BRIGHT GREEN BUILDINGS

Convergence of Green and Intelligent Buildings

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As a note to the reader, Frost & Sullivan research papers are written so that each chapter has enough background information to stand on its own, therefore, in some instances, there might be some redundancy in information that carries over form one chapter to another.

When this report refers to industry experts or consultants, we are referring to information gathered from consulting with companies such as Smart Buildings, Clasma Events, Inc., Building Intelligence Group, AutomatedBuildings.com and others.

The concept of “Bright Green Building” was suggested by Scott Walker, of Waveguide representing InfoComm International, in one of our brainstorming sessions.

A free copy of the final report is available for download by the Continental Automated Buildings Association (CABA) at: http://www.caba.org/brightgreen

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Executive Summary

1.1 "Bright" Green Buildings

The intent of this research is to provide documented evidence and build tools that can be used to educate and influence end-users, building owners, architects, and contractors that a "greener building" can be achieved using intelligent technology, and will provide a tangible and significant return on investment. This concept – intelligent, green, and profitable – is what we call a bright green building.

This research identifies the exciting developments taking place on the technology front and analyzes their implications for intelligent and green buildings, highlighting examples of "best in class" buildings employing green and intelligent technologies. These buildings are dynamic environments that respond to their occupants' changing needs and lifestyles.

1.2 Fundamental Elements of a Bright Green Building

A bright green building is one that is both intelligent and green. It is 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. It provides timely, integrated system information for its owners so that they may make intelligent decisions regarding its operation and maintenance, and has an implicit logic that effectively evolves with changing user requirements and technology, ensuring continued and improved intelligent operation, maintenance and optimization. A bright green building is designed, constructed, and operated with minimum impact on the environment, with emphasis on conserving resources, using energy efficiently and creating healthy occupied environments. It must meet the needs of the present without compromising the needs of future generations. Sustainability is measured in three interdependent dimensions: environmental stewardship, economic prosperity, and social responsibility. Bright green buildings exhibit key attributes of environmental sustainability to benefit present and future generations.

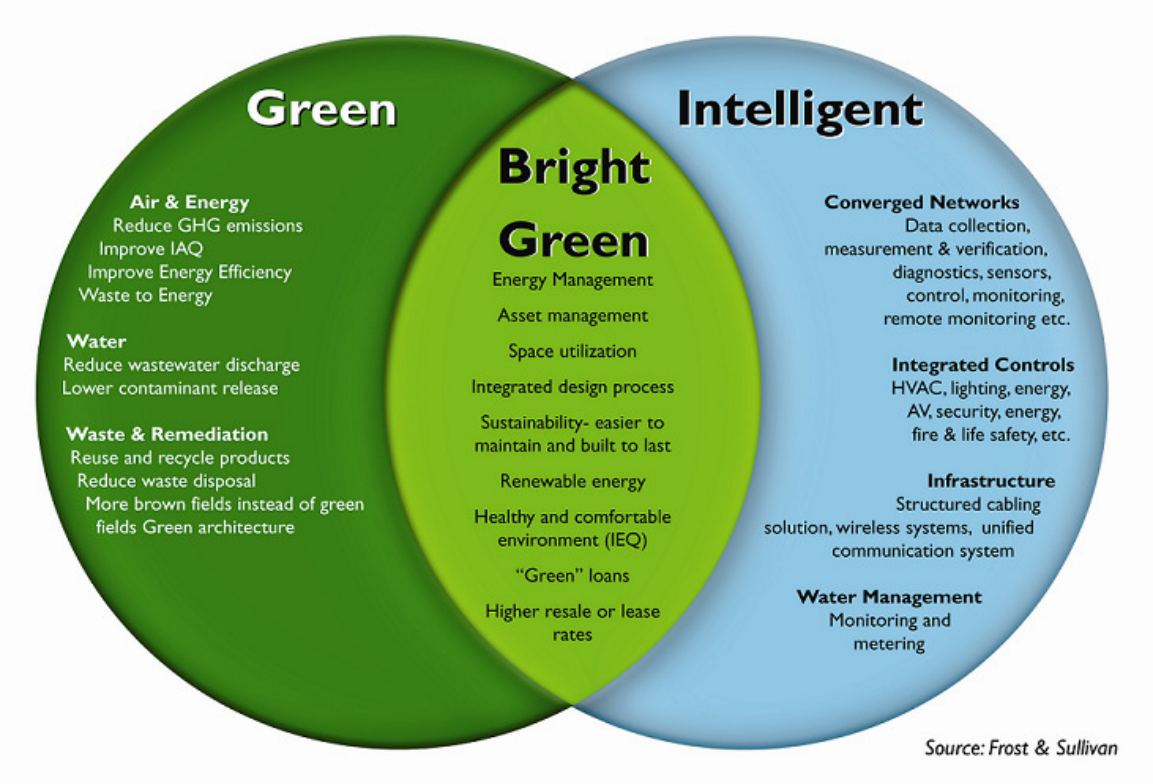
In bright green buildings, fully networked systems transcend the simple integration of independent systems to achieve interaction across all systems, allowing them to work collectively, optimizing a building's performance, and constantly creating an environment that is conducive to the occupants'

goals. Additionally, fully interoperable systems in these buildings tend to perform better, cost less to maintain, and leave a smaller environmental imprint than individual utilities and communication systems.

Energy Star-rated buildings in the United States earn substantial benefits compared to non-green buildings; in particular 40% greater energy efficiency compared to standard buildings and significant lower operations costs. Based on industry data, approximately 85% of Energy-Star rated buildings use a system with energy management controls and 50% use lighting system motion sensors to qualify for the Energy-Star certification. The idea of leveraging intelligence to enhance building performance, either for energy efficiency or occupant comfort and thereby obtaining credits is also acknowledged by USGBC. "If the objective is clear, the credit system under LEED is geared to recognize building performance that has been enhanced by automation and IT-centric intelligence," states USGBC.

Each building is unique in its mission and operational objectives and therefore, must balance short- and long-term needs accordingly. Bright green buildings provide a dynamic environment that responds to occupants' changing needs and lifestyles. As technology advances, and as information and communication expectations become more sophisticated, networking solutions both converge and automate divergent technologies to improve responsiveness, efficiency, and performance. To achieve this, bright green buildings converge data, voice, and video with security, HVAC, lighting, and other electronic controls on a single network platform that facilitates user management, space utilization, energy conservation, comfort, and systems improvement. Chart 1.1 outlines the commonalities between intelligent and green buildings that form the basis of a bright green building and highlights the impact of that convergence.

Chart 1.1 – Convergence of Intelligent and Green Buildings



1.3 Why Build "Bright" Green - Concept Adoption Factors

One of the primary goals of this research was to identify and explore factors that drive the adoption and convergence of intelligent and green buildings. These adoption factors are of particular significance, because they represent key challenges to building owners and form the basis of the understanding of the various factors that augment the acceptance and adoption of intelligent and green convergence.

Overview of rating system:

We have identified and rated the key concept adoption factors for this research. Our rating system is based on the potential each of the key concept adoption factors such as energy savings, Greenhouse Gas (GHG), operation and maintenance (O&M), water conservation, and productivity. Each factor has various monetary and non-monetary benefits such as return on investment (ROI), life cycle cost, impact on image and corporate social responsibility (CSR). These ratings are subjective rating based on our analysis of the case studies and research findings to provide an indication of the potential benefits of bright green buildings for stakeholders.

One out five represents low impact

Five out of five represents high impact

Energy Savings

Energy costs represent about 30% of an office building's total operating costs (excluding staffing costs), hence, providing enormous opportunity for building owners not only to reduce operating costs but also to make significant improvements in the overall environmental performance of buildings. Retrofits are frequently driven by the desire to reduce energy costs. These are often cases where the existing technology or system in a building can be upgraded easily and the payback period is expected to be short. Intelligent features of a building, such as better monitoring and control of energy-intensive systems such as HVAC and lighting, can be measured for optimum performance and predictive maintenance needs, reducing both energy usage and operating expense.

By changing energy management practices and instituting technologies that build energy efficiency, Energy Star notes that building managers can reduce energy consumption by up to 35%. However, it is becoming increasingly common for more advanced, intelligent, and green buildings to routinely reduce energy usage by as much as 50% over conventional buildings, with the most efficient buildings currently performing up to 70% better than conventional properties.

Summary of key benefits from energy savings:

As the price of energy continues to rise and the amount of energy per square foot of space consumed by the commercial and industrial building sectors continues to grow, total building energy costs will rise significantly where energy savings becomes an even bigger incentive.

Greenhouse Gas Emissions

The climate change debate and its potential impact on building owners has incited action to reduce GHG emissions by using energy efficient technologies and practices in the commercial and industrial sectors. Property owners are under increasing pressure to provide detailed accountings of their GHG emissions. Investors are concerned about current legislative and regulatory trends that threaten to impose restrictions on GHG emissions, taxes on carbon and pass the costs of environmental damage on directly to energy producers and consumers such as British Columbia's tax on carbon. Many companies will also be buffeted by changes in consumer preferences and demands resulting from increased awareness of climate change risks.

Stakeholders must be able to show that they are green and socially responsible to meet consumer demands in these areas. However, beyond image, investments in green and intelligent building technologies and processes can improve business efficiency, creating an improved ROI equation where value added improvements become much broader than just energy savings. CSR provides an opportunity for building owners to differentiate themselves, providing an improved image, better lease-up times and renewal rates, while reducing vacancy rates and churn.

Summary of key benefits from lower GHG emissions:

Operations & Maintenance

Ongoing operating costs represent 50 - 80% of a building's total life cycle costs over an estimated 40-year life span. Therefore, even a modest reduction in lifetime operating costs can enhance a building's asset value.[1] Owners responsible for energy utility payments in gross lease systems are driven further to maintain or lower energy operating costs and increase asset value upon building sale. Controlling operating expense increases affects more than cash flow. Since building net operating income decreases when operating costs rise, increasing costs lower the building's asset value. Energy Star notes that where an owner invests in upgraded energy systems and technologies, these incurred costs can achieve a 20-30% ROI, with minimal risk.

Summary of key benefits from O&M:

Water Conservation

The acceleration of climate change has created a sense of urgency for water managers to prepare for both increased drought conditions, as well as the increased severity of flooding. Coupled with the increasing unpredictability of rainfall, increasing consumption volumes in the commercial and industrial sectors are making water management an urgent issue in many areas. To help address these budget issues, fee-based and other incentives for facilitating water conservation and stormwater management are on the rise. Other incentives include metering, consumer, and commercial education regarding irrigation issues, low-flow/no-flow technologies, permeable pavers, xeriiscaping, and the mandating of green roofs.

Summary of key benefits from water conservation:

Due to artificially low prices for municipal water, water conservation often has a limited impact on overall operating costs. However, significant savings can be accrued through lower energy costs

[1] The total annual savings divided by the capitalization rate equals the augmented asset value

resulting from reductions in the amount of energy used to pump and heat water. Water shortages are expected to be an ever-present challenge in several regions in the near future, so there is tremendous market potential for water conservation technologies and products. One such option that has displayed growing potential is the use of sensors to monitor and control water use.

Comfort and Productivity

The non-energy benefits of commissioning of both new construction and existing buildings have a major impact on building performance and occupant comfort. Since occupant costs command the greater proportion of building life cycle costs in owner-occupied buildings (as much as 85%), enhancing occupant productivity in high-performance buildings – often measured through reduced absenteeism – can result in major operational savings. Due to the relative size of staffing expenses as compared to other operating expenses, building owners can leverage effective energy management retrofits to produce significant administrative savings

Summary of key benefits from comfort and productivity:

A variety of studies have demonstrated productivity benefits in commercial and industrial settings. For example, according to the U.S. Green Building Council, office worker productivity increases between 2-18% on average in green buildings. Reduced churn, quicker lease up, and higher re-up rates all work to reduce operating costs and enhance building asset value, although it is more difficult to empirically measure the value of these factors.

1.4 Making a Business Case for Bright Green Buildings

According to industry experts, building owners are not going to make any investment unless it has an ROI. The question building owners should ask is what is going to drive the ROI calculations. If there is no value in carbon and no value in saving energy and no value in terms of CSR, then there is no value and there are no ROI calculations. In developing a financial justification for investments in intelligent and green technologies, and assessing the potential return on that investment, it is necessary to consider new construction and retrofit projects separately, because the requirements, and therefore the economic fundamentals of the two types of projects are very different.

New Construction

In a new construction scenario, the cost of creating a green and intelligent building is often not that different than the costs associated with creating a traditional building. Certain aspects associated with intelligent technology and applications, such as cabling, are actually less costly than traditional infrastructure – in the case of cabling, labor costs are often lower where intelligent designs are used. However, other technologies and equipment will require additional investment to integrate all of the components of the system. For example, integrating the access controls system with lighting and HVAC systems will cost more up-front than installing disparate systems alone. As has been found in all of the case studies examined as part of this research, this initial investment in green and intelligent design and technology generally has a relatively short ROI period when compared to the anticipated usable life of a modern building.

Existing Buildings

Retrofits are more frequently driven by the desire to reduce energy costs than anything else. These are often cases where the existing technology or system in a building can be upgraded easily and the payback period is expected to be short. Intelligent building features such as better monitoring and control of energy-intensive systems such as HVAC and lighting can provide for optimum performance and predictive maintenance needs, reducing both energy usage and operating expense. Additionally, reporting features assist in making decisions that make the building more efficient and more reliable.

Integrated building professionals report that facilities managers get very little decision making information, so tuning up the control system is the best thing they can do to optimize the building. With one unified approach to monitoring facilities, buildings can change the underlying infrastructure without changing the enterprise level reporting mechanisms. This allows building owners to have a heterogeneous infrastructure that creates more competition between technology vendors, where they can begin to generate savings more quickly, and can generate an ROI payback in two to three years rather than over the course of a decade. Integrating utility bills into the enterprise asset management system, facility managers can further provide diagnostic information to facility managers, enabling them to take immediate action. In order to conserve energy – and money – it is imperative that proper information management architecture is in place, which makes the information actionable and definable.

Occupant Productivity and Comfort

Occupant productivity, especially in owner-occupied buildings, has a significant measurable impact on the ROI calculation. Given that energy costs represent about 1% of the overall cost of doing business and investment expenses are about 10%, staffing costs can represent up to 85% of the total cost of doing business. Any improvement in productivity can therefore have a significant positive financial return.

Life Cycle Benefits

Depending on how the life cycle cost analysis (LCCA) is addressed, this could potentially enable facilities and organizations to attain their long-term sustainability goals by developing their environmental monitoring systems to generate pertinent data. Therefore, keeping in mind that intelligent technologies are installed to deliver effective payback and long-term returns, it is critical for such systems to incorporate LCCA.

Building owners typically perceive that green and intelligent buildings will cost more. In reality however, and industry experts agree, green and intelligent buildings ultimately cost less. Although the capital expenditure or first cost of doing a more integrated concept typically costs the owner more, the operating and productivity cost will drop significantly and the economic cost or life cycle cost will be significantly lower. Hence, green and intelligent improvements or investment in a building actually costs less if the building owner holds the building for a little while.

