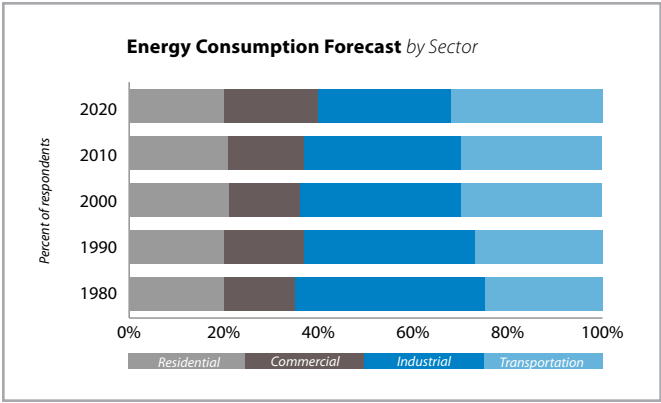
Energy Savings through Water Conservation

While Green House Gas Emissions get an awful lot of press, they are not the only concern to environmentalists, building investors, corporate executives and facilities managers. North Americans are the largest per capita consumers of water in the world. [7] Concerns about **increased droughts**, as well as increased flooding, are straining an aging infrastructure and creating growing concern. But as municipalities look for solutions to their maturing pipelines and rising delivery costs, they have not found it a politically viable option to pass on their water woes to businesses and consumers. Rather, they have taken the tact of creating higher demand for more efficient water management usage from corporate and residential customers alike.

Fortunately, such demands are often accompanied by a carrot AND a stick – with the lure of local incentives for such things as storm water management (the carrot) and increased fines for noncompliance (the stick), facilities stakeholders are likely to be more open to innovative systems, sensors and monitors for more effective water conservation.

Energy Savings Examples

Case Study [8]	Energy Savings	Technology Trade Names
State of Missouri	17% annual energy savings (post retrofit)	Enterprise Asset Management & Building Information Management Systems
Kwantlen University College	30% annual energy savings compared to 1999	Integrated Building Automation System
Rogers Centre	76% savings on lighting energy costs (post retrofit)	Energy Control Systems
The Verve – High Rise Condominiums	35% annual energy savings	Energy Management Systems (BAS / BEMS)

[5] (Excluding staffing costs.)

[6] Frost & Sullivan, 2009.

[7] OECD, Organization for Economic Co-Operation and Development.

[8] "Bright Green Buildings, Convergence of Green and Intelligent Buildings," a 2008 study published by CABA (Continental Automated Buildings Association) and funded by BAE Systems, Herman Miller Inc., Johnson Controls, Cisco Systems, Delta Controls, Trane and other industry stakeholders.

Functions of BAS

Integrators with a reputable brand name and who adopt new technologies will be the ones to survive and eventually thrive.

COMMUNICATION – A CHANGING DEFINITION

One of the most significant trends in modern building practices is the widespread adoption of digital technologies for both intra- and inter-building communications. Today, integrated building systems require sophisticated, yet highly reliable, communications platforms to facilitate clear, accurate and timely information to the occupants.

VoIP and Wireless

Fifty years ago, business communication was firmly dependent on wires and cabling. Ten years ago, cell phones and cell towers became the industry standard. Today's communication media of choice are VoIP (Voice Over Internet Protocol) and wireless technology. Ken Sinclair, Editor and President of AutomatedBuildings.com, sees VoIP and wireless technology having the same dramatic impact on BAS as it did in the telecommunications industry. "Cisco is in the market – I didn't see that one coming," he admits. *"The way Cisco puts it, what they did in the phone industry with VoIP will be the same kind of transformation in BAS. As we move up the evolutionary chain, whether in BAS or voice, VoIP thinking is where we have to go."*

Double Cost Savings

The implications of VoIP are more far-reaching than simply connecting the sales staff to the office through a computer. Advancements in video technology fan out across the broad spectrum of BAS, in Sinclair's words, *"from installing micro cameras on fans and belts to adopting cameras as counters in foyers and lobbies."* The technology of advanced communication via the Internet easily expands beyond e-mails and faxing into the realm of security and access. According to Jim Sinopoli, author of *Smart Buildings*, it could include *"even monitoring whether or not a PC is idle for a period of time and powering down, sending that energy back to the grid, and recognizing double cost savings."*

Just how far-reaching is the communication component with regard to BAS? Voice, video and data technologies are so pervasive in the industry, that while CEOs and facilities managers must pay attention to phone systems and teleconference equipment, the real momentum behind changes in this arena is found in the area of remote monitoring and both physical and virtual (data storage) security.

> **2009 PREDICTION**
>
> In the future, middleware will become the domain of ERP business software vendors such as SAP and Oracle; and network switch manufacturers such as Nortal and Huawel will add middleware into their switches. —*AutomatedBuildings.com*

Communication Trends

Communication, while identified as relating to voice, data and video, is no longer isolated in the basement of the BAS paradigm. The following are some key trends in this area:

- The introduction of **IPv6**, an upgrade to the Internet's main communications protocol, known as IPv4, is expected to provide networks like automated building operations systems with additional capacity and capabilities.

- Advances of video-based **security systems** and growing pervasiveness of **micro-video cameras** will expand beyond the perimeter of security – pinhole and microchip cameras provide opportunities for use in hard-to-reach areas (and the added expectation is that prices of such technologies will fall while installation will become easier).

- **Introduction of Wireless Networks.** The ZigBee platform is widely used to create what are referred to as self-healing and scalable wireless networks that enable solutions in building automation, energy efficiency, HVAC, AMR [9], predictive maintenance, asset tracking and other application areas.

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[9] AMR = Advanced Meter Reading

Functions of BAS

- **Connecting networks to unconnected legacy devices.** Solutions to the problem of what to do with unconnected existing devices have long driven the BAS industry. Companies across the industry continue to innovate in this direction.

- **Network "Clouding."** Given considerable press in recent months, network clouding is the name applied to putting computing services, such as web services and software, as a Service (SaaS) on computers in a wider (WAN) network. In such discussions, the technological issue of information or systems "silos" becomes dominant, and the use of a "cloud" metaphor, as opposed to a "tower" metaphor is built on the idea that traditional building systems have, until recently, gone up to a central point, or tower. Information in independent networks reaches only one access point, rather than being accessible from multiple locations, or more nebulously, from any location. End user interface becomes a significant selling point in cloud vs. tower scenarios.

The use of micro-video cameras will expand beyond the perimeter of security – pinhole and microchip cameras provide opportunities for use in hard-to-reach areas (and the added expectation is that prices of such technologies will fall while installation will become easier).

- The contribution of **middleware** to protocol development and system integration continues to grow. Used to connect applications to other applications, middleware is considered the "glue" between software components or between software and the network. In the past, it was common for middleware to be packed with an automation system, security and life safety systems from one vendor. This scenario, like so many others in the industry, is also rapidly changing. There are a number of companies developing middleware for building management, with more entering the areas all the time.

- RFID (Radio Frequency Identification Systems). Web-based RFID is one of the first research areas integrating RFID technology, database, Internet technology and scheduling theory in building maintenance and promises to offer some significant advantages: [10]

  – Such systems can be implemented from anywhere, at any time, for any platform with wired or wireless Internet connections, which enhances managerial efficiency.

  – Data stored in RFID tags can be easily modified.

  – Non-contact and non-line-of-sight RFID technology promises to enhance maintenance convenience.