Typically, operations-related impacts account for over 80% of life cycle impacts in buildings. Owners' operating costs are significantly lowered as a result of more efficient operations and better control, enhancing a building's asset value. By enhancing connectivity between building systems and users, intelligent buildings help to balance the operational objectives and economic performance of buildings with emphasis on scalability and changing priorities. In an endeavor to provide a comfortable and reliable environment, intelligent buildings essentially help achieve a reduction in energy consumption, use resources more efficiently, and explore renewable alternatives that enable them to be financially, as well as environmentally sustainable assets over time. Reducing operating costs enhances a building's asset value.[2]

Intelligent and green buildings experts and consultants, such as Smart Buildings, provide sophisticated ROI tools for commercial real estate to demonstrate initial cost savings, lowering vacancy rates in buildings, tenants staying longer, lowering amount owner is paying in terms of tenant improvement and improving net operating income, which all helps out a building's operating income which creates more value to the building.

1.5 Bright Green Technologies

This research introduces the concept of improved intelligence to make buildings greener; provides an analysis of the current state of existing and emerging technologies in the building automation space; and outlines products and processes, as well as trends, which support this concept. The objective of this research is to identify and analyze what lies behind this concept, and to examine what efforts are being made across the industry to achieve that objective. This research identifies the developments taking place on the technology front with the various aspects associated with building systems, and analyzes their implications for intelligent buildings.

[2] The total annual savings divided by the capitalization rate equals the augmented asset value

Discussing influential market adoption factors and technological trends forms the basis of understanding the various factors that augment the acceptance of intelligent buildings. To this end, real-life examples of these technologies and processes have been examined. These case studies, developed in conjunction with the research sponsors, look at a wide range of technologies, applications, and end-users including universities, healthcare facilities, state governments, a sports complex, and other commercial and residential developments.

The concept of using intelligent technology to provide a tangible and significant return on investment is what we refer to as a bright green building. We have identified and rated the key concept adoption factors behind bright green building. Our rating system is based on the key technology aspects of bright green buildings and impact on ROI, O&M. life cycle costs, comfort and productivity. These ratings are subjective rating based on our analysis of the case studies and research findings to provide an indication of the potential benefits of bright green buildings for stakeholders.

Converged Networks

Fully networked systems transcend integration to achieve interaction, in which the previously independent systems work collectively to optimize the building's performance and constantly create an environment that is most conducive to the occupant's goals. According to integrated building professionals, the convergence reflects an evolution of the building systems to an IP network, the financial advantages for building owners to integrate their systems, and the important role of the building systems in controlling energy usage and costs. The information is further addressed in some of the case studies where the goal was to manage a portfolio enterprise and lower the cost of ownership by attacking energy, cost of deferred maintenance, operating cost, space utilization, and asset management. Once the utility bill is integrated with the building controls system, supportive diagnostic information can be presented and made easily accessible to staff. This allows them to instantaneously look at the information and adjust any issues themselves instead of waiting until end of the month- saving time and money.

Conventional buildings suffer from the inability to communicate and intelligently manage the large amount of data that they possess and generate. A converged network solution allows a higher level of connectivity for a variety of products from multiple manufacturers. This results in benefits such as cost effectiveness, process improvements in facility automation, monitoring and management, and more efficient real estate portfolio management. Streaming building control and utility data into a shared network enables optimum management of facilities by connecting various silo systems and applications.

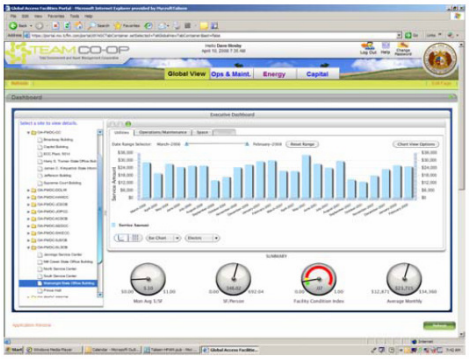
Summary of key benefits from converged networks:

Impact on ROI	$ $ $ $ $
Impact on O&M	$ $ $ $ $
Impact on Life Cycle Cost	$ $ $ $ $
Impact on Comfort & Productivity	$ $ $ ○ ○

Legacy system incompatibility, outdated information, a lack of historical data, proprietary system architectures, and dysfunctional operating processes are some of the hurdles which can be resolved by streaming building control and utility data into a shared network. This enables optimum management of facilities by connecting various silo systems and applications. The following examples highlight the benefits of using a variety of technologies for increased efficiency, cost savings, and asset management.

State of Missouri

This project leveraged many technologies to deliver a complete enterprise asset management and information management system solution to meet the sustainability goals set out by the State of Missouri. The State of Missouri was spending $300M annually to operate and maintain approximately 32 million square feet, spread across numerous facilities in its real estate portfolio.



To manage its portfolio and reduce cost of ownership, the State had to determine what it owned in terms of facilities, locations, conditions, value, office space (both leased and vacant), capital needs utilization, energy usage, and cost of energy. Integrating buildings and systems at a common user interface level enabled operational activity monitoring to detect inefficient operating conditions and allowed corrective action to be taken to bring buildings back to normal performance patterns. As a result, the State of Missouri is now saving $35.6M annually from real estate, operations, construction, utilities budgets, creating a ROI of less than one year.

Ave Maria University

Situated on a 908-acre campus in Ave Maria, Florida, the Ave Maria University campus has 500,000 square feet of facilities, serving nearly 500 students and 200 faculty and staff. By resorting to single party technology contracting, integrating systems management into a single network and avoiding unnecessary and redundant cabling characteristic to conventional campus design, the Ave Maria University has optimized both capital budgets and time to achieve an outcome that is truly smart, scalable and financially beneficial over time.

As a result, Ave Maria University saved over $1M in building costs by eliminating the redundant wiring and cabling of multiple isolated building systems, reduced staffing costs by enabling IT to assume tasks of building maintenance staff with an estimated $350K savings annually in human resource costs, and enabled significant efficiencies in utility usage with an estimated $600K in annual savings.

Integrated Building Control Systems

Programmed and computerized networks of electronic devices are employed for control and monitoring of systems such as HVAC, lighting, security, fire and life safety, and elevators. Known as building automation systems (BAS) and building energy management system (BEMS), these solutions typically aim at optimizing the performance, start-up, and maintenance of building systems and greatly increase the interaction of mechanical subsystems in the building. This leads to improved occupant comfort, optimum energy consumption, and cost-effective building operation. All these can be done remotely or from a centralized system with a minimum human-in-loop factor.

Summary of key benefits from integrated building controls systems:

Impact on ROI	$ $ $ $ ○
Impact on O&M	$ $ $ ○ ○
Impact on Life Cycle Cost	$ $ $ ○ ○
Impact on Comfort & Productivity	$ $ $ ○ ○

Building automation systems (BAS) and building energy management system (BEMS) vary in capability and functionality, but are all designed to provide centralized oversight and remote control over lighting, HVAC, security, fire and life safety, elevators, water management, and AV technologies. The following examples highlight the benefits of using a variety of technologies for optimum energy consumption, cost-effective building operation, and improved occupant comfort.

Rogers Centre

Rogers Centre, Toronto, is a world class sports and entertainment complex, with capacities from 5,000 to 60,000 spectators. The complex contains approximately 7,000 light fixtures distributed over a total area of 1.4-million square feet. By combining addressable networking technology in conjunction with advanced control hardware and software, this retrofit was designed to maximize energy savings and provide an ROI that exceeds customer expectations.

The Rogers Centre facility had an electricity bill exceeding $3M annually. Currently, cost savings have reached $325K annually after phase two, generating an

ROI of about two-and-a-half years. By the time the project is fully completed, the project is expected to generate a 76% savings in energy expenses from lighting. With energy reductions of 3,731,000 kWh annually, the project will have reduced its dependency on the energy grid equal to the energy required to power over 400 homes in Toronto.

Providence Newberg Medical Center

Providence Newberg Medical Center (PNMC), a new hospital - a 175,500 square feet facility with a 40-bed hospital and medical offices - has integrated HVAC systems to help reduce overall energy consumption.

The primary factors driving the adoption of HVAC controls included escalating energy prices, environmental concerns, and emphasis on air quality and comfort. Accurate zoning controls and very tight pressure envelopes are critical requirements for the hospital environment. The solution has improved IAQ, resulting in improved occupant safety, comfort, and productivity. Additionally, joint commission audit trails and on-demand reports are required for healthcare organizations.

Now a Leadership in Energy and Environmental design (LEED) Gold certified facility, the new PNMC reduced overall energy consumption by 26% compared to energy code 90.1 of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard, providing a favorable ROI.

The Verve - High Rise Condominium

The Verve, downtown Toronto, is a newly developed high rise condominium. Monitoring, measurement and verification (M&V) enables the ongoing accountability and optimization of the Verve's energy consumption and provides suite owners and the property manager with the data necessary to identify systems that may not be functioning as expected.

Sub-metering technology enables individual zones to use their own meter to measure the amount of energy consumed in an individual suite. This allows the billing contractors to collect data and provide billing services for individual meters and encourage suite residents to pro-actively lower their utility bills. As a LEED silver candidate, residents can expect lower energy bills, good value-add at the point of sale, and a higher degree of satisfaction, and is expected to facilitate 35% annual energy savings.

Kwantlen Polytechnic University's Cloverdale Campus

Kwantlen Polytechnic University's Cloverdale campus is a new high-tech facility and LEED Gold candidate. The campus covers 185,177 square feet, including multiple buildings that require monitoring and control, including classrooms, office areas, workshops and laboratories.

Kwantlen wanted a cost effective building management system that could save energy from the date of installation. A controls' platform, designed based on HVAC controls, was deployed capable of controlling interior and exterior lighting, all fully integrated to enhance performance and reduce operating costs. As a result, Kwantlen is able to produce about 30% annual energy savings compared to energy code ASHRAE 90.1 -1999, as well as improve occupant comfort, productivity, interaction, and collaboration.

Structured Cabling Infrastructure

Based on the Telecommunications and Electronic Industry Association 568 Standard, a structured cabling solution (SCS) can significantly increase the lifespan of cabling infrastructure in a building, obviating extensive changes or expensive upgrades. A SCS integrates voice, data, video and other buildings systems. A SCS is an open system architecture that is standard based and can reduce construction costs for the cabling infrastructure by as much as 30% and 25-60% for cabling related changes. Minimized upfront costs due to labor and material savings, increased lifespan and durability, and minimal maintenance costs are various direct/monetary benefits that can be realized. The ability to run data signals and power to the devices over the same cabling infrastructure can be a dramatic cost saver in high labor rate construction projects. Several additional advantages are the relative ease of expandability and adaptability for rapid and easy changes involving minimal disruption, the logical outcome is faster ROI, better utilization of installed cabling, and a lower total cost of ownership.

Summary of key benefits from structured cabling solutions:

Impact on ROI	$ $ $ ○ ○
Impact on O&M	$ $ $ ○ ○
Impact on Life Cycle Cost	$ $ $ ○ ○
Impact on Comfort & Productivity	$ $ ○ ○ ○

End-users are demanding suitably designed cabling infrastructure, balanced with desired power and cooling thresholds which are reliable, interoperable, and scalable over time. These challenges arise as

buildings integrate more sophisticated voice, data, and video equipment into applications. By consolidating/integrating cabling from multiple stand-alone systems, material and labor inputs can be reduced, thus providing savings in initial construction costs. The following example highlights the benefits of using structured cabling and a converged physical infrastructure.

The King Abdul Aziz Endowment

The King Abdul Aziz Endowment, Saudi Arabia, boasts a 1.4 million square meter built area supporting 75,000 tenants and a podium for commercial space. This project demonstrates that a converged physical layer infrastructure can provide operational excellence, minimized upfront costs, increased lifespan and durability, and minimal maintenance costs.

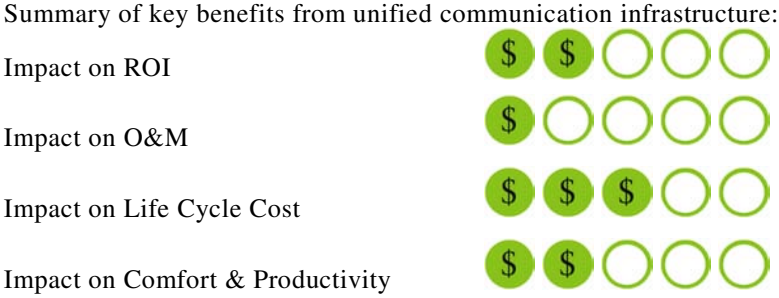
The key to integrating various systems was to connect to a common IP backbone enabling easy communication and control of the plethora of systems through a unified outlet. This converged physical layer infrastructure lowered construction costs, optimized operational expenditures, and eliminated dealing with multiple contractors, while simplifying the installation process to minimize potential system conflicts and reduce implementation timelines. The project is estimated to generate 33% reduction in cost due to avoiding redundant cabling and containment space (as well as labor, scheduling, commissioning, etc.).

Communication Infrastructure

Intelligent buildings are typified by their innovative qualities, facilitated by the integrated design process. Building owners, developers, and managers are increasingly committed to providing better services to the tenants and occupants by way of increased voice, video, and data integration and communication, and these expanding capabilities not only offer better management of buildings and associated operational costs, but also enhance the well-being of the occupants.

A converged voice, video, and data network streamlines the asset allocation, tracking, and management process, which improves security and optimizes flexibility, and improves interaction and integration between the various individual IP-based systems. Communication services help anticipate increasing demand for complex and integrated networks, and facilitate revenue-generating differentials such as digital signage and multimedia presentations. Communication allows all types of users to not only improve efficiency and reduce operating expenditures, but also create opportunities for unique interaction between buildings and their users.

Summary of key benefits from unified communication infrastructure:



Given the increasingly competitive business environment for real estate, the presence of value-adding network and communications technology may serve as a compelling differentiator in a market increasingly saturated with look-alike properties. The following example highlights the benefits of using a converged communication infrastructure.

CityStars Cairo

CityStars is the first and largest integrated project of its kind in the Middle East. With a total built-up area of 750,000 square meters, the project is the 12th largest shopping and entertainment center in the world and the second largest outside of North America.

A unified communication platform was deployed to meet the networking and value-added service demands of the unique project. The mega-complex is equipped with some of the most advanced infrastructure and multimedia systems, which enable CityStars to both smoothly integrate and manage all of its communication and information networks and offer value-added services, such as wireless connectivity and media on-demand to all of its residents, visitors, merchants, and customers.

This value creation was felt by most participants in the project, resulting in new profits for CityStars owners, developers, managers, and merchants, high satisfaction ratings from tenants and visitors, and reports of increased employee productivity.

1.6 New and Developing Bright Green Technologies

Water Conservation Technologies

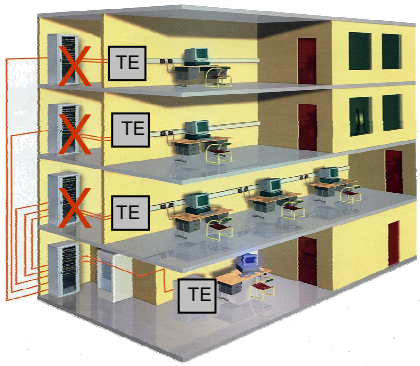
Water shortages are expected to be an ever-present challenge, and offers tremendous market potential for water conservation technologies and products. One such option that has been displaying growing potential is the application of integrated monitoring and control of water use. By networking sensor-

operated faucets and flushometers in conjunction with supplemental water meters and sensors, facilities managers are able to monitor the entire restroom environment.

Total realistic life cycle costs of the restroom are, for the first time, within the grasp of owners and developers. This new level of integration will help companies establish a single source of water knowledge while increasing both the overall sustainability of the restroom space and positive experience for the end-user.

Fiber-to-the-Telecom-Enclosure (FTTE) or Zone cabling

With commercial industry relying heavily on solutions provided by information technology, the network infrastructure is more critical than ever. The cost to business for installation and maintenance is a large investment. Users seeking data communications architectures that support a wide range of network applications can use a Telecommunication Industry Association (TIA) standards based solution: Fiber-to-the-Telecom-Enclosure (FTTE) or Zone cabling.



The FTTE architecture extends the fiber optic backbone to telecom enclosure closer to workstations throughout a building. The telecom enclosure can then distribute a flexible topology of mixed media and power to the devices using copper category cable, fiber optics, coaxial cable, and A/V cable. As a result, buildings can benefit from more useable real estate due to the removal or consolidation of the telecommunications room on each floor. Also, there is a 20-30% cost reduction on cabling due to consolidation and removal of proprietary networks, improved network performance, single contractor/integrator vs. several specialists for disparate systems, and a substantial reduction in cost and disruption to staff when making changes within work areas.

Electrical Architecture

To meet the needs of flexible and integrated infrastructures, electrical infrastructures are flexible, adaptable, and are able to serve as the integrated center for lighting, energy, and control systems. This new programmable environment combines a new electrical infrastructure that replaces the traditional pipe and wire electrical systems with embedded lighting controls that are connected together through nodes on a network.

This technology can address the following three major needs of building owners and tenant: 1) facilitate people using the building to become active agents in the utilization, creation, and evolution of spaces that support their activities; 2) preserve and improve the investment and ROI for the building owners and managers; and 3) reduce the impact on the environment by the building, from its initial construction stage through its life cycle. Labor costs can be reduced by 40-60% over the life of the building as it requires less labor during the initial installation and requires less labor to maintain the building. The ability to save money also extends to energy savings, as it can reduce the energy

costs in a building by making it more energy efficient whereby recouping 20-60% energy savings that would otherwise have been lost by traditional electrical infrastructure.

Integrated AV Systems

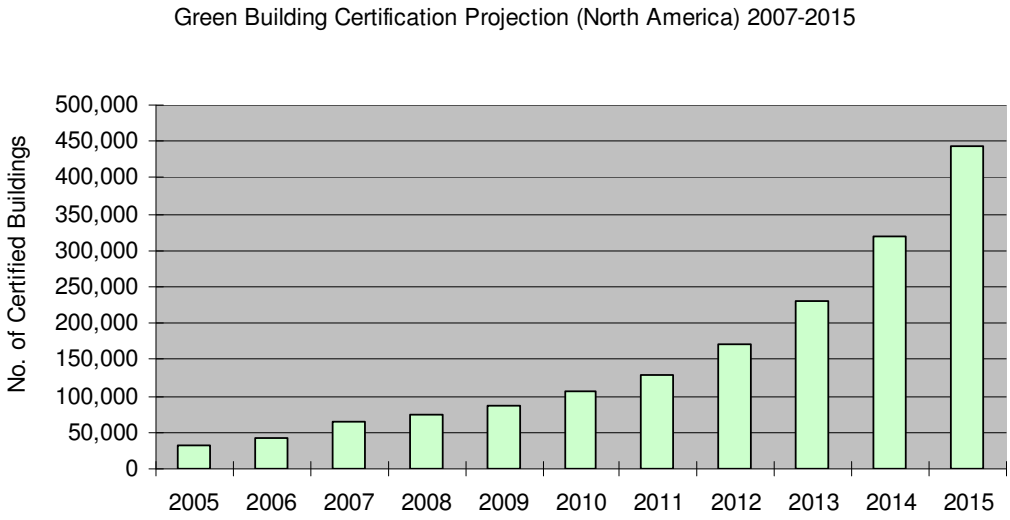
Over the past several decades, audiovisual (AV) technology has evolved from simple, piecemeal loudspeakers and projectors used as presentation tools into integrated and networkable systems capable of linking organizations and their facilities in new and dynamic ways. The convergence of AV and IT technologies has raised the bar for usability and systems integration, especially in intelligent and green buildings where user comfort, energy efficiency, and asset management are key features.

A modern intelligent conference room with green AV features may include a networked projector and/or LCD displays, intelligent lighting and window shade systems, a digital audio system, and a high-definition videoconferencing system. Based on requested capabilities in the meeting invite, the AV control system would take over the task of turning on the AV components, setting them to the proper operational mode, and adjusting the room temperature to a comfortable level prior to the meeting start time. Ambient light sensors installed in the room would measure the amount of incoming natural light (which is becoming more prevalent in green building), adjust window shades as appropriate for the function, and supplement the natural light with the interior lighting system to achieve the proper environment for a presentation or videoconference. The videoconference bridge can be dialed five minutes prior to the meeting so all attendees have to do is enter the room.

1.7 Green Measurement Ratings Driving Intelligent Buildings

Motivated by a desire to appear environmentally conscious, many commercial facilities have adopted “Green technologies” in order to earn “Green and Sustainable” certifications. The Green Buildings Ratings and Certification process has gained tremendous momentum over the last few years. Particularly, growth in the number of projects certified by rating systems such as Energy Star and LEED has nearly doubled in size during this period. Chart 1.2 depicts the growth in green building certifications 2007-2015 by rating systems such as LEED, Energy Star, Green Globes, and BOMA Go Green.

Chart 1.2 - Green Building Certification Projection 2005-2015



Source: Frost & Sullivan

The key drivers fueling this trend are energy efficiency prerogatives and enhancement of buildings' operational performance on the part of building owners and managers. Other factors contributing to this trend include a desire to substitute environmentally friendly alternatives, renewable resources, integration and intelligence benefits through incorporating intelligent building solutions. While there are a few challenges concerning high capital costs, low awareness, and receding economic conditions with a sluggish construction market, green certifications are projected to grow steadily over the next five- to seven-year period.

By enhancing connectivity between building systems and users, intelligent products and technologies help to balance operational objectives and the economic performance of buildings with due emphasis on scalability and changing priorities. These products and technologies, and the buildings they retrofit and sustain over time, stand to benefit from green measurement tools in reaching out to the larger marketplace for confirmed acceptance and propagation. Results achieved through the deployment of intelligent products and technologies in buildings make such intelligent solutions imperative to the success of a building's environmental profile and increased adoption.

The idea of leveraging intelligence to enhance building performance, either for energy efficiency or occupant comfort and thereby obtaining credits is acknowledged by USGBC. "The credit system under LEED is geared to recognizing building performance that has been enhanced by automation and IT-centric intelligence," states USGBC. The ability to track utility use on a real-time basis will increase the ability of the project team to document compliance with LEED. Similarly, occupant comfort and air quality can be documented through having a centralized system installed to enhance operational performance and ultimately ensure LEED certification down the road.

1.8 Conclusion

This research provides documented evidence to educate and influence end-users, building owners, architects, and contractors that a “greener building” can be achieved using intelligent technology and that this “greening” will provide a tangible and significant return on investment. The industry is expected to experience rapid growth for projects advocating intelligent-to-green building solutions; however, the deployment and success of the solution will ultimately rest on the capability and experience of the project team and the return on any additional investment required. Ultimately, the implementation of intelligent technologies will cost less than traditional technologies, because life-time operating costs are significantly lower and labor costs are also likely to drop significantly. This concept – intelligent, green and profitable – is what we call a bright green building.

2

Scope and Methodology

2.1 Research Goals and Objectives

This project has two primary goals, namely:

- To build a business case detailing ROI and other tangible and intangible justifications supporting investment in intelligent building technologies in order to achieve "greener" buildings
- To document success stories demonstrating both the tangible and intangible benefits of the implementation of intelligent technologies and processes, as well as the "green" results

In addition to the overall project goals, there are several defined research objectives such as:

- To examine the various levels of intelligence for buildings and the impact on green technologies and processes (new and retrofit)
- To evaluate the convergence of intelligent and green technologies in commercial, institutional and multi-residential buildings (new and retrofit)
- To provide justifications and recommendations for the implementation of intelligent and green technologies and processes
- To examine and analyze the measurement criteria for quantifying the impact of the convergence of intelligent and green technologies on commercial, institutional, and multi-residential buildings (new and retrofit), and the environment
- To assess the impact, benefits, and sustainability of intelligent technologies and processes (new and retrofit)

2.2 Research Methodology

Frost & Sullivan used a combination of primary and secondary research methodologies to compile all the necessary information for this project.

Primary Research

Primary research formed the basis of this project, making up approximately 80% of all market information collected. It also formed the basis for analysis of the case studies that best demonstrate the capabilities and benefits of each technology being evaluated.

Primary research interviews were conducted with technology providers who are supporting this project, as well as competitors in each of the technology markets. To provide balance to these interviews, industry thought leaders who track the implementation of the outlined technologies were also interviewed to get their perspective on the issues of green and intelligent technologies.

Furthermore, primary research included interviews with selected facility managers to collect information for case studies. This was supported and consolidated with documented literature and white papers provided by the technology providers.

In order to ensure that the primary research provides as complete a picture as possible of what is happening in the industry at present, as well as what can be expected in the near future, specific information was sought from the following:

- Suppliers of green and intelligent technologies
    - Technology analysis with qualitative and quantitative metrics on cost, operations, savings, energy, sustainability, tenants, and so on from intelligent and green technologies
    - Challenges in the implementation process and solutions; analysis of the design and deployment process
- Commercial, institutional, and multi-residential building owners
    - Qualitative and quantitative metrics on cost, operations, savings, energy, sustainability, tenants, and so on from intelligent and green technologies
    - Challenges in the implementation process and solutions; analysis of the design and deployment process
- Industry thought leaders
    - Trend analysis on the convergence of intelligent and green technologies, challenges, drivers, and so on
- Associations and other public/private entities
    - Trend analysis on the convergence of intelligent and green technologies, challenges, drivers, and so on with relevance to intelligent and convergent technologies in commercial, institutional, and multi-residential buildings (new and retrofit); and measurement and criteria analysis

Secondary Research

Secondary research comprised approximately 20% of the research being conducted; the following were included:

- Published sources
- Government bodies and industry associations
- Internet sources

This information was used to enrich and externalize the primary data. This data was then compared with and contrasted to market data from Frost & Sullivan's internal databases for validity and authenticity. These databases span more than 20 years of research across most market segments, technologies, and geographies.

2.3 Definitions

Green Buildings

For the purposes of this research, a green building is defined as follows: "A Green building is designed, constructed, and operated with minimum impact on the environment and with an emphasis on conserving resources, using energy efficiently, and creating healthy occupied environments. A Green building must meet the needs of the present without compromising the needs of future generations. Sustainability is measured in three interdependent dimensions: environmental stewardship, economic prosperity, and social responsibility which entails providing healthy communities and creating a safe work culture." (CABA Steering Committee)

Green buildings include the following attributes:

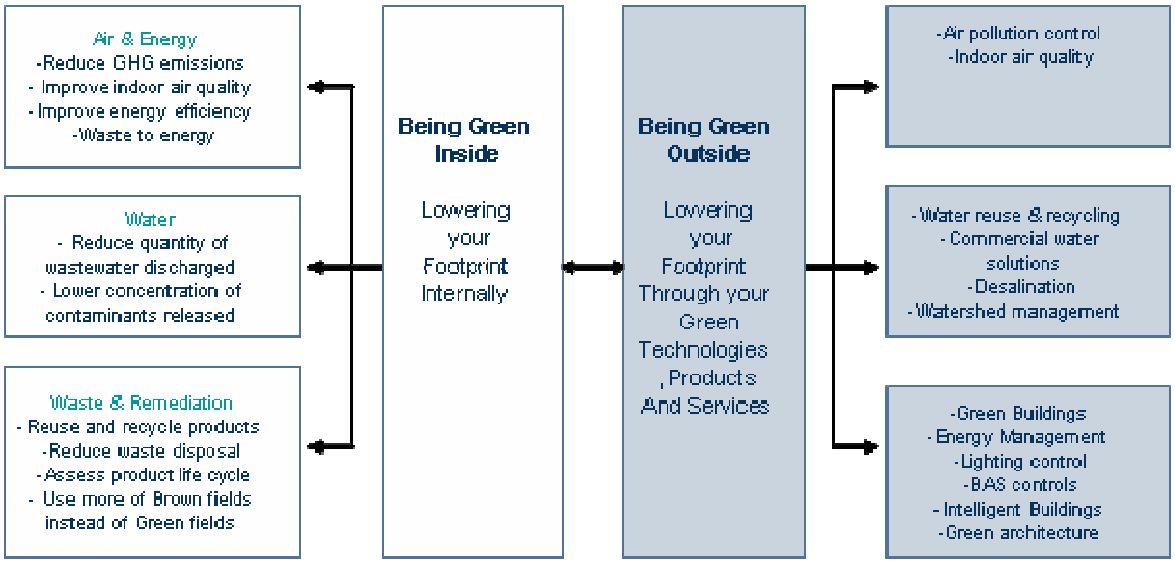
- Provide a healthy and comfortable environment
- Improve long-term economic advantages
- Incorporate efficient energy, water, and air technologies
- Involve less wasteful construction and demolition processes
- Improve adaptability for rapid and easy changes through the capacity for on-going collaborative design
- Provide long-term value and quality of construction or use

Figure 2.1 - Impacts of the built environment

Built Environment	Consumption	Environmental Effects	Ultimate Effects
Siting Design Construction Operation Maintenance Renovation Deconstruction	Energy Water Materials Natural Resources	Waste Air pollution Water pollution Indoor pollution Light Pollution Heat islands Stormwater runoff Noise Loss of natural environment	Harm to Human Health Environment Degradation Loss of Resources

Green buildings have been gaining attention in Canada and the United States because of their potential to reduce building energy costs, mitigate greenhouse gas emissions, consume less water (thus relieving the burdens of municipal water and wastewater providers), and Green buildings can add value to buildings given the savings and the positive effects on occupant comfort and satisfaction, in comparison to conventional buildings. Presently, "Green" is widely used to describe buildings designed and constructed with minimum negative impact to the environment, with an emphasis on conservation of resources, energy efficiency, and healthier interior spaces.

Chart 2.1 – Being Green "Inside and Out"



Source: Frost & Sullivan

Sustainability is measured in three interdependent dimensions: environmental stewardship, economic prosperity, and social responsibility, referred to as the triple bottom line. Social responsibility includes providing healthy communities and creating a safe work culture. As such, a Green building must meet the needs of the present without compromising the needs of future generations.

Intelligent Buildings

Definition of intelligent building is: “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. An intelligent building 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.” (CABA Steering Committee)

What can we expect of such a building?

- Improved interdependency between building systems, building users, and building systems and users
- A building that can detect the state it is in and make adjustments to itself
- Provides a healthier and more comfortable environment
- Improves long-term economic performance
- Reduces energy and water usage
- Reduces construction and demolition waste
- Brings higher resale value or lease rates
- Leverages renewable energy technologies
- Improves indoor air quality and occupant satisfaction
- Is easier to maintain and built to last
- Advanced/enhanced capabilities to deal with "churn" (occupant turnover/evolving mission)

Key intelligence attributes including:

- Sustainability
- Mobility
- Interoperability
- Technology
- Scalability
- Reliability
- Efficiency
- Security
- Flexibility
- Longevity

Intelligent buildings transcend integration to achieve interaction, in which the previously independent systems work collectively to optimize the building's performance and constantly create an environment that is most conducive to the occupants' goals. Additionally, fully interoperable systems in intelligent buildings tend to perform better, cost less to maintain, and leave a smaller environmental imprint than individual utilities and communication systems.