  – RFID tags can be used under practical challenging conditions such as paint, grime and dust.

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[10] Chien-Ho Ko, 2009: RFID-based building maintenance system, Automation in Construction 18 (2009), 275–284.

COMMERCIAL LIGHTING

Talk to some industry insiders and they'll tell you that the lighting segment of the market has been, consistently, outside the domain of BAS. They'll tell you that only about 10 percent of the lighting business crosses over to BAS and they'll tell you that the unique world of lighting is inhabited primarily by electrical engineers and lighting manufacturing companies. And in explaining all this, they wouldn't be wrong. But other industry insiders also suggest that the situation is the same for many other building operations. That challenge is being met by systems integrators who keep on top of changing technology and understand the need to integrate them into the BAS fold. Lighting systems technologies are advancing as rapidly as HVAC and security and the sooner they are merged with intelligent design through BAS, the sooner will there be efficiencies (translated $ savings) across the board. According to one expert, *"There's going to need to be a concerted effort to understand lighting. And, since it's such a big part of the energy costs, the technologies will overlap with BAS."*

2009 PREDICTION "Daylighting (substituting outside ambient light to replace internal electric light) requires a significant BA interaction with clients and ambient light sensors, as well as motorized fenestration controls."—*Ken Sinclair, AB.com*

Payback is Good
Favorable payback rates make control systems a cost-effective choice in lighting design within both commercial and residential buildings. According to the new Buildings Institute, lighting controls can reduce lighting energy consumption by 50 percent, when chosen as retrofit and by 35 percent in new construction. The U.S. lighting equipment manufacturing industry includes about 1,100 companies with combined annual revenue of about $12 billion. Major companies include Acuity Brands, Hubbell and Philips Lighting. Divisions of large integrated companies, such as General Electric, also manufacture lighting equipment. The industry is concentrated: the largest 50 companies have about 70 percent market share.

Trends
- Rising energy costs, the green movement, building energy code requirements and the demand for LEED-certified buildings, continue to create calls for lighting controls.
- However, the lighting industry itself has struggled significantly in recent years. Strong import competition, nano-technology, legislation and even the push to environmentally green building design, have been blamed for revenue declines.
- Integrators with a reputable brand name and who adopt new technologies will be the ones to survive and eventually thrive.
- The falling cost of green design strategies and technologies will continue to make lighting controls an attractive industry option.
- Confronted with the low efficiency of existing lighting systems, the lighting industry is seeing rapid innovations in the development of advanced, energy-efficient and environment-friendly solutions. (Think day-lighting might hurt the BAS? Think again. Effective day-lighting can only be incorporated using ambient light sensors and motorized fenestration[11] control).

  Day-lighting (substituting outside ambient light to replace internal electric light) requires a significant BA interaction with clients and ambient light sensors as well as motorized fenestration controls.

[11] Fenestration controls trap solar radiation, increase daylight level, keep out insects (in the process reducing air speed) and modify air velocities. They affect and control heat gain, daylight and ventilation.

2009 PREDICTION "Just sensing whether a building space is occupied or not will no longer suffice… systems will need to provide real-time information about how many people occupy the space and where they are located."—*Jim Sinopoli, author of Smart Building*

Functions of BAS

- LEDs, the future promise of cost-efficiencies through light-emitting diode technologies, are developing along different paths. Their continued development is anticipated to have significant cost savings and increased occupant satisfaction across the industry. OLEDs (organic light-emitting diodes) additionally produce electricity off-the grid, adding to cost savings.

Lighting is a significant consumer of electricity. Its influences, however, reach into other areas as well. The lighting issue is part of safety and security (no one wants to be standing in the restroom when the lights go out). It is part of the HVAC system because of its heat production. And, lighting is a social issue that has become part of the social consciousness. There is growing social awareness of light pollution (what is seen to be a waste of energy) and "dark sky" initiatives are even forming with the mission to combat such waste. In the future, Building Standards Initiative leader and author Bill Swan suggests there is much work to be done, and that much of this work will be in the form of lighting guidelines for the industry, though he has not yet seen what forms those guides will take. *"They may call out the use of daylighting controls (stepped or dimmed lighting near windows), individual controls for some percentage of the building's occupants, non-emergency lighting dimmed or turned off during non-business hours, and manual on/automatic off lighting controls using occupancy detectors, whether passive infrared (PIR) or ultrasonic."* [12]

Industry insiders agree. According to Jim Sinopoli, author of *Smart Buildings*, *"Just sensing whether a building space is occupied or not will no longer suffice ... systems will need to provide real-time information on how many people occupy the space and where they are located."*

Further statistics on the state of the commercial lighting industry and a breakdown of both commercial and residential building markets are included in the appendix to this report.

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[12] Bill Swan, 2009. Building Integration Trends, Today's Facilities Manager.

"Increasing R&D in the lighting industry is expected to make next-generation lighting sources more efficient and reliable, along with enabling them to provide increased design flexibility over conventional light sources." – Paul Ehrlich, PE
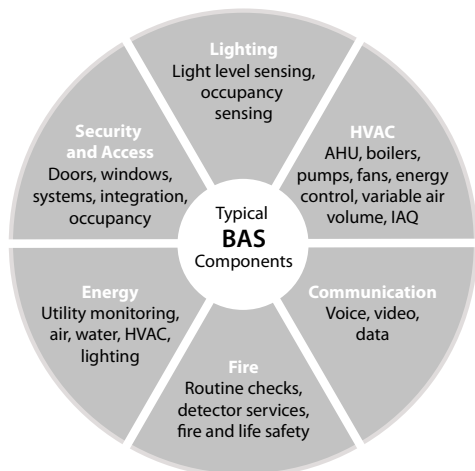
The BAS Marketplace

Market segments, traditionally created as a means to reach different customers and to understand the needs of individual corporations, have long been the standard for businesses in BAS. The traditional graph shown here offers a simple and easy-to-assimilate model for strategic planning purposes. But with the tremendous changes taking place in the industry, such clear distinctions are likely to become blurred. A look at the traditional matrix leaves one to assume only a level of interactivity between all functions of BAS – and, if this study suggests nothing else, it is clear that the dynamic has changed. The forces of integration, convergence and interoperability continue to move through the industry, sweeping aside those companies that cannot stay ahead of the advances, and burying those that are unwilling to change.

A new understanding of building automation exists in the virtual world, in clean operator user interface, in the programming language of a multitude of systems, and, clearly, in a sea of environmental consideration. The walls between the individual markets begin to fade, interconnectivity becomes truly a part of the convergence of IT and BAS, and, in the end, the entire infrastructure of the industry is encapsulated in the energy efficiencies and demands of an ever-greening economic, social and political environment.
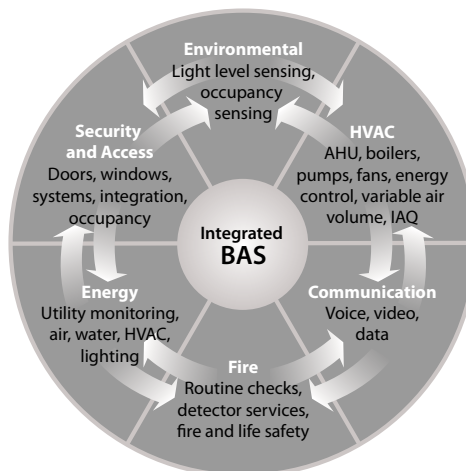
THE SOCIO-POLITICAL LANDSCAPE

It is impossible to look at the current state (and the immediate future) of BAS without taking a moment to comment on the socio-political drivers in the industry. While industry publications and secondary research regularly mention the Department of Energy, LEED certification, ASHRAE standards and other forces impacting the business, it is in personal conversation with industry experts and industry insiders (construction companies, advisors, CEOs) that we find a growing perception regarding the impact of legislation on business, spilling over to the BAS arena. Consider the following two camps of thought:

Camp 1

Camp One. Individuals at the grass-roots level of the industry (small business people, entrepreneurs, general contractors) are more likely to be extremely frustrated with what they consider to be undue government interference in mandating building energy efficiency standards. The following is a selection of comments from the experts on our panel who fit into this category:

"What is affecting the industry the most is the economy. I cannot help but talk about the current administration and their incompetence."