Each building is unique in its mission and operational objectives and therefore, must balance short and long-term needs accordingly. Intelligent buildings serve as a dynamic environment that responds to occupants' changing needs and lifestyles. As technology advances, and as information and communication expectations become more sophisticated, networking solutions both converge and automate the technologies to improve responsiveness, efficiency, and performance. To achieve this, intelligent buildings converge data, voice, and video with security, HVAC, lighting, and other electronic controls on a single IP network platform that facilitates user management, space utilization, energy conservation, comfort, and systems improvement.

2.3 List of Frequently-Used Acronyms

AIA	American Institute of Architects
ANSI	American National Standards Institute
BAS	Building Automation Systems
BENS	Building Energy Management Systems
BIQ	Building Intelligence Quotient
BOMA	Building Owners and Managers Association
CABA	Continental Automated Buildings Association
CAGR	Compound Annual Growth Rate
CIEB	Continual Improvement of Existing Buildings
CO2	Cabon Dioxide
CSR	Corporate Social Responsibility
DJIA	Dow Jones Industrial Average
DJSI	Dow Jones Sustainability Index
ECS	Energy Control Systems
EMS	Energy Management Systems
FTTE	Fiber to the Telecom Enclosure

GBI	Green Building Institute
GHG	Greenhouse Gas
iiSBE	International Initiative for Sustainable Built Environment
LCA	Life Cycle Cost Analysis
LEED	Leadership in Energy and Environmental Design
M&V	Measurement and Verification
NOI	Net Operating Income
O&M	Operations and Maintenance
PC	Performance Contractor
PNMC	Providence Newberg Medical Center
ROI	Return on Investment
SBI	Sustainable Building Information
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USGBC	U.S. Green Building Council
XML	Extensible Markup Language

3

Concept Adoption Factor Analysis

3.1 Analysis of Intelligent and Green Technology Drivers

One of the primary goals of this research is to identify and explore factors driving the adoption and convergence of intelligent and green building technologies and processes. These market drivers are of particular significance because they form the basis for understanding the various factors that augment the acceptance and adoption of intelligent and green convergence.

The concept adoption factors considered here include:

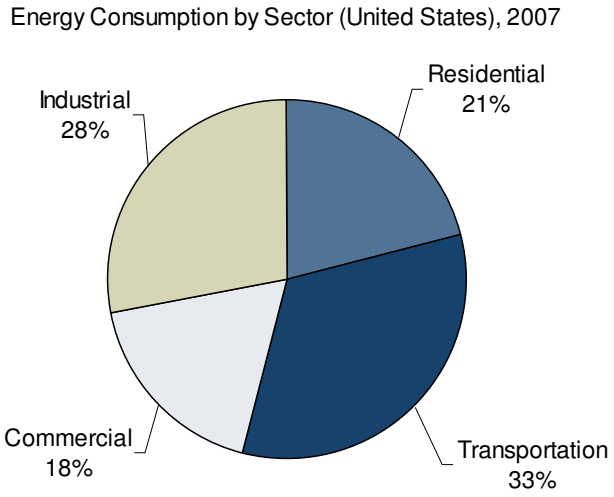
- Energy efficiency and savings
- Financial impact
    - Up-front costs
    - Lifetime ROI
    - Financing and lending options
- Reliability of the infrastructure: bandwidth and performance requirements
- Reduction of greenhouse gas and carbon dioxide emissions
- Water conservation
- Reduction in operating and maintenance costs
- Building transparency and visibility
    - Auditing
    - Reporting
    - Diagnostics
- Comfort, indoor environmental quality (IEQ), productivity and overall tenant satisfaction
- User experience and innovation
- Sustainability: the ability of the building to adapt to changing requirements over time
- Corporate social responsibility

3.2 Energy Efficiency and Savings

Commercial buildings in the United States account for 18% of total energy consumption and 76% of electrical energy consumption[3]. Electric energy consumption doubled between 1989 and 2005 and is expected to keep increasing unless remedial measures are taken. With rising energy costs and the continued increase in consumption by the commercial and industrial building sectors, building energy operating costs will continue to rise unless energy use is more effectively managed.

Energy costs represent about 30% of an office building's total operating costs (excluding staffing costs). Given that commercial buildings account for about 18% of total national energy consumption in the United States, as highlighted in Chart 3.1, energy price increases will have significant effects on these sectors' operating costs unless viable solutions are adopted[4].

Chart 3.1: United States Energy Consumption by Sector



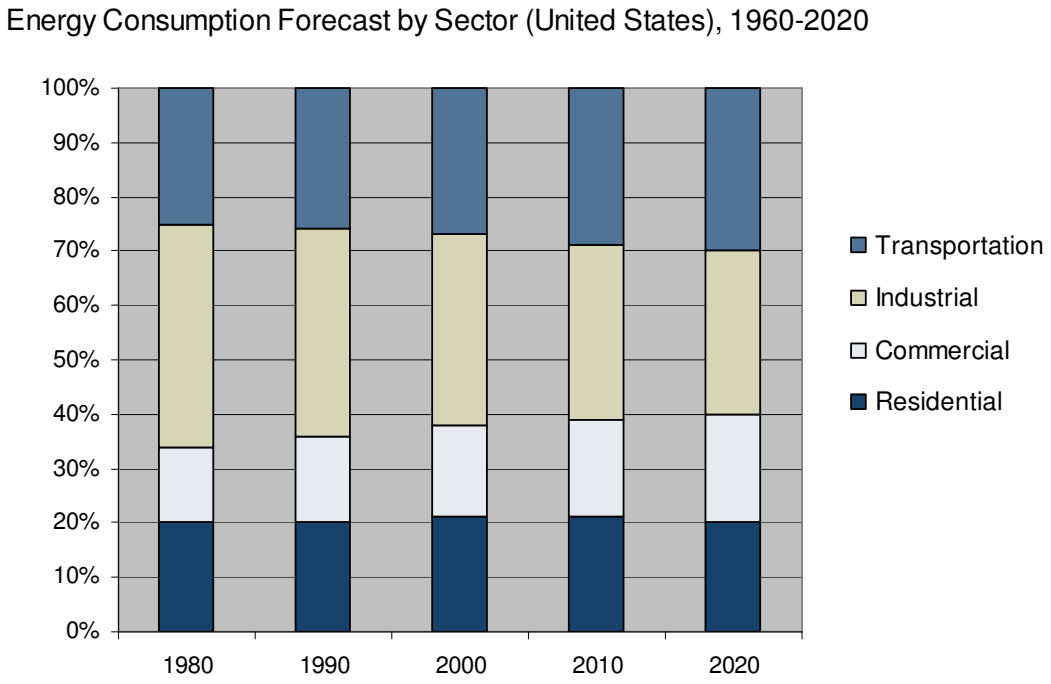
Source: Energy Information Administration (EIA)

Today, office buildings use about 16% more energy per square foot than those built 25 years ago. The total amount of energy used by commercial buildings has risen significantly since the 1980s, reflecting a 50% growth in the total amount of office space available and a 33% increase in energy consumption per square foot of space. The result is a 70% overall increase in the amount of energy used by commercial buildings since 1980, as highlighted in Chart 3.2.

[3] United States Department of Energy

[4] A comparable Canadian market statistic could not be located but it is assumed, for the purposes of this research, that both the United States and Canada share structural similarities allowing statements for one market to be applicable to both, unless otherwise noted.

Chart 3.2: United States Energy Consumption Forecast by Sector



Source: Energy Information Administration (EIA)

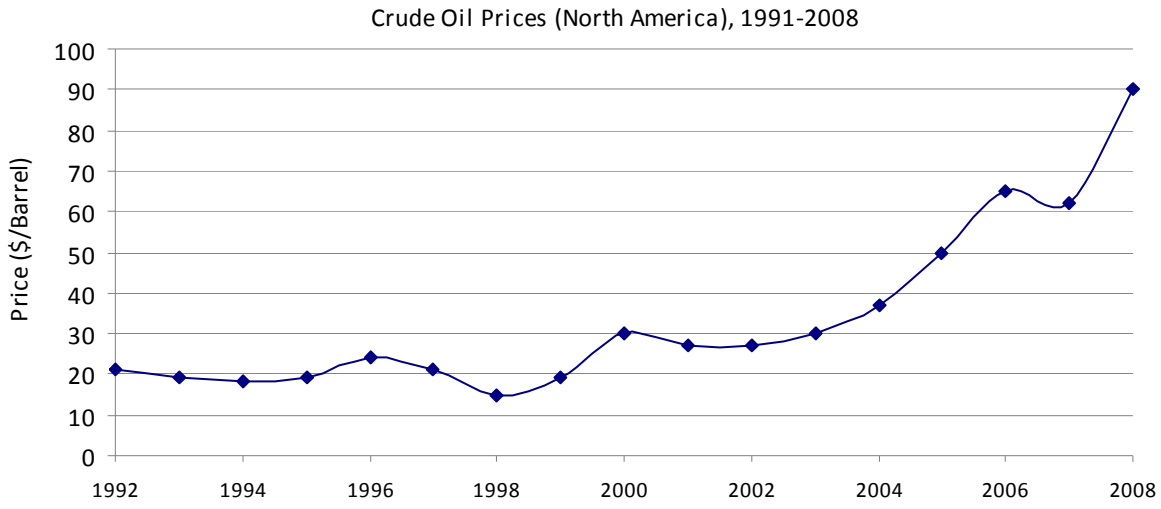
By changing energy management practices and instituting technologies that build energy efficiency, Energy Star notes that building managers can reduce energy consumption by up to 35%. However, it is becoming increasingly common for more advanced, intelligent, and green buildings to routinely reduce energy usage by as much as 50% over conventional buildings, with the most efficient buildings currently performing up to 70% better than conventional properties.

This potential for improvement has positive financial results for building owners and tenants alike. In net lease arrangements, for example, building owners pass on energy costs directly to tenants. When energy costs are low, these expenses are often not significant enough to impact tenant leasing decisions. However, as energy costs continue to rise, these savings become an incentive not only for tenants to conserve energy, but will impact their long-term leasing decisions. In gross lease arrangements, owners are responsible for energy bills and so have a greater financial incentive (than in net lease circumstances) to purchase energy-efficient technologies that are likely to save on building operating energy costs. The potential for savings is so great that one property owner, Thomas Properties Group, is switching its buildings from net to gross lease over three years, so they can reap the benefits of green retrofits, boosting the health of their bottom line.

Cost of Energy

Commercial and industrial markets in Canada and the United States are increasingly subject to variable, rising energy prices. Crude oil prices have been rising since 1999, and have become increasingly volatile. The 12-month average annual price of natural gas sold to the commercial customers of United States increased 79% between November 1999 and 2005, and has continued to increase. Chart 3.3 illustrates the selected crude oil prices in North America from 1992 to 2008.

Chart 3.3: North American Crude Oil Prices Trends, 1992 – 2008



Source: Energy Information Administration (EIA)

The United States consumes approximately 25% of the global oil output annually, despite having only 2% of proven reserves and is one of the largest oil importing countries in the world. Fossil fuels are the main source of energy in the United States, with over 70% of the total energy production derived from them. Furthermore, there is an ever-increasing gap between the demand and supply of energy in the United States. The production of energy recorded a drop to -0.6% compound annual growth rate (CAGR) for the period 2000 to 2005, while the consumption of energy registered a CAGR of 0.2% for the same period. Energy imports recorded a CAGR of 3.5% for the period from 2000 to 2005.

Supply challenges have been exacerbated by several events in the last five years, including tensions in the Middle East, rapidly growing demand from emerging markets such as China and India, and natural disasters impacting domestic production, including the hurricanes that struck the United States during 2005. All of these have caused a significant surge in oil and natural gas prices. Resource concerns such as these are drawing greater attention to green and intelligent buildings and shifting the focus on renewable energy sources.

Energy managers are entering a period driven by the increasing volatility of energy prices and uncertainty surrounding energy supplies, especially oil. Successful organizations must put plans in place to help mitigate the economic effects of this uncertainty on their companies through efforts

aimed at improving energy efficiency, reducing consumption, and making provisions for on-site or local generation where disruptions to grid access can significantly hamper operations.

Energy management in the 21st century must address the operational risks associated with power outages. Every facility has a threshold beyond which power shortages begin to have a significant impact on operations. For some operations this threshold may be as much as several hours, while for others, like a credit card data centre processing billions of dollars worth of transactions every day, this threshold is measured in microseconds. Mission critical segments of any organization must identify their vulnerability to long-term power loss and develop plans to mitigate this vulnerability through reductions in peak demand, overall energy efficiency, and onsite generation.

Demand Response (DR)

Traditionally, energy consumers have enjoyed flat, average cost-based electricity rates with no indication of electricity changing values over time. With DR, consumers can track and respond to prices as they change over time, adapting to external situations in order to reduce energy use and costs. Energy and cost savings are possible by responding to the variations of market prices in real-time by reducing demand, shifting loads to less expensive time periods, or by substituting another source for delivered electricity during peak-price periods.

DR can be defined in three ways:

- Manual DR - involves turning off unwanted lights or equipment manually
- Semi-automated DR - uses a person to initiate a pre-programmed demand DR strategy
- Fully automated DR - does not use human intervention but instead is initiated remotely and automatically through an external communications signal

For example, in Ontario, Canada, Hydro One, the leading utility and power transmission provider, has a DR program in place that allows it to automatically reduce lighting levels and cut back air conditioning in more than 100 large grocery stores in the province. This action reduced the overall electricity usage in these stores by 20%, taking 10 megawatts of load off the grid at peak times.

Other examples where demand response has or could have resulted in significant energy savings include:

- Chicago, Illinois, where the Energy-Smart Pricing Plan led to a reduction of 3-4% in consumption
- The California Automatic Demand Response System (ADRS) saved several percentage points in the summer of 2004-2005.
- During the California electricity crisis of 2000-2001, a 5% reduction in demand would have resulted in a 50% price decrease during the crisis' peak hours

- Studies by Carnegie Mellon found that a 1% shift in peak demand in the US would result in savings of 3.9%, and a shift of 10% would result in savings at the system level of $8B to $28B.

DR augments energy awareness and offers feedback for consumers on their energy usage behavior pattern. In addition, market-wide financial benefits include lower wholesale market prices, improved reliability, operational security and adequacy savings, and benefits from mitigating the power supplier's ability to raise power prices above cost.

Incentives for Implementing Demand Response Programs

At the US federal level, the Energy Policy Act of 2005 proposed the realization of DR throughout the country. Currently, half of all US states have implemented technology that allows DR and advanced metering. The opportunities afforded by DR are not limited to the state and federal levels. The building industry can use DR in combination with a building's controls to combine efficiency and DR capabilities, gathering information about the load shape and energy use patterns. There are several different methods available at state and federal levels for utilities and electricity companies to apply DR. The first avenue of application consists of two methods for implementing load changing in DR, namely price based and incentive based.

Price based DR utilizes time of use, real time pricing, and critical peak pricing to incite changes in customer usage based on the change in price. The United States Natural Resources Defense Council (NRDC) and other organizations are promoting policy changes, such as mandatory real-time pricing and tax codes, to incentivize the replacement of existing building energy systems. Real-time pricing is an inducement to reduce peak demand consumption. Higher costs during peak usage times stimulate direct metering to allow users to modify energy usage patterns, and encourage computer systems that shift energy utilization to non-peak times.

Incentive based DR programs are established by utilities, load serving entities, or regional grid operators to give customers load reduction incentives. These programs are comprised of direct load control, interruptible/curtailable (I/C) service, demand bidding/buyback programs, emergency demand response programs, capacity market programs, and ancillary services market programs. Incentive based DR can be seen in demand bidding/buyback programs where the customers bid to curtail their energy demands based on the wholesale electricity market prices.