In the early days of BAS, systems were typically made up of components fairly isolated from each other.

Typical **BAS** Components

- **Lighting** — Light level sensing, occupancy sensing
- **HVAC** — AHU, boilers, pumps, fans, energy control, variable air volume, IAQ
- **Communication** — Voice, video, data
- **Fire** — Routine checks, detector services, fire and life safety
- **Energy** — Utility monitoring, air, water, HVAC, lighting
- **Security and Access** — Doors, windows, systems, integration, occupancy

Over time, integration and interconnectivity has grown, along with a growing awreness of environmental impact.

Integrated **BAS**

- **Environmental** — Light level sensing, occupancy sensing
- **HVAC** — AHU, boilers, pumps, fans, energy control, variable air volume, IAQ
- **Communication** — Voice, video, data
- **Fire** — Routine checks, detector services, fire and life safety
- **Energy** — Utility monitoring, air, water, HVAC, lighting
- **Security and Access** — Doors, windows, systems, integration, occupancy

The BAS Marketplace

"We're getting regular calls from small business owners who are worried about having to deal with governmental mandates. They want to know what cap and trade means for them. And, frankly, we're not there yet. We're just at the tool creation stage."

"If they mandate energy savings, it's going to put small businesses out of business."

"As it is, we'll not see any new buildings until after 2010."

"This administration has put a huge cloud over business. They are antithetical to the business mindset and to getting business done in America. All of this says to the business community: 'We're going to tell you what to do and how to do it.'"

"If I would recommend one thing, it's to remember that small business drives the economy. Government's role is to incentivize toward energy efficiency. Incentivize manufacturers to limit waste. With incentives, the small businessman is fully capable of making his own decisions, not being legislated to do something."

These individuals are careful to point out that legislating energy savings is not an effective means of doing business. The DOE, they say, has been incentivizing for years and needs to get more creative with incentives.

The new paradigm is a dynamic system where the lines are blurred beween components. Interconnectivity becomes truly a part of the convergence of IT and BAS. The entire infrastructure is encapsulated in the energy efficiencies and demands of an ever-greening economic, social and political environment.
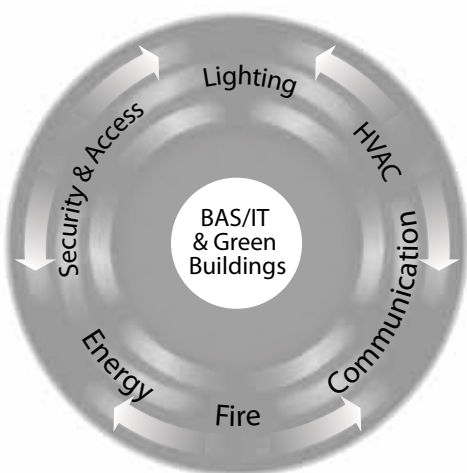
Camp 2

Camp Two. In the other camp, however, are the industry experts who do not seem overly concerned with legislative issues. Some remarked that the impetus for the smart grid implementation will be a major cost savings to small- and medium-sized businesses, that the current administration seems to "get it" with regard to the need for energy conservation and innovation in that field. The bottom line, to these individuals, is that there will be savings and more efficiencies in the system. Their comments include:

"There are a lot of organizations like ours (Quad/Graphics) who understand that sustainability is just good business. I can't emphasize enough just what the branding possibilities are. It's no coincidence that National Geographic, the Sierra Club, the Nature Conservancy are all our customers. They needed to line up their supply chain with like-minded forward-thinking organizations."

"Cap and trade for calculating energy use or carbon emissions will only impact the really large corporations."

"Not really worried about the current administration. In fact, their emphasis on the smart grid is really needed. Politicians tend to be dinosaurs … and we've got some dinosaur tipping to do. Obama seems to get it, I don't know if the rest of the government does."

"If you look at LEED certification prior to 2006, you find that the certification did little to help companies meet energy performance projections. Twenty-five percent (prior to 2006) never met their projections. Yes, they got points for having bamboo flooring, but still didn't manage their energy use. So, LEED woke up and changed things the 1st quarter of this year."

"There are plenty of companies like ours, who are working with Bill Mitchell and ESI and others to provide mentoring for small businesses. We'll always have those who are fearful of change, but if they don't get ahead of the curve, they'll be left behind."

"Interestingly, it seems to be moving from the lowest levels of politics – upward. While you can't perhaps get anything done in congress, I see individual cities who say they can do this – be sustainable, carbon neutral. So, they implement it, and then another city sees what they've done and they go ahead and do it. And the impetus comes from the lower levels and it's really interesting."

BAS IN THE LAND OF GREEN

An environmentally friendly, sustainable and net-zero world to some industry insiders has long seemed the stuff of dreams – like the first time Dorothy laid eyes on the Emerald City. But "green" is no longer just the "if we lived in a perfect world" scenario. The move to blend environmental initiatives into every corner of building design, planning, maintenance and automation has not only found its ideological footing in the industry, but it has continued to gain financial advantages and incentives as well. Joe Muehlbach, Corporate Director of Facilities and Environmental Policy with Quad/ Graphics in Sussex, Wisconsin, works with the largest manufacturing facility in the U.S. to be LEED certified. *"BAS,"* he explains, *"helped get us points toward that certification."* As a representative of a leading corporation in the green movement, Joe also points out that *"Companies that fail to realize what is coming, in terms of becoming carbon neutral and CO_2 emissions, are going to be in for a rude awakening."*

INSIDERS' NOTES

"I'd like validation or repudiation of my suspicion that the smart grid is going to be a regional system first. "

Green Buildings and BAS

- Installation of **smart thermostats** or other load control devices represents a growing market for utilities to cycle equipment for shorter, less intrusive periods of time.

- Industry insiders, in fact, are waiting to find out whether or not **utilities** will take the lead in regulating energy through the smart grid. They see this as an interim step in the process of going directly from the smart grid to building systems.

  "I'd like validation or repudiation of my suspicion that the smart grid is going to be a regional system first." (Managed through utilities.)

2009 PREDICTION

"For the smart grid to be effective, it must include deep integration with energy-consuming systems which are part of HVAC and lighting in the buildings."—*Ken Sinclair, AB.com*

"Am I being optimistic about utilities using DR (demand response) to speak to BAS?"

- For the smart grid to be effective, however, analysts also believe that BAS will need to be integrated into the energy efficiency of the entire building.

  "For the smart grid to be effective, it must include deep integration with energy-consuming systems such as the controlled systems which are part of HVAC and lighting in buildings."

- With the introduction of **Gridwise**[13], buying back peak electrical demand will continue to have far-reaching effects on automation. A $900 billion market opportunity has been identified for the industry to make the U.S. national grid smart and wise with interactive connectivity.

- It is anticipated that, in the 21st century, every facility (not just those in California) will need efficient and effective means with which to respond to power shortages and blackouts. Implementation of Demand Response programs provides the opportunity for facilities to operate in response to demand and / or utility rates in real time. This will be a key component of smart grid implementations in the future.

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[13] GWAC, 2007. Grid Wise Architectural Council created by the U.S. Department of Energy "to promote the modernization and interoperability of the electricity system, using common standards and protocols for automation, information technology, interconnectivity and communications to improve the integration, operation and efficiency of the grid from end-users up through transmission and distribution to power plants," has had significant technological implications.

The BAS Marketplace

It is anticipated that in the 21st century, every facility (not just those in California) will need efficient and effective means with which to respond to power shortages and blackouts.

- Since all components of an automated building operations system must work together, **compatibility** and **standardization** are significant issues. There is an industry push, therefore, to adopting more stringent industry-wide protocols to ensure compatibility among different brands. Unified system architecture (with Internet Protocol as a key, pervasive element of networking technology at the enterprise / IT level) is one such area.

- The criteria and credits for **LEED® certification** will continue to evolve. Further, they will become more geographic in their approach, paying attention to efficiencies that can be recognized by regional responsiveness to weather patterns, corrosion, seismic monitoring and even personal rapid transit.

- **Touchscreen** and digital displays will rapidly evolve to provide information for real-time energy usage monitoring. *"The fact is, when people are given energy information and system control, they tend to do the right thing, which is conserve energy. Simply providing information about energy usage will prove to be the most cost-effective energy strategy."* – Sinopoli. In the area of digital displays, also called **digital signage**, there are companies making truly innovative strides in this area.

  "QA Graphics, they used to be Quality Automated Graphics, has done tremendous work in the field of digital signage. This becomes a PR issue as well, as they educate the public and help brand the building."

  "Branding is an incredibly important part of the equation. Too many companies miss this."

"It is pretty clear that the U.S. is built out. The market in the immediate future will be for retrofit."

- **Open standards** will lead the industry's move toward green and sustainable development.

- **Net-zero** design, on the other hand, is also rapidly coming of age, but will once again rely heavily on the development of industry standards and protocols for ensuring that buildings, once on the grid, operate at an exceptionally high level of efficiency.

- Through government incentives toward a greener world, certain BAS-related products and services – including environmentally friendly HVAC controls, solar panels and chemical-free ozone water treatment systems – qualify for **tax breaks** under the provisions of the Federal Recovery Act.

- Among various programs that are part of the DOE and even the federal stimulus package are efficient heating and cooling **cash-back rewards** programs, the clean energy business loan program and utility programs such as the Madison Gas & Electric Commercial Energy Efficiency Loan Program.

- The General Services Administration (GSA)[14] will spend $5.5 billion on 250 construction projects located throughout the United States with the goal of helping to underwrite sustainable buildings for clean energy use. Most industry insiders, however, suggest that new building construction, outside this realm, is stagnant.

  "The only new building that's going on is the one or two stimulus-related projects."

  "It's pretty clear that the U.S. is built out. The market in the immediate future will be for retrofit."

[14] Carrier Corporation "Stimulus Resource Center," 2009.

"Let's see, new buildings are what, currently running at 2 percent? So, if we wait for efficiencies to take effect, it will be 50 years before our infrastructure has changed enough to make an impact."

Private organizations throughout the world, as well, are contributing to fund the new development of "sustainable" buildings. While new construction in India, Dubai and China, may be the place for design growth, grant money is also available in the U.S. to retrofit older structures with BAS to reduce waste and improve efficiency.

Greenhouse Gas Emissions – The Flying Monkeys of BAS[15]
While it might be tempting to suggest that environmental awareness is simply an expensive business proposition, the argument is mute in light of 21st century scientific and social concerns. We've heard these statistics before:

- The U.S., accounting for only five percent of the world's population, but consuming more than 25 percent of the world's energy, has long been on a collision course with environmental realities.

- Along with China, the U.S. has also been one of the world's largest carbon dioxide (CO_2) emitters[16] and despite many efforts to counteract a growing negative perception regarding its lack of environmental awareness, has ranked 109th out of 146 countries in reducing its contributions to global warming.

- In 2005, CO_2 emissions attributed to the power usages of commercial buildings were said to account for approximately 18 percent of total US energy-related CO_2 emissions.

In light of these issues (and driven by energy conservation needs), the North American markets will soon experience a version of the **Building Labeling** programs that have been a part of the EU since the early part of this decade. The labeling system calculates the performance of buildings on a number of key environmental issues, efficiency and impact. Section 204 of the American Clean Energy and Security (ACES) Act contains provisions for this. Section 204 *"Establishes an EPA program to develop procedures to **label buildings** for their energy performance characteristics, using building type and consumption data to be developed by the Energy Information*

Administration. The program would be implemented by states in a manner suited to increasing public knowledge of building energy performance without hindering real estate transactions."[17] Systems integrators who understand the system and those who help shape the system [18] will have the upper hand, not only in promoting it to market, but in promoting themselves, as well.

**INCREASES IN CUSTOMER COMFORT AND OCCUPANT PRODUCTIVITY**

The customer is never absent from the BAS equation. On center stage in the development of intelligent buildings relying on building automation, are the issues of **comfort** and **productivity**. In the commercial arena, it has been estimated that occupant costs can be as much as 85 percent of the proportion of building lifecycle costs. From an end-user perspective, building transparency and visibility can be extremely valuable. *"A common network enterprise helps*

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[15] They get under your skin, they seem to be everywhere at once, but there have, to date, been few ways to put a dollar value on them.

[16] Yale University, Environmental and Sustainability Index, 2005.

[17] H.R. 2454 – American Clean Energy & Security Act (ACES).

[18] ASHRAE is also developing a Building Energy Labeling Program.

1% Transportation
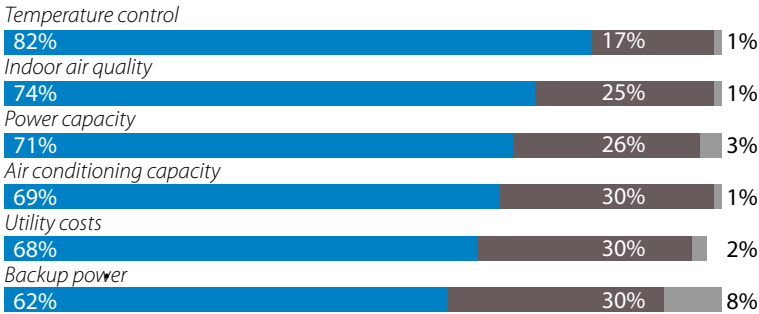23% Industry
76% Buildings
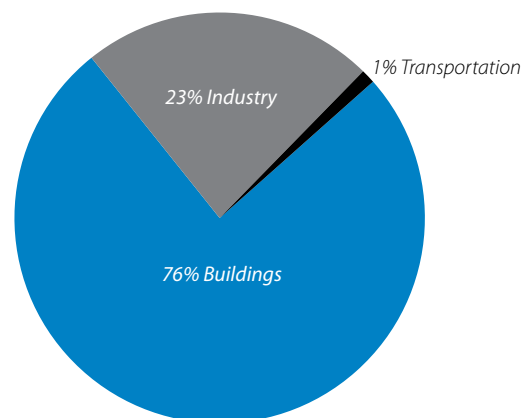
Source of information:
U.S. Energy Information Administration

The BAS Marketplace

HOW IMPORTANT ARE THE FOLLOWING FACTORS?