Other DR incentive programs include:

- Emergency demand programs, which provide incentive payments to customers to reduce their load during reserve shortfalls
- Capacity market programs involve customers offering curtailments to replace the conventional generation of delivery resources
- Ancillary market services programs in which the customers bid load curtailments to be chosen as operating reserves where, if their bid is accepted, they will be paid to be on standby and then paid the spot market price if curtailments are needed

Contributions by Intelligent and Green Buildings to Energy Savings

The U.S. Green Building Council (USGBC) estimates that a green building, on average, can reduce energy use in buildings by 25-30% over the national average. Chart 3.4 highlights some current examples of energy savings possibilities based on the results of projects examined for the case studies included in this research service.

Chart 3.4: Energy Savings Examples

Case Study	Energy Savings	Technology Trade Names
State of Missouri	17% annual energy savings (post retrofit)	Enterprise Asset Management & Building Information Management System
Kwantlen University College	30% annual energy savings compared to energy code ASHRAE 90.1 -1999	Integrated Building Automation System (BAS)
Rogers Centre	76% savings on lighting energy costs (post retrofit)	Energy Control System (ECS)
Providence Newberg Medical Center	26% annual energy savings compared to ASHRAE 90.1	Integrated HVAC system
The Verve – High Rise Condominiums	35% annual energy savings compared to local energy code (similar to ASHRAE 90.1)	Energy Management Systems (EMS)

Source: Frost & Sullivan

Intelligent buildings can integrate building control systems with DR programs, allowing them to monitor and control the energy use of the building in real-time. This not only extends the building's ability to be fully automated and integrated, but can lead to substantial energy savings by giving the building control system the ability to automatically reduce energy consumption during peak periods.

3.3 Financial Impact

In developing a business case for intelligent and green technologies, a building owner/manager must be convinced that the payback period is significantly less than the expected working life of that asset. It must be demonstrated clearly that this investment will be favorable to the investor. Technologies applied in intelligent buildings will improve the building environment and functionality for occupants, while reducing operational costs. Higher ROI and returns on assets are the key benefits: The building will have a higher value, with improved leasing possibilities. The US EPA's Energy Star program estimates that owners investing in energy upgrades can enhance building asset value by two to three times the amount invested. Furthermore, where a building's energy use is reduced by 30%, Net Operating Income (NOI) and building asset value are increased by about 5%.

However, owners and building managers have been reluctant to invest additional up-front funds in intelligent and greening upgrades because of concerns about payback, especially in cases where the payback on capital outlay may be longer than the typically desired two to three year investment horizon. Chart 3.5 highlights ROI examples from the case studies included in this research service.

Chart 3.5: Payback Examples

Case Study	Payback Period	Technology Trade Names
State of Missouri	Payback in less than two years	Enterprise Asset Management & Building Information Management System
Rogers Centre	Phase One: Payback in three years Phase Two: Payback in two-and-a-half years	Energy Control System (ECS)
The Verve – High Rise Condominiums	LEED premiums Payback in seven years or less	Energy Management Systems (EMS)

Source: Frost & Sullivan

Other technologies assessed for this research demonstrate that using telecom-enclosure (TE) cabling could save 38% on material and labor costs, and integrated building automation system (IBAS) infrastructure could save 33% on material and labor costs, when compared to conventional buildings.

3.4 Reliability of the Infrastructure: Bandwidth and Performance Requirements

Several challenges face information technology (IT) and facility managers at present, including increasing bandwidth and performance requirements on their networks, the need to utilize network electronics for as long as possible, the need to move to new technologies with the minimal downtime and disruptions, and the need to respond to continuous requests for moves, adds, and changes (MAC) to equipment and the environment. These challenges are compounded as buildings integrate more sophisticated voice, data, power, and video equipment into applications. The plethora of cabling for HVAC, fire and life safety, security, voice and data, and paging contribute a great deal of complexity to a building's cabling infrastructure. An intelligent infrastructure solution provides the foundation for a reliable and high performing communication infrastructure with a strong backbone to power the lifeline of an enterprise. The integration of these various applications benefits from a structured cabling system (SCS) providing innovative and less costly connectivity to these types of systems.

As technology and connectivity demands continue to grow rapidly, communications infrastructures need to become more intelligent and robust to accommodate these changing needs. End-users are demanding suitably designed cabling infrastructure that is reliable, interoperable, and scalable over

time. Seamless access to corporate networks is necessary for existing corporations, and this inevitably makes various MAC demands including:

- More bandwidth
- More applications- from multimedia to VoIP to security
- More user policies and regulations
- Greater demands for flexibility
- Ubiquitous networking

The increasing amalgamation of information technology, equipment manufacturers, and physical and computer security providers is of prime importance in buildings. Dealing reliably with system and component failures when compared to existing solutions is very important. Conventional techniques fail to provide effective resolution and are incapable of problem isolation. Next generation electronic devices and computer equipment will be vital in maintaining the security of buildings. This will include simple tasks such as monitoring building or facility access through to more complex tasks such as data protection across an entire network. The use of open standard IT platforms enables end-users to limit redundancy, while still being able to customize systems according to their individual requirements. The flexibility offered by open systems will allow IT professionals to be better prepared to deal with security breaches and computer threats.

An efficient and robust communications system forms the backbone for the integration of all building networks. It is the superior capabilities in areas such as voice and data communication that lead to the efficient operation of a building. A structured cabling infrastructure can lower construction costs, optimize operational expenditures, and eliminate dealing with multiple contractors, while simplifying the installation process to minimize potential system conflicts and reduce implementation timelines.

Structured cabling provides several opportunities for improvement and cost savings in new construction or retrofit project, including:

- Operational efficiencies
- Reduced infrastructure material requirements
- Reduced maintenance
- Increased productivity to due reduced down-time
- The ability to provide real-time reports and monitoring

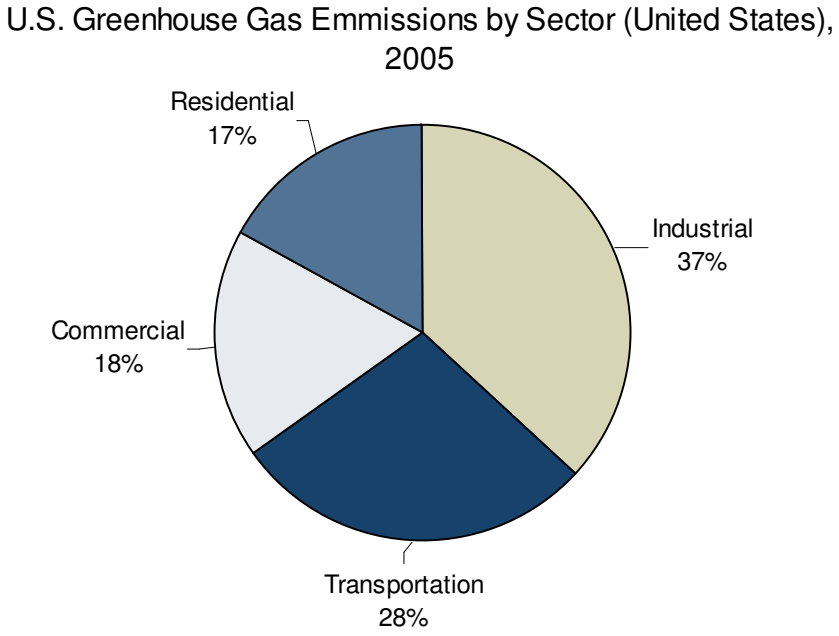
In addition, empowering a unified team of professionals to implement the cabling process can reduce the time spent in project management. Integrating various systems to reduce complexity can enable quick service provisioning for occupants and tenants resulting in ease of maintenance and configuration of various outlets and ports. Facility owners may also benefit from lower financing costs, because of faster occupation rates resulting from faster commissioning. Such facility owners can

typically command leasing premiums based on the ease and flexibility afforded by the infrastructure in deploying technologies to suit customer needs.

3.5 Reduction of Greenhouse Gas Emissions

Concerns over climate change have incited action to reduce GHG emissions through energy efficient technologies and practices in the commercial and industrial sectors. Carbon dioxide (CO2) is the largest component of GHG, accounting for approximately 70% of total emissions. CO2 emissions to power the commercial buildings sector accounted for about 18% of total United States energy-related CO2 emissions in 2005, as highlighted in Chart 3.6.

Chart 3.6: United States Greenhouse Gas Emissions by Sector (2005)

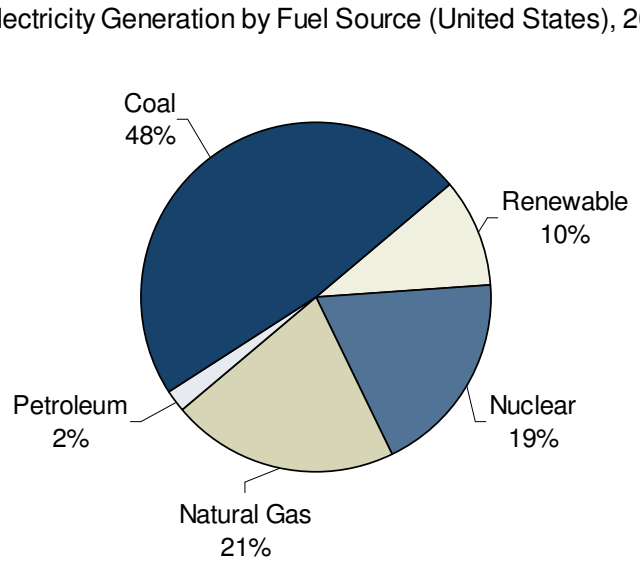


Source: U.S. Energy Information Administration

The United States accounts for only 5% of the world's population, but consumes about 26% of the world's energy. It is also the world's largest CO2 emitter, followed by China. Canada ranked as the seventh largest CO2 emitter in the world. On a per capita basis, the United States ranks as the world's number one CO2 emitter, followed by Canada. Despite efforts by a variety of sectors in North America to reduce GHG emissions, Canada and the United States ranked 107th and 109th, respectively out of 146 countries in mitigating these contributors to global warming according to the Yale University 2005 Environmental and Sustainability Index.

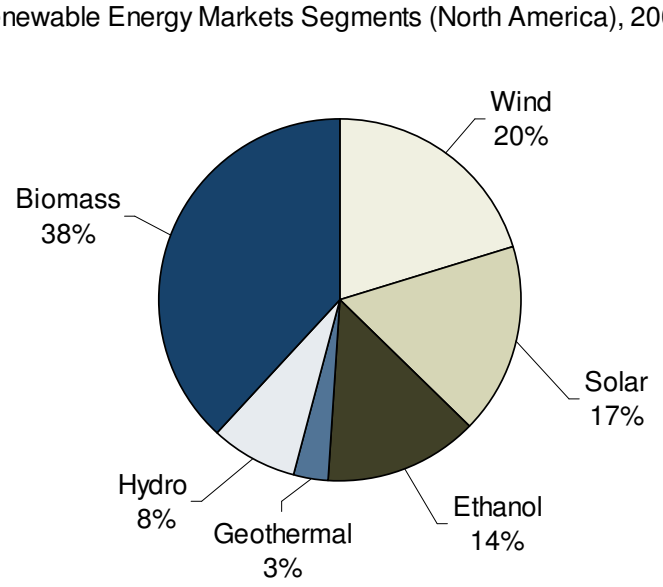
The mixture of fuels used to power electricity generation in the United States consists primarily of fossil fuels, with 19% of electricity coming from nuclear sources and 10% from renewable resources, as highlighted in Chart 3.7 and Chart 3.8. Coal is the main fuel used for electricity generation and is responsible for 81% of CO2 emissions from power generation. However, the percentage of coal used in electricity generation decreased marginally from 50% in 2001 to 48% in 2006. Canada is more heavily reliant on renewable energy, primarily hydroelectric generation which provides 58% of total capacity. Chart 3.9 outlines electricity generation in Canada by source.

Chart 3.7: The United States Electric Power Sector Fuel Usage



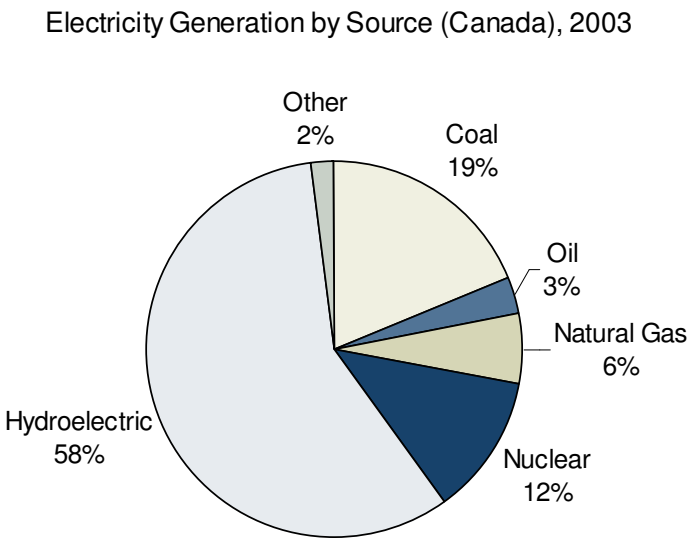
Source: EIA and Frost & Sullivan

Chart 3.8: Renewable Energy Market Segment (North America), 2006



Source: Frost & Sullivan

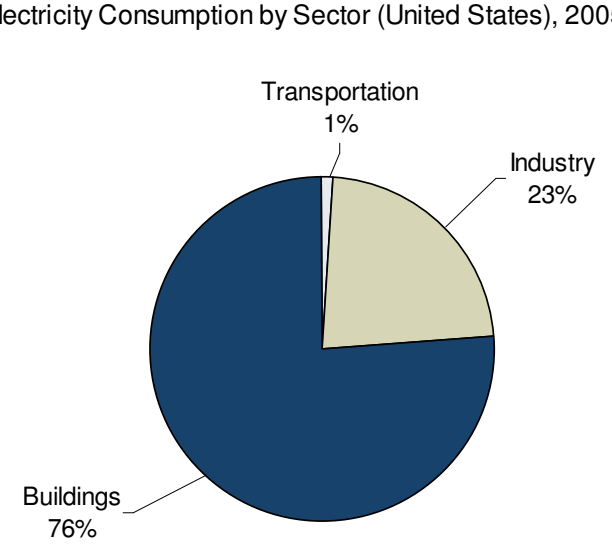
Chart 3.9: Canadian Electric Power Sector Fuel Usage (2003)



Source: Canadian Electricity Association

As shown in Chart 3.10, 76% of the United States' electricity is used to operate buildings. It is, therefore, necessary to consider energy efficiency in buildings as a way of reducing CO2 emissions, and as an important component in a viable strategy to address global warming. According to CaGBC Municipal Green Building and the EPA, buildings in the United States account for 38% of total CO2 emissions and for 35% of CO2 emissions in Canada. The USGBC estimates that green buildings can, on average, reduce energy use by 30% and CO2 emissions by 35%.