Critical consideration	Secondary consideration	Not important

Top Priorities – HVAC Power

Temperature control
82% | 17% | 1%

Indoor air quality
74% | 25% | 1%

Power capacity
71% | 26% | 3%

Air conditioning capacity
69% | 30% | 1%

Utility costs
68% | 30% | 2%

Backup power
62% | 30% | 8%

Occupant Satisfaction a Key

Quality of overhead lighting
58% | 42% | 0%

Noise levels
55% | 42% | 3%

Restrooms
52% | 46% | 2%

Information Infrastructure Matters to Many

High tech features (WIFI, high speed internet, etc.)
52% | 41% | 7%

Availability 24/7 of chilled water
43% | 37% | 20%
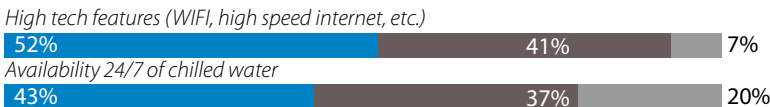
Other Issues Also Important

Availability of daylight and other green elements
34% | 54% | 12%

Reliability and speed of elevators
32% | 52% | 16%

facilitate building systems analytics, automated fault detection and diagnostics (AFDD), automated demand response (ADR), remote monitoring, predictive maintenance and renewable energy solutions implementation." Clients demanding to be seen as environmentally responsible, cost efficient and customer responsive will be looking for the best possible automation solutions offered by BAS.

- **Comfort, IEQ** (Indoor Environmental Quality) and **tenant satisfaction** play key roles in the cost / benefit analysis for BAS. Any gains in productivity are known to shorten the time for ROI considerably and, contrary to popular belief, can be quantitatively measured against cost.

- Companies designing for **productivity** have found that enhanced productivity and reduced absenteeism have often paid for any investments in IEQ.

- Factory owners, in fact, can easily show **increased production** with advanced BAS, hospitals have reported earlier patient discharge rates and even schools and institutions report improved student test scores.

- The National Energy Management Institute in the U.S. identified a potential $20B to $200B **non-health productivity** gain and $25B to $58B in health gain from enhancing indoor environmental quality.

- According to the New Buildings Institute, **lighting controls** alone can reduce lighting energy consumption by 50 percent when chosen as a retrofit, and by 35 percent in new construction.
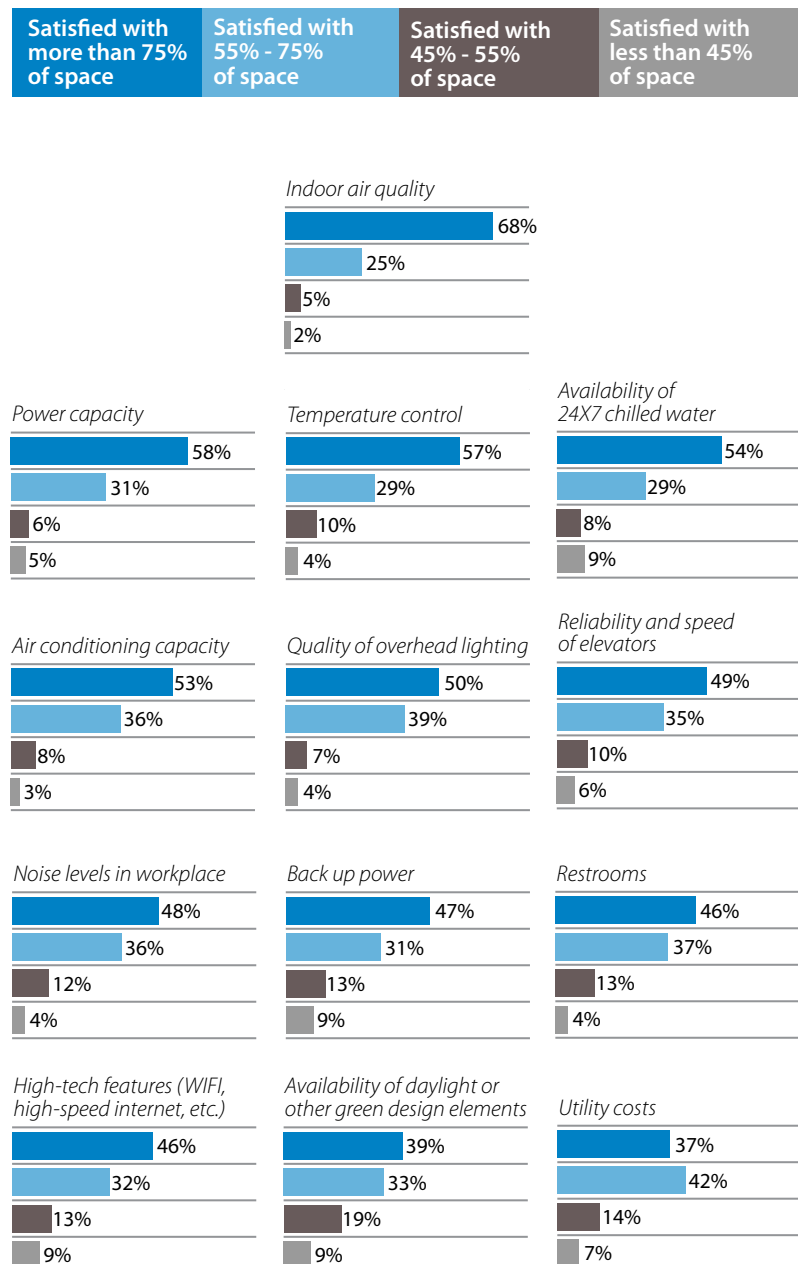
- Improvements in IEQ can also boost tenant retention for building owners. *"A good lighting system can seal the deal for your property,"* suggests one industry expert, *"making it commercially valuable and optimizing occupancy rates."* [19]

- **Satisfied tenants** are the watchwords in real estate and commercial investment property and, according to a Building Operations Management Study, the industry does a particularly good job in this area.

- However, the study suggests that tenants show particularly solid satisfaction rates because they take a good hard look at space before leasing.

- When it comes to evaluating such space, the survey shows that very few things are not important to tenants. In fact, only three elements in the study were rated "not important" by 10 percent or more of respondents.

  Source: Building Operating Management [20]

[19] Lighting Systems and IEQ, Building Operating Management, July 2009.

[20] Survey of 6,662 readers of Building Operating Management including facility executives on both the tenant and landlord sides screened to limit responses to facility executives responsible for leased space within the continental United States.

HOW SATISFIED ARE YOU WITH THE FOLLOWING ASPECTS OF YOUR SPACE?