Chart 3.10: United States Electricity Consumption by Sector, 2005



Source: U.S. Energy Information Administration

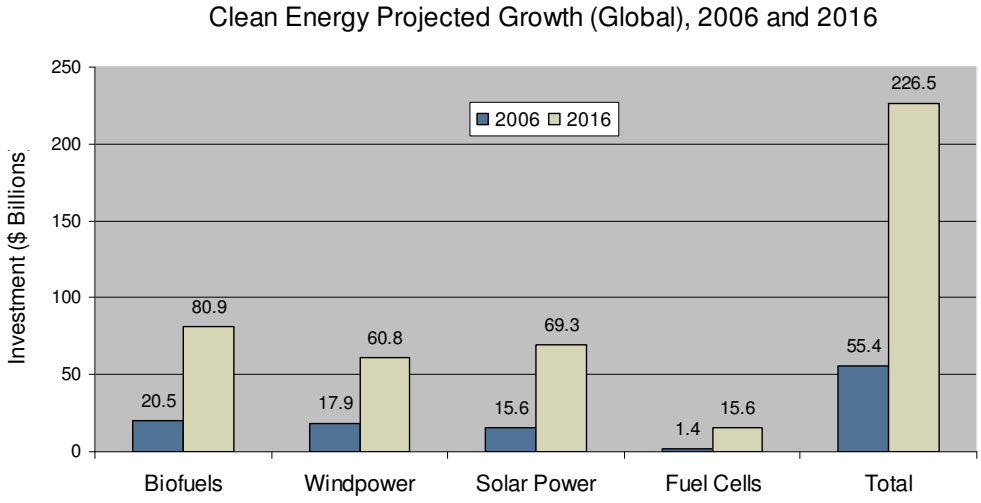
Renewable Energy

In an era of volatile energy prices, increasing concern over climate change, the need for innovative technologies to address the needs of infrastructure and natural disasters disrupting energy production. Further, political debate in the United States over the reliance on foreign sources of energy, especially oil, domestic development of renewable energy sources is viewed by many as a potential answer to these energy challenges.

The increasing growth of renewable energy sources, both globally and in the United States and Canada, has placed the development and use of renewable energy high on the policy agenda of the federal, state, and provincial governments. In many jurisdictions, governments have developed regulatory programs offering financial incentives to spur the growth of renewable sources of energy.

Indeed, global investments in renewable energy are expected to grow significantly in the next decade, as shown in Chart 3.11. Governments and consumers in most developed markets have realized the importance of renewable energy as part of any national energy strategy. As a result, it is expected that global investments in clean energy will increase to more than $225B by 2016, from $55B in 2006.

Chart 3.11: Global Renewable Energy Investment Forecasts



Source: Clean Edge, Inc.

A major drawback of many renewable energy sources is their high cost compared to conventional energy sources. For example, the cost of generating electricity from wind turbines is nearly five cents per kilowatt hour (kWh). Solar or wave power costs at least 18 to 20 cents per kWh. The cost of electricity generated from conventional energy sources, in contrast, is typically much lower: as little as three to five cents per kWh. Costs are declining for some alternative energy sources, driven by technology and renewed development interest. Despite this, alternative energy sources still cannot compete with fossil fuels on price. However, this trend is likely to change as the price of oil and gas continue to rise. Withdrawal of tax subsidies for oil and the shifting focus on renewable energy

sources are likely to eventually accelerate the already declining renewable energy prices to make them more cost effective.

American Institute of Architects (AIA) "2030 Challenge"

In January of 2006, AIA officially issued the "2030 Challenge", a set of goals to achieve a dramatic reduction in GHG emissions by changing the way buildings are constructed and renovated. The AIA's goal is to achieve carbon neutrality for fossil fuels in buildings by 2030. There are two key strategies to meeting this goal:

- Every new building and retrofit project must be designed to operate on half of the fossil fuel energy when compared to conventional buildings.
- Fossil fuel reduction standard should be required for all new buildings, along with increasing reduction requirements to 60% in 2010, 70% in 2015, 80% in 2020, 90% in 2025, and achieving carbon neutrality by 2030.

This AIA 2030 strategy also calls for the 20% purchase of renewable energy and a reduction in energy consumption using design and energy efficiency measures. The leading organizations that have committed to this challenge include the AIA, the United States Conference of Mayors, the U.S. Green Building Council, the National Association of Counties, California Public Utilities and Energy Commissions, and several individual cities, counties and states.

Contributions by Intelligent and Green Buildings to GHG Reductions

High performance buildings reduce the overall demand for energy, helping to limit the need for new power plants. As many new plants still burn coal, this reduction also helps limit associated emissions. Intelligent buildings make several contributions to reducing GHG emissions:

- Improve the reliability of the electrical system by better managing peak demand
- Reduce electricity costs
- Increase market efficiency
- Improve risk management and help to reduce the risk of outages
- Improve the use of assets
- Help minimize the environmental impact.

Chart 3.12 highlights the contributions made to the reduction of GHG emissions by facilities examined for this project.

Chart 3.12: GHG and CO2 Reductions from Case Studies

Case Study	Annual GHG / CO2 Emission Reduction	Technology
State of Missouri	Eliminated 205 million pounds of CO2 equivalent emissions, an amount equal to the annual CO2 emissions of 40 coal-fired power plants.	Enterprise Asset Management & Building Information Management System
Rogers Centre	Reduced CO2 emissions by 2,797 tons annually, the equivalent to taking 465 passenger vehicles off the road.	Energy Control System (ECS)
Providence Newberg Medical Center	Reduced CO2 emissions by 731 tons annually, an amount equivalent to CO2 emissions produced to power 88 homes for one year.	Integrated HVAC system
The Verve – High Rise Condominiums	Annual GHG reductions due to energy efficiency measures equaling 887 tons (805 metric tons), equivalent to CO2 emissions from 91,336 gallons of gasoline.	Energy Management Systems (EMS)

Source: Frost & Sullivan

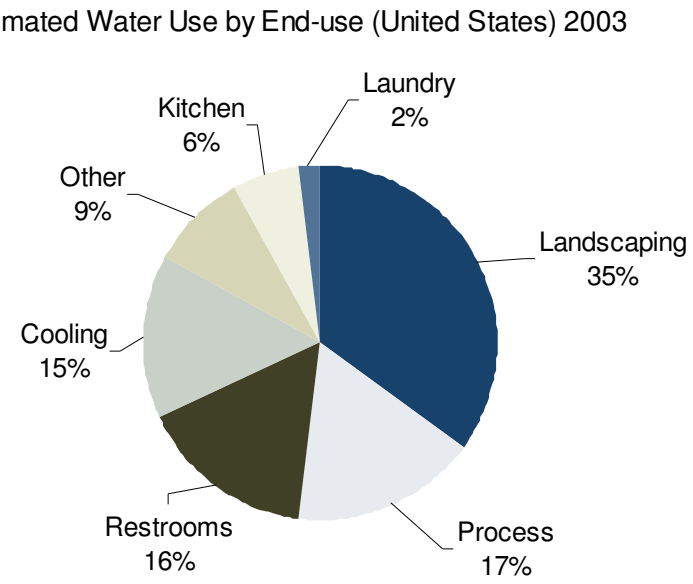
3.6 Water Conservation

The concern over climate change has not only created a call to action to reduce GHG emissions, but has created a sense of urgency for water managers to prepare for both increased drought conditions, as well as the increased severity of flooding. Coupled with the increasing unpredictability of rainfall, increasing consumption volumes in the commercial and industrial sectors are making water management an urgent issue in many areas.

North Americans are the largest per capita consumers of water in the world according to the Organization for Economic Co-operation and Development (OECD), using significant amounts of water both indoors and outdoors. Primary water demand management drivers in both Canada and the United States include regulations, municipal water and wastewater infrastructure replacement and repair, population, and budgetary and consumption issues. Municipalities trying to deal with aging, leaking and outdated municipal infrastructure that requires replacement and repair are often facing significant budget restraints with revenue sources insufficient to implement these changes. Population increases and support requirements for economic development pose an additional load on an already strained system.

Water rates have not traditionally covered the full cost of pumping, treatment, and supply. This scenario is unlikely to change significantly, since ratepayers and politicians are resistant to price increases. Instead, municipalities are opting for demand management practices (including education and incentives), which delay the need for infrastructure expansion. Municipalities are using water conservation strategies aimed at changing customer behavior and encouraging the up-take of water efficient technologies to generate sufficient savings and slow the need for infrastructure growth. Chart 3.13 illustrates estimated water use by end-use with current infrastructure in place.

Chart 3.13: United States Water Usage Breakdown by End-Use



Source: Gleick, et al., Pacific Institute

To help address these budget issues, fee-based and other incentives for facilitating water conservation and stormwater management are on the rise. Other incentives include metering, consumer and commercial education regarding irrigation issues, low-flow/no-flow technologies, permeable pavers, xeriscaping and the mandating of green roofs.

Water demand management reduces water volumes consumed, but artificially low prices for municipal water means that these efforts often have a limited impact on overall operating costs. However, significant savings can accrue through lower energy costs resulting from reductions in the energy used to pump and heat water. Water demand management also introduces natural solutions for siting and landscaping to mitigate irrigation volumes, and potentially combines building goals through one system (such as green roofs). It employs methods to ensure that water quality input matches its use; and provides on-site water pre-treatment before use and/or discharge for risk mitigation.

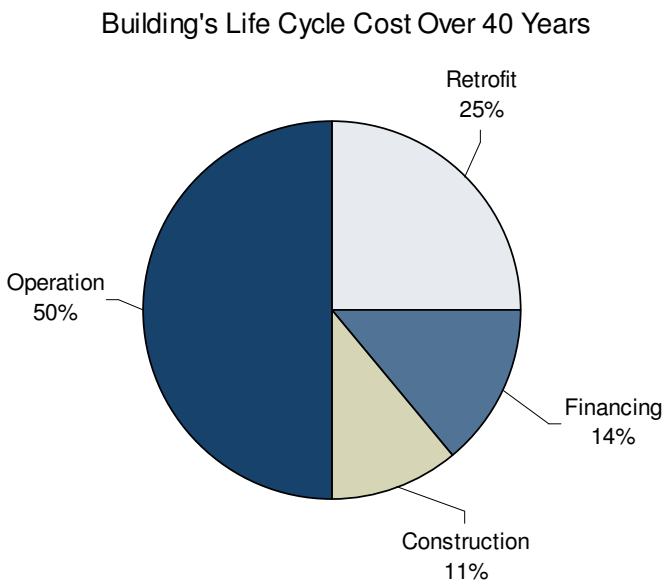
Green building water management disciplines include water management, wastewater treatment, and stormwater management in both commercial and industrial sectors. Water-efficient technologies needed both indoors and outdoors combine measurement with financial incentives for water conservation. Water shortages are expected to be an ever-present challenge in several regions in the

near future, so there is tremendous market potential for water conservation technologies and products. One such option that has displayed growing potential is the use of sensors to monitor and control water use. Based on CaGBC Municipal Green Building and the EPA, buildings account for 12% of the total water consumption in the United States. The USGBC estimates that green buildings, on average, currently reduce water usage by 30-50%.

3.7 Reduction in Operating and Maintenance Costs

In today's world, large buildings have to exhibit high operational efficiency and low cost with respect to factors such as energy consumption and operating costs. Apart from this, factors such as life cycle benefits, management of resources, and legislative requirements place significant importance on Building Energy Management Systems. As demonstrated in Chart 3.14, ongoing operating costs represent 50% of a building's total life cycle costs over an estimated 40 -year life span.

Chart 3.14: A Building's Life Cycle Cost over 40 Years



Source: ASHRAE

Reducing operating costs enhances a building's asset value.[5] When the building is a commercially leased property, the resulting increase in occupant productivity provides an opportunity for building owners to differentiate themselves, providing an improved image, and better lease-up times and renewal rates, while reducing vacancy rates and churn.

[5] The total annual savings divided by the capitalization rate equals the augmented asset value

With intelligent buildings, owners' operating costs are significantly lower as a result of more efficient operations and better control. Intelligent features of a building, such as monitoring and control of energy-intensive systems such as HVAC and lighting, can be measured for optimum performance and predictive maintenance needs, reducing both energy usage and operating expense.

Monitoring, measurement and verification (M&V) is important in making building managers better able to analyze the information associated with operating equipment; however, most conventional buildings have only a rudimentary ability to use their existing infrastructure to utilize the available data. In fact, most buildings lack the ability to collect data and turn it into actionable information. Parameters such as temperature, flow, pressure, and actuator positions can be used to monitor information. These data will help to determine whether equipment is operating incorrectly or inefficiently, and make troubleshooting easier.

3.8 Building Transparency and Visibility

From an end-user perspective, having visibility over a building's operational data is extremely valuable. This can be facilitated by upgrading existing legacy systems and connecting them with building automation data and enterprise data from building systems for better control and building performance. A seamless integration is the ultimate aim that will lead to transparency and visibility, and promote the intelligent building concept.

Large scale building owners typically have one of every system and protocol layer available in the market. Using a bridge that can move everything to an IP network enterprise allows building owners to integrate their various systems and protocols into one common platform. A common network enterprise helps facilitate building systems analytics, automated fault detection and diagnostics (AFDD), automated demand response (ADR), remote monitoring, predictive maintenance, and renewable energy solutions implementation. Integrating intelligence is not only desirable, but is also becoming a mandatory requirement to provide clients the best automation solutions with the simplest connections to real-time data, Web-based data, and the corporate enterprise.

Open system integration provides effective overall control of a large number of buildings with remote monitoring and diagnostic capabilities. Remote access to all building systems is one of the major advantages of an intelligent building system. Advances in networking technologies and the Internet have opened the door to a network-enabled world. With device networking technology and system integration, an intelligent building can be created, allowing control over almost every system from a remote location. It can allow for predictive fault detection, reporting, timely diagnosis, and prognosis capabilities for all connected buildings anywhere in the world from a centralized location.

3.9 Green Financial Building Valuations

Real estate valuers, insurers, lenders, and accountants have been slow in recognizing the differential value between high-performance and conventional buildings. This is partially due to the need to modify financial instruments for assessing these differences.

Lenders, insurers, and property valuers need data supporting the differential value of green buildings over traditional ones. Methods currently used are not well suited to quantify the benefits and value of intelligent and green building. Although the Dow Jones Sustainability Index (DJSI) and other investment industry participants have begun to distinguish corporate achievement as being related to green matters, and investors' incorporation of environmental and social risks into business value assessments is growing, green clients' accountants, valuers and appraisers are not necessarily using assessment methods that demonstrate the increased triple-bottom-line value of these properties. Chart 3.15 identifies how valuers and appraisers value real estate assets and the impact on a green building's perceived value.

Chart 3.15: Typical Real Estate Valuation Approaches and Methods

Typical Real Estate Valuation Approach	Method	Impact on Green Building Value
Direct Comparison	Compares properties	Appraisers may not ask for enough detail to observe green value differentiation.
Investment Approach	Uses future income expectations based on asset operations expenses	Opportunity to quantify green building value Needs adjustment in the US to account for longer life spans of green buildings and an improved income stream
Cost Approach	As defined by the Appraisal Foundation: "The cost to replace or reproduce the property being appraised."	Typically disregards green components' benefits, differential performance and the impact on asset value Higher cost may be disregarded as value additions from benefits and depreciation rates may not reflect building life cycle
Alternative Real Estate Valuation Approach	**Method**	**Impact on Green Building Value**
Triple-Bottom-Line	Includes economic, societal, and environmental performance	Needs agreement on methods of valuing and auditing Gaining popularity as a concurrent valuation measure with other approaches

Full-Cost Accounting	Portrays full cost of implementing decisions, e.g. environmental, social, and economic consequence	Lacks detail on how to include broader aspects in full analysis – no robust standards.
Accounting Approaches	**Method**	**Impact on Green Building Value**
Cost Approach	Identifies cost and depreciation as measures of value	Does not address how increased cost may enhance market value directly and indirectly, e.g. via lower operating costs and a longer lifespan
Market Value Approach	Identifies benefits beyond cost such as operational costs	Used by International Reporting Standards Capacity to recognize benefits of green buildings

Source: Frost & Sullivan

Building valuation systems support the development of high-performance building markets through benchmarking and marketing. They also provide opportunities to recognize the differential valuation of green buildings, although currently this is seldom the case. Ideally, lenders would offer differential rates for green buildings based on lowered risk compared to conventional facilities; insurance companies would provide differential premiums for property and casualty, life/health, and employee assistance programs. These differential rates would more fully value how green buildings address the risks of GHGs, increasing energy costs, costs of municipal water, and wastewater infrastructure that are typically externalized to governments and taxpayers, but which may impact organizations' operations, occupants' activity, and performance.