Satisfied with more than 75% of space	Satisfied with 55% - 75% of space	Satisfied with 45% - 55% of space	Satisfied with less than 45% of space

Indoor air quality
- 68%
- 25%
- 5%
- 2%

Power capacity
- 58%
- 31%
- 6%
- 5%

Temperature control
- 57%
- 29%
- 10%
- 4%

Availability of 24X7 chilled water
- 54%
- 29%
- 8%
- 9%

Air conditioning capacity
- 53%
- 36%
- 8%
- 3%

Quality of overhead lighting
- 50%
- 39%
- 7%
- 4%

Reliability and speed of elevators
- 49%
- 35%
- 10%
- 6%

Noise levels in workplace
- 48%
- 36%
- 12%
- 4%

Back up power
- 47%
- 31%
- 13%
- 9%

Restrooms
- 46%
- 37%
- 13%
- 4%

High-tech features (WIFI, high-speed internet, etc.)
- 46%
- 32%
- 13%
- 9%

Availability of daylight or other green design elements
- 39%
- 33%
- 19%
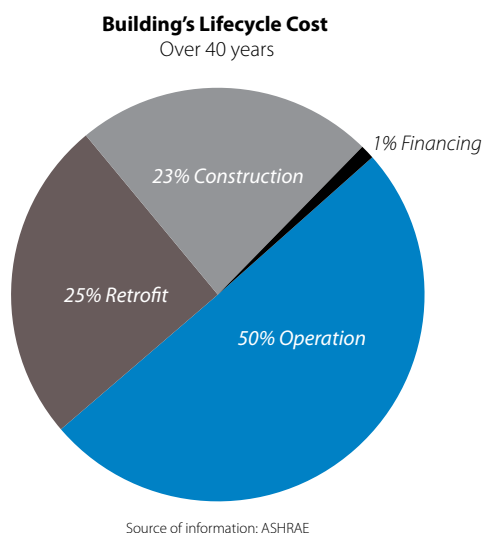- 9%

Utility costs
- 37%
- 42%
- 14%
- 7%

The BAS Marketplace

The moral of the story, therefore, is that the benefits of BAS extend far into the intelligent building systems arena and continue to grow with regard to green initiatives, rising energy costs and a more knowledgeable and savvy consumer population. Industry experts and leaders in automation know how to stress the importance of these benefits in discussions across a wide range of applications.

CALCULATING ROI – WHERE THE RUBBER MEETS THE ROAD

Green initiatives, sustainability, lowered life-cycle costs are all pretty intuitively appealing arguments for projecting a strong future for BAS. But for the building owner, corporate CEO and even design and systems engineers, attempts to sort through the clutter of this technology dependent, rapidly changing industry can be daunting enough to make even the most fearless reach for a steady dose of extra strength Tylenol.

Industry insiders and experts suggest that the task is not necessarily as daunting as it may appear. According to one such insider, CFOs are often the most reticent to discuss energy management.

Building's Lifecycle Cost
Over 40 years

- 1% Financing
- 23% Construction
- 25% Retrofit
- 50% Operation

Source of information: ASHRAE

"In general, people overcomplicate the issue. You explain to the CFO that you will maximize output while minimizing the use of resources and it's a language they understand. That's all sustainability is … wise use of resources with the end result being a more efficiently run business."

Operating Costs and Maintenance
Operating costs can be 50 to 80 percent of a building's total lifecycle cost. [21] With this in mind, owners, investors and facilities managers are known to see even small operations and maintenance efficiencies as significantly impacting the bottom line as they contribute to a building's asset value. Current research indicates that the majority of buildings in the U.S., however, are untapped with regard to the benefits that can be brought through efficient BAS. Without the ability to collect data, and turn it into useable information on which to base decision-making, these potential customers are unable to see where they are leaking profit.

The Language of Cost Savings
All this is to say, whether a Chief Operations Officer of a multi-million dollar corporation or design engineer for a regional restaurant chain, a frank discussion of **Return on Investment** (the ultimate language of the business universe) is key to understanding costs and simple payback.

- Industry convergence with BAS and Intelligent Design has allowed for more accurate savings calculations capabilities.

- Returns for investment in smart buildings come by means of both lowered operating costs and improved occupant experience.

- With **dash-board technologies**, more accessible user interfaces, IPv6 and demand response, customers have greater real-time access to usage data, making it more relevant to their day-to-day cost calculations.

- Intelligent buildings now offer tools to optimize the staffing and operations of the building, allowing for improved efficiency and a potential reduction in the labor required to operate the building.

[21] Over an estimated 40 year life span.

A sample calculation of ROI, offered here by Paul Ehrlich, P.E. and President of Intelligent Buildings, Inc., provides a visual perspective of potential cost savings for a typical developer-owned building. [22]

ESTIMATED NET RESULTS OF AN INTELLIGENT BUILDING

Result	Impact	Benefit (per sq. ft. / yr)
Energy Savings	12%	$0.19
Operational Savings	10%	$0.80
Employee Productivity Improvement	1%	$1.40
Rental Rate Over Market	4%	$1.00
Occupancy Improvement	4%	$1.00

[22] Intelligent Buildings Today, Paul Ehrlich, P.E., (Building Intelligence Group), 2006.

INPUTS FOR A TYPICAL BUILDING

Construction Cost[1]	$175 / sq. ft.
Energy Costs[2]	$1.57 / sq. ft.
Maintenance and Operations[3]	$8 / sq. ft.
Market Rate Rent	$25 / sq. ft.
Capitalization Rate	5 to 10 x
	(8x used in this example)
Space Per Occupant[4]	369 sq. ft.
Average Employee Costs	$52,000 / yr
Salary Cost[5]	$40,000 / yr
Average Benefits[6]	$12,000 / yr
Employee Impact	$140 / sq. ft. per year
Investment for Intelligence[7]	$4 / sq. ft.

Sources:

[1] Saylor Commercial Square Foot Costs, 2004
(numbers are for large urban markets and vary depending on location)

[2] DOE Buildings Energy Data Book, 2004

[3] IFMA Benchmarks III Report, 1999

[4] IFMA Benchmarks IV Report, 2004

[5] U.S. Department of Labor – Bureau of Labor Statistics, 2003

[6] Estimated at 20 percent

NET RESULTS OF A DEVELOPER-OWNED BUILDING

Investment $600,000 ($4 / sq. ft.)
Savings $120,000 / yr ($.80 / sq. ft.)
Rent premium $150,000 / yr (4%)
Occupant improvement $150,000 (4%)

**Simple payback 1.4 years,
ROI 265 percent over five years**

NET RESULTS OF AN OWNER-OCCUPIED BUILDING

Energy and operational savings only:

Investment $600,000 ($4 / sq. ft.)
Savings $150,000 / yr ($1 / sq. ft.)

**Simple payback 4.0 years,
ROI 95 percent over five years**

Owner-occupied building with employee productivity

Investment $600,000 ($4 / sq. ft.)
Operational savings $150,000 / yr
Occupant productivity improvement $210,000 / year

**Simple payback 1.7 years,
ROI 227 percent over five years**

Market Strategies

Most analysts agree that building owners should seek integrators that differentiate themselves through experience, innovation and engineering resources.

Changing Business Model

Traditionally, once a manufacturer installed a system in a building, the company could rely on years of continued business – according to one report, a typical supplier would generate about two-thirds of their annual revenue from routine or *"call-back"* maintenance. This business model, however, is changing as building owners become more sophisticated and shop around for the best systems and solutions to meet their needs. To gain a competitive edge, most analysts agree that building owners should seek integrators that differentiate themselves through *experience*, *innovation* and *engineering resources*.