Building industry participants involved in asset valuation would benefit by being included in, for example, the integrated design process (IDP) and in ongoing client and green building industry deliberations, to help quantify the differential value of green buildings more accurately. Once appraisers realize the potential to augment value, this will help facilitate more financially viable green advantages. When a market value accounting approach is used in assessing building value, green buildings fare better than they do using the cost approach, which simply addresses building cost and depreciation, not any long-term effect such as operational savings.

Green Lease

Many building owners are attempting to green their existing buildings, and tenants are seeking out buildings that allow them to reduce their carbon footprint and achieve sustainability in alignment with their corporate goals. The green lease begins with the integrated design process, construction, and operation of the green building as it relates to sustainability, energy and water efficiency, atmosphere, materials and resources, and indoor environmental quality. In order to maintain a green space over the duration of a lease, the lease must be flexible enough to allow for green advances. A green lease gives the landlord the ability to retrofit the building, making it greener, to adjust year-end base expenses to

the level they would have been if green measures were in place at the time, to amortize the cost of energy-saving systems, and to have reasonable access to spaces in order to install energy-efficient systems. Since leases may last five, ten, or even 20 years, it is vital that the landlord and tenants have flexibility in adapting the building and spaces to future needs and conditions.

3.10 Comfort/IEQ/Productivity/Tenant Satisfaction

Productivity costs have remained under-recognized by the broader building industry, but due to the relative size of staffing expenses as compared to building energy and investment costs, building owners can leverage effective energy management to produce significant administrative savings. A variety of studies have demonstrated productivity benefits in commercial and industrial settings. For example, the Rocky Mountain Institute indicates productivity costs augment productivity performance by 6-26%. Office worker productivity on average increases between 2-18% in green buildings according to the U.S. Green Building Council. Interface Engineering has noted that relative annual building operating costs per square foot can be:

- O&M $1.35
- Total Energy $2.00
- Rent $20
- Salaries: $200 to $600

Productivity gains shorten the ROI period on energy capital costs considerably in owner-occupied buildings. Given that energy costs represent about 1% of the overall cost of doing business and investment expenses are about 10%, staffing costs can be up to 85%. Any improvement in productivity can, therefore, have a significant positive financial return. Further pressures to improve indoor environmental quality (IEQ) include the significant increase in the cost or the complete withdrawal of building insurance coverage for problems resulting from molds and other airborne contaminant health and security risks. The National Energy Management Institute in the United States identified a potential $20B to $200B non-health productivity gains and $25B to $58B in health gains from enhancing indoor environmental quality. When William McDonough and Partners architects incorporated nature into a factory they designed for Herman Miller, they found enhanced productivity and reduced absenteeism paid for the extra costs.

This is a significant rationale for enhancing productivity in national economic environments, where all opportunities to increase productivity are being sought. Business owners and building managers are motivated by several factors:

- Intelligent and green buildings that can help attract and retain talent
- Factory owners can show increased production
- Retailers can increase sales per square foot
- Hospitals can discharge patients earlier
- Schools can show an improvement in students' school test

3.11 User Experience/Innovation

Intelligent buildings are typified by their innovative qualities as facilitated by the integrated design process to enable building owners, developers, and managers an environment that allows for better services to the tenants and occupants. These expanding capabilities not only offer better management of buildings and associated operational costs, but also enhance the well being of the occupants. Real estate owners can take advantage of a fully converged intelligent information network to create virtual workspaces that provide more flexible and efficient work environments anywhere on the premise.

As technology and network demands continue to rise, communications infrastructure needs to become more intelligent and robust to accommodate these changing needs. Intelligent buildings converge data, voice, and video with security, HVAC, lighting, and other electronic controls on a single IP network platform that facilitates user management, space utilization, energy conservation, comfort, and systems improvement. A robust infrastructure solution provides the foundation for a reliable and high performance communication infrastructure and a strong backbone to power the lifeline of an enterprise.

Fully networked systems transcend integration to achieve interaction, where the previously independent systems work collectively to optimize the building's performance and constantly create an environment that is the most conducive to the occupant's goals. This move requires interoperable, flexible, and open systems to ensure ease of operability in a building, and to cater services to the user's overall experience, and add scalability and extensibility to enable and smooth systems evolution, and reduce environmental impact.

By integrating digital signage and multimedia presentations in the retail space, to the existing converged platform, end-users can generate additional revenue differentiable services. Innovations such as video conferencing, digital signage, and integrated controls for lighting and temperature are technologies being merged with audio visual (AV) technology that serves to produce better picture quality for videoconferencing, and also leads to integrated rooms and buildings that can improve comfort and user experience. For example, digital signage, also known as electronic billboards, delivers live and on-demand video streaming from a centralized location enabling end-users to reach a specific audience with specific information at a specific time. High definition (HD) is another advancement in technology that enhances digital signage and teleconferencing experiences. Rich media is emerging as a platform for delivering customized and personalized experiences by connecting a variety of devices, such as audio conferencing, video on demand, live video, video conferencing, and Web conferencing to the Internet.

These technologies also provide green benefits not only to a building, but also to an entire company across all of its facilities by using the converged network to support teleconferencing and allow company employees in different locations to communicate using videoconferencing, as opposed to travel.

3.12 Sustainability – Adapting to Changing Requirements over Time

Green, high-performance buildings embody increased efficiencies in resource utilization, reduced waste and environmental impact, enhanced economic performance, and an overall positive impact on the quality of life for the inhabitants. To significantly reduce or eliminate the negative impact of buildings on the environment and on the building's occupants, green building design and construction practices need to address:

- Sustainable site planning
- Energy efficiency
- Safeguarding water and water efficiency
- Conservation of materials and resources
- Indoor environmental quality

As public insight into environmental sustainability evolves over time, there will be a noticeable shift in the realization that we dwell in a pool of finite resources. Sustainability is key, and is the natural headway for the building industry and its associated vertical segments. The process of formulating standards for building design that allow stakeholders to weigh their system solutions against the impact on the environment has become critical.

New building projects must take into consideration how resources will be used in the building. It is estimated that 30% of the energy consumed in buildings is unnecessary or not efficiently utilized. The efficient use of water, heating, and electricity will assist in stabilizing long-term economic growth, while simultaneously lowering lifetime utility costs for individual owners and tenants. Although there has been a great deal of emphasis on implementing sustainable techniques for new buildings in the planning stages, it is the bulk of the existing facilities in the market that have less than optimal energy efficiency standards, and therefore, have a much greater environmental impact. This also offers a significant business opportunity for industry participants.

In the United States, it is estimated that, each year, approximately five billion square feet of new buildings are built, five billion square feet are renovated, and 55,000 obsolete commercial buildings comprising approximately 1.75 billion square feet are demolished. By 2038, three-quarters of the built-environment in the United States will be either new or renovated. By enhancing connectivity between building systems and users, intelligent products and technologies help to balance the operational objectives and economic performance of buildings with emphasis on scalability and changing priorities. In their endeavor to provide a comfortable and reliable environment, they essentially help achieve a reduction in energy consumption, more efficient use of resources, and explore renewable alternatives that enable buildings to be financially, as well as environmentally, sustainable assets over time. According to industry experts, without a building being smart and adaptive to its environment and energy costs, it can't be efficient in its use of energy and can't help in

ensuring sustainability. The meaning of smart buildings is that it can figure out behavior and behave according to impacts of parameters around it.

3.13 Corporate Social Responsibility

Market performance, environmentally preferable purchasing policies, supply chain demands for green in both directions, and the increasing need for transparent corporate accountability are driving greening of all sectors, not just buildings. Green companies perform better in the market as evidenced by the DJSI, whose companies have outperformed the Dow Jones Industrial Average (DJIA) over the last few years. Membership in the DJSI is indicative that the company's management addresses future potential and is more transparent than are other corporate performance measures. As investor and community members insist companies act environmentally responsible in their activities, greater transparency will become the norm.

Supply chain demands in both directions for green procurement have ensured, for example, that green building technology manufacturers must themselves seek green product components. Green building industry participants must also 'walk the talk', and their purchasing policies, production processes and energy management, facilities, and water management need to be transparently green. Markets are increasingly watching for congruence between image and action.

Many companies will also be buffeted by changes in consumer preferences and demands resulting from increased awareness of climate change risks. If stakeholders can show that they are green and socially responsible, it can improve business efficiency, creating a different ROI equation where value adds become much broader than just energy savings. This issue has become so critical that most global corporations are issuing annual CSR reports, typically signed by the CEO. Approximately 44% (785 companies) of top 1,800 companies globally issued Sustainability Reports between 2005 and 2007. About 40% of the companies used external standards provided by the Global Reporting Initiative (GRI). Reporting practices varied by region but the trend is increasing.

Companies that do not participate in this collective greening process will find themselves left behind. Greening is a tactical move at this stage of the industry life cycle and the increasing number of corporations reporting on sustainability to their shareholders attests to this burgeoning trend.

4

Evaluating the Impact and Benefits of Intelligent and Green Building Technology

4.1 Convergence of Intelligent and Green Buildings

This research introduces the concept of improved intelligence to make buildings greener, provides an analysis of the current state of existing and emerging technologies in the building automation space, and outlines products and processes, as well as trends, which support this concept. The objective of this research is to identify and analyze what lies behind this concept, and then to examine what efforts are being made across the industry to achieve that objective. This research identifies the developments taking place on the technology front with the various aspects associated with building systems, and analyzes their implications for intelligent buildings.

Green Buildings

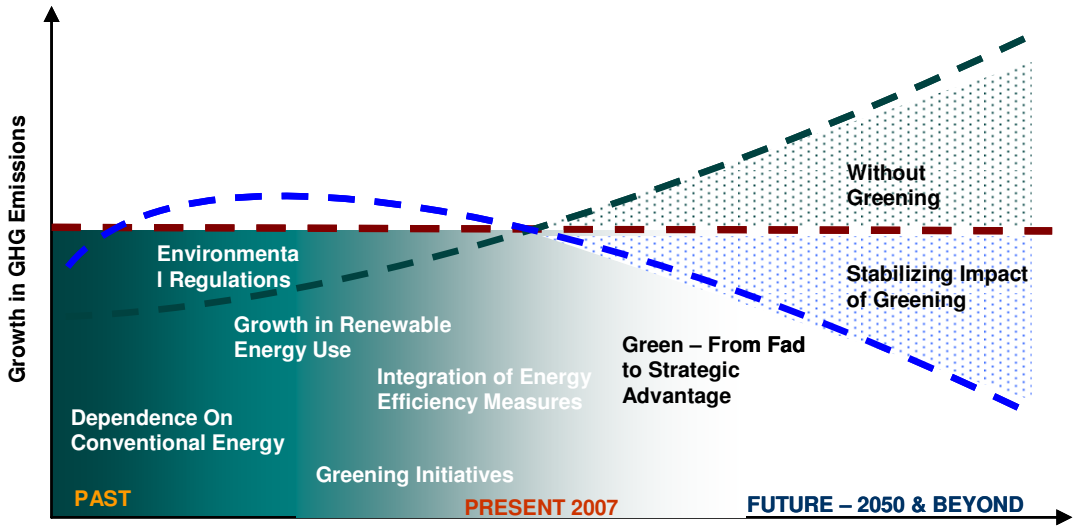
Green is a term widely used at present to describe buildings designed and constructed with minimum negative impact to the environment and with an emphasis on the conservation of resources, energy efficiency, and healthier interior spaces. Green buildings must meet the needs of the present generation without compromising the needs of future generations. Sustainable buildings are considered a step toward being green. Sustainability is measured in three interdependent dimensions: environmental stewardship, economic prosperity, and social responsibility; referred to as the triple bottom line. Social responsibility involves providing healthy communities and creating a safe work culture. [6]

Frost & Sullivan's report N321-19 on Evolving Trends in Green & Intelligent Buildings in North America found that what makes greening initiatives more pronounced and streamlined in this industry are the developments leading to the foundation of the Green Building Council in the United States followed by their affiliate regional chapters and the formulation of the LEED rating system for recognizing green and intelligent buildings. The market trend observed has a direct correlation to the

[6] For more details on definitions of Green Buildings please refer to Chapter 2.

burgeoning importance of green and intelligent buildings in North America. Emphasis on being LEED certified and the integration of energy efficiency measures in commercial, industrial, and institutional buildings across North America has influenced revenue and growth rate across these markets.

Chart 4.1 depicts the evolving status of the greening initiative in the North American industry



Source: Frost & Sullivan, 2007

Intelligent Buildings

An intelligent building is one that uses both technology and processes to create a facility that is safer and more productive for its occupants and more operationally efficient for its owners. It exhibits key attributes of environmental sustainability to benefit present and future generations. Each building is unique in its mission and operational objectives, and therefore, must balance short and long term needs.

A building is typically termed intelligent when the building's subsystems provide the occupants with productive and comfortable conditions by responding to their requirements and enhancing the workplace environment. The concept of an intelligent building originated when applying individual areas such as security, lighting, energy efficiency, maintenance, operation, heating, ventilation, air conditioning (HVAC), communication, and IT into a building, to give it an improved life expectancy that is smarter, more user-friendly, safer, more cost effective, and easier to maintain. Figure 4.1 shows the key benefits of intelligent buildings.

Figure 4.1 - What can be expected from Intelligent Buildings

Real Estate Value	Sustainable Asset Management	Environmental Effects	Ultimate Effects
Improved indoor air quality (IAQ), productivity, and occupant satisfaction Advanced capabilities to deal with "churn" (occupant turnover / evolving mission) Reduced future capital expenditures Higher resale value or lease rates	Optimized asset management and better space utilization Reduced cost for moves, adds and changes (MAC) Reduced capital costs including cabling, administration, training, and project management	Reduced greenhouse gas and carbon dioxide emissions Reduced energy and water usage Reduced construction and demolition waste Leveraged renewable energy technologies	Healthier and more comfortable building environment Improved long-term economic performance Sustainability- easier to maintain and built to last More competitive; “best of breed” procurement More efficient use of O&M

Source- Frost & Sullivan

Convergence of Intelligent and Green Buildings

Green and intelligent buildings have been getting increasing attention in North America due to their potential to reduce building energy costs, mitigate greenhouse gas emissions, reduce water consumption, and add value to the buildings given the savings and the positive effects on occupant safety, comfort, and satisfaction. Actions taken to reduce building energy consumption and minimize fossil fuel pollution will have lasting environmental effects given that most power-plant-generated energy in North America is supplied by fossil fuels (see chapter 3 for details). Processes, building and system design, and high-performance technologies are being sought to reduce energy consumption and mitigate the production of greenhouse gas emissions.

Figure 4.2 shows the mutual means adopted by intelligent and green building to achieve the same common goals.