Consolidation in the industry is expected to help level the playing field between the large corporate suppliers and the smaller, more innovative and flexible companies now entering the marketplace. However, leading industry advisors[23] suggest that the BAS industry is still struggling through the consolidation process without offering clear leadership in such areas as intelligent building integration. As the dust settles, those organizations that can return to value-added innovations and services will be the ones to take the leadership role.

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[23] P. Ehrlich, I. Goldschmidt; Building Intelligence Group, LLC, "The State of the Building Automation Market" 2009.

BAS, once the isolated purview of a few manufacturing companies with control devices for managing air flow, lighting and building maintenance, has not just turned one corner with regard to technology, innovation and industry development, it has literally spun around a wide range of turns, sauntered through alleys, headed down the autobahn and, at a few points in the industry's history, come pretty close to spinning off the edge completely. Manufacturers to the industry come and go, and many small HVAC, lighting and commercial contractors try mightily to position themselves as knowledgeable and capable stewards of the industry. But the truth is, as one industry resource suggests, that *"anyone can hire two engineers and claim to be a systems integrator, but it takes real expertise to understand the needs of customers today."*

As another suggests: *"Innovative approaches that have yet to be widely adopted will become the norm, and existing companies will give way to innovative start-ups by the time the recession ends and the recovery is in place."*

As the walls between the individual components of BAS become thinner, and the distinction in the marketplace is no longer that of product line, but product knowledge, it will be innovation that drives the greatest efficiencies and savings.

2009 PREDICTION	"Innovative approaches that have yet to be widely adopted will become the norm, and existing companies will give way to innovative startups by the time the recession ends and the recovery is in place."*—Jim Sinopoli, author of Smart Building*

Appendix 1

HVAC INDUSTRY STATS

One way to assess the relative size of the automated building operations systems industry is to examine the worldwide growth of individual segments of that market – HVAC Controls, residential building and commercial buildings. Although the projections are tempered by an uncertain global economy, analysts believe the entire automated building operations systems industry is poised for steady, stable growth for the foreseeable future.

Major Residential HVAC Equipment Lifetimes, Ages & Replacement Picture

Equipment Type	Typical Service Lifetime Range	Average Lifetime	1990 Average Stock Age	Units to be Replaced during 2009 (in thousands)
Central Air Conditioners	8 to 14 years	11 years	9	4,980
Heat Pumps	9 to 15 years	12 years	8	1,131
Furnaces – Electric	10 to 20 years	15 years	11	N/A
Furnaces – Gas-Fired	12 to 17 years	15 years	12	2,866
Furnaces – Oil-Fired	15 to 19 years	17 years	N/A	141
Steam / Hot Water Boilers (gas and oil)	20 to 40 years	N/A	14	N/A

Market share, in the HVAC industry, is an exceptionally important consideration. 2007 Air Conditioner / Heat Pump Manufacturer Market shares are therefore identified here.

Total market share of major HVAC equipment manufacturers as of 2007, is as follows:[24]

2007 Air-Conditioner / Heat Pump Manufacturer Market Shares

| Company	Market Share (Percent of Products Produced)
LG Electronics	17%
UTC / Carrier	13%
Whirlpool	9%
Goodman (Amana)	7%
Trane	6%
Fedders	6%
Electrolux	6%
Lennox	6%
Rheem	6%
York	4%
Nordyne	4%
Haier	4%
Others	12%

Total Units Shipped: 16,619,296
Information in the Table above is taken from the September 2008 issue of Appliance Magazine.

[24] BTS / A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Vol. II.

Appendix 1

Another way to visualize the HVAC market is to take a look at the number of manufacturers in various segments: air handling units, cooling towers, pumps, central system terminal boxes, classroom unit ventilators and fan coil units. The market, itself, is largely populated with air handling unit manufacturers and manufacturers of cooling towers as shown in the graph.

HVAC Market Manufacturers
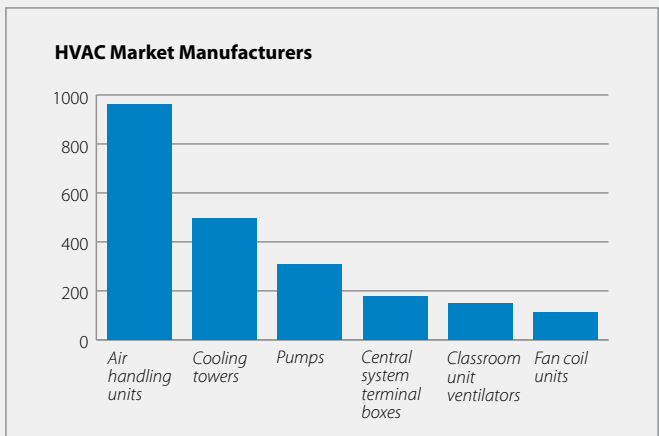
COMMERCIAL BUILDING SECTOR

Commercial sector demands for BAS continue to be linked to technology developments. The growth of the commercial building sector, however, promises to continue, even during challenging economic times. Key selling points for recognized efficiencies offered through BAS should incorporate the following understanding of the commercial building sector:

- Floor space devoted to commercial activity totaled 74.8 billion square feet in 2006. Commercial floor space is expected to reach 100.8 billion square feet by 2030.

- Electricity accounts for 74 percent of all energy expenditures in the commercial sector.

- Commercial floor space located in the south represents 37 percent of total floor space, the largest amount of any region.

- The most energy intensive buildings are those related to food sales, using 535.5 thousand Btu's per square foot. Building types with the lowest intensity, on average, (excluding vacant buildings) tend to be centers of worship (using 77.0 Btu's per square foot).[25]

Commercial Market Statistics

Principal Commercial Building Types (as of 2003)

Area	Percent of Total Floorspace		
	Total Floor Space	Total Buildings	Primary Energy Consumption
Office	17%	17%	19%
Mercantile – Retail	6%	9%	5%
Mercantile – Enclosed & Strip Shops	10%	4%	13%
Education	14%	8%	11%
Warehouse & Storage	14%	12%	7%
Lodging	7%	3%	7%
Service	6%	13%	4%
Public Assembly	5%	6%	5%
Religious Worship	5%	8%	2%
Health Care – Inpatient	3%	0	6%
Health Care – Outpatient	2%	2%	2%
Food Sales	2%	5%	5%
Food Service	2%	6%	6%
Public Order & Safety	2%	1%	2%
Other	2%	2%	4%
Vacant	4%	4%	1%
TOTAL	**100%**	**100%**	**100%**

[25] 2008 Building Energy Data Book, U.S. Department of Energy.

Total Commercial Floorspace and Number of Buildings

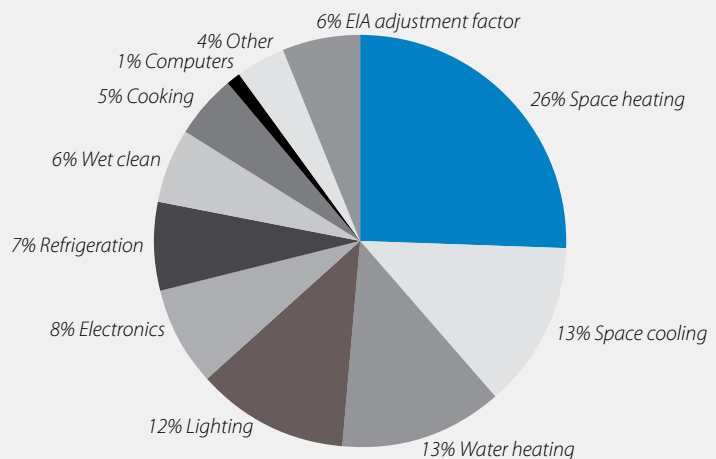| Year	Total Floor Space (in sq. ft.)	Percent Post-2000 Floor Space	Number of Buildings
1980	50.9	N/A	3.1
1990	64.3	N/A	4.5
2000	68.5	N/A	4.7
2006	74.8	15%	N/A
2010	78.8	24%	N/A
2015	83.9	33%	N/A
2020	89.3	41%	N/A
2025	94.8	49%	N/A
2030	100.8	56%	N/A

Along with an increased growth rate of 56 percent over the next 20 years, there continues to be anticipated energy consumption rates. Divided by type of energy used, the EIA annual outlook for 2008, predicts expenditures in the commercial building sectors to rise to over $170 billion.

Buildings Aggregate Energy Expenditures, by Major Fuel Type ($2,006 Billion)

Year	Electricity	Natural Gas	Petroleum	Total
1980	66.0	19.1	15.7	100.7
1990	86.6	18.1	8.1	112.8
2000	99.2	24.9	7.1	131.2
2006	123.1	33.6	10.0	166.7
2010	131.9	32.3	9.8	173.9
2015	132.6	31.9	8.9	173.3
2020	145.3	34.4	9.2	188.9
2025	158.1	38.0	9.7	205.8
2030	173.3	43.2	10.4	226.9

The specific breakdown of energy-end use expenditures is also somewhat telling for BAS.[26]

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[26] EIA, March, 2008. BTP / Navigant Consulting, U.S. Lighting Market Characterization, Vol. I.

Primary Energy End Use Residential (2006)

- 6% EIA adjustment factor
- 4% Other
- 1% Computers
- 5% Cooking
- 6% Wet clean
- 7% Refrigeration
- 8% Electronics
- 12% Lighting
- 13% Water heating
- 13% Space cooling
- 26% Space heating

Source of information: EIA, Residential Energy Consumption

Appendix 1

RESIDENTIAL SECTOR

Residential sector demands for automated building systems continue to grow. Even with the current housing market recession, projections of residential homes are expected to rise from a 15 percent increase in 2010 to 38 percent in 2030. EIA compilations suggest a residential housing market of 141 million households by 2030 – increasing by 15 percent in 2010 up to 38 percent by 2030.

Total Number of Households and Buildings, Floorspace and Household Size

Year	House-holds	Percent Post-2000	Floor Space (in billions of sq. ft)	U.S. Population	Average Household Size
1980	80*	N/A	142	227*	2.9
1990	94*	N/A	169	250*	2.6
2000	106*	N/A	N/A	282*	2.7
2006	113*	11%	N/A	299*	2.7
2010	116*	15%	N/A	309*	2.7
2015	123*	22%	N/A	322*	2.6
2020	129*	28%	N/A	336*	2.6
2025	135*	33%	N/A	349*	2.6
2030	141*	38%	N/A	364*	2.6

Millions of units.
Information in the table above was taken from the DOC, Statistical Abstract of the U.S., 2008. EIA, Annual Energy Outlook 2008.

Construction Statistics of New Homes Completed / Placed

Year	Single-Family Units		Multi-Family Units		Mobile Home Unit		Total
	Number*	Avg. sq. ft.	Number*	Avg. sq. ft.	Number*	Avg. sq. ft.	
1980	957	1,700	545	979	234	N/A	1,736
1985	1,072	1,760	631	922	283	N/A	1,986
1990	966	2,050	342	1,005	195	N/A	1,503
1995	1,066	2,050	247	1,080	319	N/A	1,632
2000	1,242	2,265	332	1,039	281	N/A	1,855
2005	1,636	2,414	296	1,143	123	N/A	2,055
2006	1,654	2,456	325	1,172	112	N/A	2,091

Numbers are in thousands of units.
Information in the table above was taken from the DOC, 2007 Characteristics of New Housing, June, 2008.

2007 New Homes Completed / Placed

Region	Single-Family Units		Multi-Family Units		Mobile Home Units	
	Number*	Percentage	Number*	Percentage	Number*	Percentage
Northeast	105	9%	40	14%	7	7%
Midwest	189	15%	34	12%	11	12%
South	632	52%	135	47%	59	62%
West	294	24%	76	27%	18	19%
TOTAL	**1,220**	**100%**	**285**	**100%**	**95**	**100%**

Numbers are in thousands of units.

Information in the table above was taken from the DOC, Manufacturing, Mining & Construction Statistics: New Residential Construction, March, 2008.

Building Automation Systems companies will most likely find themselves paying more and more attention to these markets in coming years. As Residential BAS continues to evolve, understanding energy consumption savings in the residential arena will be key to cultivating a presence in this developing market.

Share of Households
By Type of Housing/Ownership
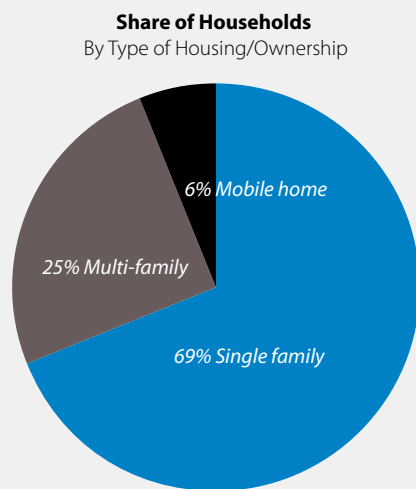
Source of information: EIA, Residential Energy Consumption

Appendix 2

PROTOCOLS, STANDARDS AND TERMINOLOGY

BAS Industry Protocols and Standards

ASHRAE	An international technical society for all individuals and organizations interested in heating, ventilation, air-conditioning and refrigeration (HVAC&R).
BACnet	A communications protocol for building automation and control networks.
C-Bus	A proprietary closed communications protocol for home and building automation developed using the ISO 7 layer reference.
CISBE	Chartered Institute of Building Services Engineers.
DALI	DALI is standardized in accordance with International Electro technical Commission IEC 60929, standard for fluorescent lamp ballasts.
KNX	KNX is a standardized (EN 50090, ISO / IEC 14543), OSI-based network communications protocol for intelligent buildings.
LonTalk	Protocol created by Echelon Corporation for networking devices, written specifically to address the needs of control devices.
Midac	An acronym created in 1981 by a Sydney-based business, Combined Resources Computing (CRC). It stands for Microprocessor Intelligent Data Acquisition and Control. CRC was established in order to complete several building automation projects commenced by R-Tec.
Modbus	Modbus is a serial communications protocol published by Modicon in 1979 for use with its programmable logic controllers (PLCs). It has become a de facto standard communications protocol in industry, and is now the most commonly available means of connecting industrial electronic devices.
oBIX	oBIX (for Open Building Information Exchange) is a standard for Web Services-based interfaces to building control systems.
Open WebNegt	A web communication protocol developed since 2000. Developed by Bticino.
ZigBee	A short range, low-powered wireless communication standard targeted at Building Automation.
Dynet	Dynalite protocol
OpenTherm	A protocol used in central heating systems between a central heating boiler and a thermostat or controller. It is a point-to-point protocol where one device (thermostat) is the master and the other the slave (boiler).

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