Figure 4.2 - Mutual Means to a Common Goal: Convergence of Intelligence and Green Buildings

Common Attributes	Common Means	Common Goals	Ultimate Effects
More efficient use of O&M resources Provides a healthy and comfortable environment (IEQ) Improves long-term economic advantages and reduces future capital expenditures Incorporates efficient energy, water, and air technologies Improves adaptability for rapid and easy changes	Optimized asset management and better space utilization Commissioning, re-commissioning, M&V Integrated design process and the capacity for on-going collaborative design Innovation and best-of-breed procurement of products and services Performance contracting Integrated facilities management Leveraged renewable energy technologies "Green" loans	Reduce greenhouse gas and CO2 emissions Increase renewable energy supplies Reduce energy and water usage Involve less wasteful construction and demolition processes More control, exchange, scalability, reliability, transparency, and visibility	Healthier and more comfortable environment, occupant satisfaction, and reduced churn Reduction in energy usage, carbon dioxide emissions, and water usage, and cut waste costs Reduced future capital expenditures Sustainability: easier to maintain and built to last. Less resource utilization and more efficient space utilization Higher resale value or lease rates

The whole premise of convergence and intelligence buildings, as noted by industry experts, is that a building can have large number of sensors providing information but which then needs to be normalize so that information is available to decision making components of the system in order to take action. Convergence is about gathering information and making decisions based on it. Without a good, robust IP centric infrastructure, buildings can't do that. The fundamental objective is to get at all the data in a consistent manner. Many experts foresee that IT will win the control and value proposition side of a building while the facility building services will continue to provide the plumbing.

4.2 Introduction to Bright Green Technologies

Conventional buildings suffer from an inability to communicate and intelligently manage the large amount of data that they possess or generate. With the advent of computers, rapid efforts were taken to automate buildings to achieve remote monitoring, diagnostics, and centralized operation. These

resulted in benefits such as cost effectiveness, process improvements in facility automation, monitoring and management, and more efficient real estate portfolio management.

Legacy system incompatibility, outdated information, a lack of historical data, proprietary system architectures, and dysfunctional operating processes are some of the hurdles which have to be resolved. The following aspects are critical to derive full benefit from a converged network system:

- Integration of existing and new systems
- Design and development of real-time communications infrastructure
- Portal, dashboard, analytics, and control technology deployment

A bright green building is one that is both intelligent and green. It is 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. It provides timely, integrated system information for its owners so that they may make intelligent decisions regarding its operation and maintenance, and has an implicit logic that effectively evolves with changing user requirements and technology, ensuring continued and improved intelligent operation, maintenance and optimization.

In bright green buildings, fully networked systems transcend the simple integration of independent systems to achieve interaction across all systems, allowing them to work collectively, optimizing a building's performance, and constantly creating an environment that is conducive to the occupants' goals. Additionally, fully interoperable systems in these buildings tend to perform better, cost less to maintain, and leave a smaller environmental imprint than individual utilities and communication systems.

4.3 Converged Networks

A converged network solution allows a higher level of connectivity for a variety of products from multiple manufacturers. Using an IP network to connect all the key elements of building services and communication systems such as telephony, core networks, and their applications and wireless connections offers tremendous potential for cost savings and improved functionality.

The aim of this convergence is to bring rapid and quantifiable cost reductions in areas such as:

- Utility bill management
- Automated enterprise monitoring
- Facilities communications infrastructure
- Portal, dashboard, analytics, and control technology deployment
- Business process management implementation and improvement

Key benefits of converged networks include:

- Integration of “best of breed” products and technologies
- Better understanding and visibility over facility operations
- Sharing of information and data on a common platform
- Lower cost of upgrades
- Flexibility on vendors for upgrades
- Ease of O&M

Integrating intelligence is not only desirable, but is also becoming a mandatory requirement to provide clients the best solutions with the simplest connections to real-time data, Web-based data, and the corporate enterprise.

In the Frost & Sullivan report D631 “Intelligent Building Systems and Technologies”, the urge to satisfy the question "how close are we to having an intelligent building facility?" is driving experts from a gamut of areas to ‘integrate’ their expertise and devise solutions that cater to the successful implementation of this idea. Supporting this notion are the efforts toward connecting devices to the Ethernet or Internet, thereby proficiently tackling the issue of embedding network connectivity in devices. With device networking technology, it is possible to bring together all building subsystems into an efficient network by having networked electronic devices. Connecting electronic devices of the various subsystems in a building through an IP backbone is the core of Intelligent Building concept. All these findings are supported by the patents that are related to the building technology space. As can be seen, the developments in both the individual subsystems as well the effort to get them on a network with IT capability, indicates the inclination of the market toward accepting this concept.

4.4 Building Automation Protocols

A building automation protocol is designed specifically to meet the communication needs of building automation and the various control systems for applications such as heating, ventilating, and air-conditioning control, lighting control, access control, and fire detection systems in a building. The protocol, which is also used for networking subsystems, provides mechanisms by which information exchange can easily take place between the systems. Be it LonWorks or BACnet, which are the major building communication protocols present today, there is one thing for sure - both have large followings. This is evident from the fairly equal acceptance level for both that has been shown by the different players in the building automation market.

With standard protocols, integration of systems and devices can take new shapes. This is because device configuration becomes easier and the choice of devices and subsystems expands. Most intelligent buildings sense or manage several variables, or manage more than one building system, extracting greater performance than several disconnected building systems could achieve. Thereby,

some form of network, or integrated information system seems to be required for a building to be called "intelligent." Thus, open building automation protocols become an important piece of the Intelligent Building proposition.

BAS used to function in separate technology silos. But the building automation space is rapidly adopting Internet protocol (IP), Web services, and other technologies that are beginning to converge with traditional IT infrastructures. This is the migration path seen right now. Emerging standards are enabling data-sharing between building systems as well as with other business applications, improving efficiency and real-time control over building operating costs. Information security concerns, immature standards, proprietary technologies, and ignorance of the convergence trend among IT professionals are all slowing the pace of this migration. But now it's gathering momentum.

BAS typically include a network of sensors and other devices connected to controllers on each floor, a master controller for a building or campus, a Web server front end for monitoring building systems, and a back-end database for storing historical data. But as intelligence continues to move into actuators, chillers, security cameras, sensors, and other elements of building systems, these devices will increasingly communicate as peers via Web services, allowing BAS to be more flexible and integrate better with other systems. Building migration to IT is all about integration. A seamless integration is the ultimate aim that will lead to the fulfillment of the IB concept. The initiatives with integration need to address two areas--a need for standard network and a need for standard definition.

Currently, the benefits of closer integration between independent building services plus IT and communications systems promise a brighter future. The secret to addressing challenges lie in the "partner, learn, and solve" formula, which will bring the disparate IT-centric and building-centric worlds closer in terms of understanding the technologies that dominate each of them.

The kinds of companies that will be successful in the emerging aspects of this market include enterprise platform providers that have the product set that fits the need, the financial resources to go after the business and the desire and strategy to go and do it. Strategy is important because in some cases the company would want to leverage an IP approach; in others a building-centric approach. It could even be two different approaches with one customer, depending upon specific project approaches. This is more common with government customers than in private sector. Successful penetration of this market also requires initiative, resources and momentum from the IP side.

4.5 Building Automation System/Building Energy Management System

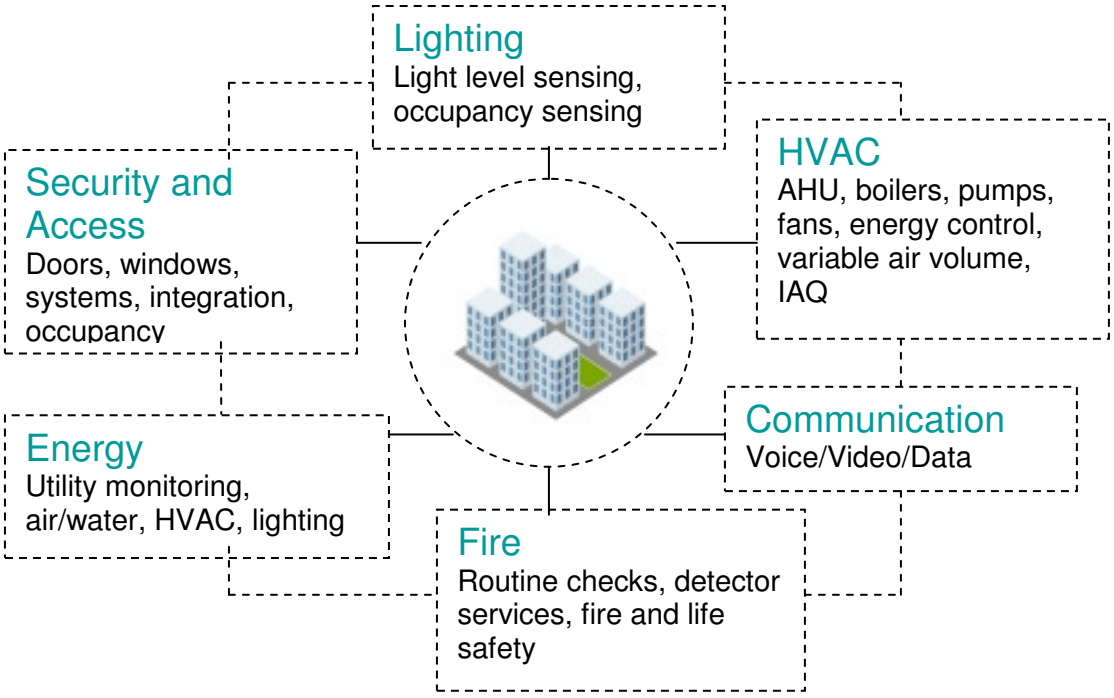
Building automation systems (BAS) and building energy management system (BEMS) are designed to provide centralized oversight and remote control of HVAC systems, lighting, and other building systems. In simple terms, BAS is a programmed, computerized network of electronic devices that are employed for control and monitoring of systems. It primarily aims at optimizing the performance, start-up and maintenance of systems and greatly reduces the interaction of mechanical subsystems in

the building. BEMS basically performs the same functions as a BAS but varies more in capability and functionality.

Both BAS and BEMS integrate all aspects of a system and take it right up to the user-interface level from where the operational activities in the various subsystems can be monitored. It is at the bus level, where data is taken from a device to the controller and then taken on the network, that there exists the option of choosing various building automation communication standards. They primarily aim at optimizing the performance, start-up, and maintenance of building systems. They greatly increase the interaction of mechanical subsystems in the building. This leads to improved occupant comfort, optimum energy consumption, and cost-effective building operation. All these can be done remotely or from a centralized system with a minimum human-in-loop factor.

Several areas that form the subsystems of a functional building and have to be addressed in order to achieve this 'ultimate integration dream' as in an intelligent building are shown in Chart 4.2.

Chart 4.2 – A typical Building Energy Management System



Source: Frost & Sullivan

BAS and BEMS are used to improve energy efficiency by monitoring the temperature inside and outside buildings and controlling the boilers and coolers. Essentially, they aim at optimizing energy consumption by employing a control strategy by integrating the various energy-consuming units. Energy management systems are helping building owners and operators reduce energy costs, while maintaining occupancy comfort.

A typical BAS/BEMS carries out the following functions:

- Optimum start/stop of systems
- Scheduling maintenance
- Predictive fault detection
- Generate alarms and preventive actions minimizing damage in the case of emergency
- Constantly monitor systems to detect abnormal operating conditions; take corrective decisions and bring the system back to normalcy

BAS and BEMS vary in capability and functionality, but typically consist of sensors, controllers, actuators, and software. Depending on whether a human-in-loop factor is involved, decisions are taken manually or by utilizing embedded intelligence such as decision-making algorithms. A critical component of these systems is the connection of the individual sensors and control elements.

Behind the success of a BAS and BEMS lie different types of control strategies. Some of the common control strategies employed include:

- Scheduling: It aims at optimizing equipment performance by automatically switching it on or off depending on a preset temperature. It leads to effective energy saving.
- Resets: A substantial amount of energy is wasted when equipment works at a greater capacity than required. Resets reduce the wastage of energy by resetting operating parameters. Examples of building control parameters that can be reset include supply-air and discharge-air temperatures for fan systems that use terminal reheat, hot-deck and cold-deck temperatures for multi zone HVAC systems, and heating-water supply temperature.
- Demand limiting: Load-shedding or demand-limiting is used to limit energy consumption by limiting the ability of equipment to load again once it has reached a preset point. Another way to minimize peak demand is to program time delays between the start-up of major pieces of electrical load equipment so that several pieces of equipment do not start simultaneously.
- Diagnostics: It is important to analyze the information associated with operating equipment. Online performance parameters give a real picture of operating performance of the device. Parameters such as temperatures, flows, pressures, and actuator positions can be used to monitor information. This has its effects in saving energy as that data will help to determine whether equipment are operating incorrectly or inefficiently and to troubleshoot problems. A thorough job of building diagnostics typically requires the building operator to monitor more points than the minimum number needed to simply control a building. This is provided by BAS and BEMS in the form of a continuous building diagnostics program.

Frost & Sullivan's report F856-19 "Green Buildings - A strategic Analysis of the North American Markets" explores how BAS and BEMS in green buildings can be used to drive performance and monitor efficiency levels for optimization. Their use particularly facilitates commissioning (in new

construction or existing buildings), and a new technology has been developed which allows open M2M communications, such as between different protocols and proprietary systems. Additionally, BAS systems in multiple facilities within a building portfolio can now be linked for more effective building management, as well as optimal asset management.

4.6 Optimization of Operations and Maintenance

Currently, buildings need to exhibit higher operational efficiency at lower cost with respect to factors such as energy consumption and operational costs, life cycle benefits, management of resources, and legislative requirements. The aim of an intelligent building is to provide operational excellence and ease in maintaining the functionality of individual system by continuously monitoring, diagnosing, and taking preventive actions with scheduled maintenance. With intelligent buildings, owners' operating costs are significantly lower as a result of more efficient operations and better control. Intelligent features of a building such as monitoring and control of energy-intensive systems such as HVAC and lighting can be measured for optimum performance and predictive maintenance needs, reducing both energy usage and operating expense.

With one unified approach to monitoring facilities, buildings can change the underlying infrastructure without radically changing the enterprise level reporting mechanisms. This allows building owners to have a heterogeneous infrastructure that creates more competition between vendors, begin to generate savings more quickly, and generate an ROI payback in two to three years rather than over the course of a decade.

To facilitate optimum management of O&M, an intelligent building connects various silo systems and applications, including:

- Facilities communications infrastructure
- Building automation controls system
- Energy management system
- Asset condition management system
- Business process and capital planning management system
- Work order system
- Portal system for remote monitoring

The goal is to provide executives, managers, and staff with information to make correct decisions depending on their individual roles and needs, on a real-time basis. With utility bills integrated into the enterprise asset management system, facility managers can further provide diagnostic information and present it to staff in the organization, enabling them to take immediate action instead of waiting until the end of the month before realizing the bill is too high. Facility managers would like to have the ability to mine data automatically and present it to corporate management and facility managers,

equipping them to take immediate action to reduce the energy consumption. In order to conserve energy, it is imperative to have proper information management architecture in place, which makes the information actionable and definable with the goal to manage portfolio enterprise and lower the cost of ownership, cost of deferred maintenance, operating cost, space utilization, and asset management.

4.7 Middleware-Integration Layer

Building controls have traditionally been divided into separate and disparate systems. With the increasing needs for automated buildings, these independent proprietary legacy systems have to be interconnected to deliver more intelligent capabilities. Large scale building owners typically have one of every system and protocol layer. To support intelligence, a building system has to provide an open infrastructure that supports real-time controls systems, enterprise applications and seamless flow of information. Middleware software integrates existing disparate systems and different control systems and provides a gateway portal that enables external vendors to manipulate the building control system remotely.

Middleware is a Web-based solution that populates enterprise applications, which can be remotely monitored to enable the integration and connectivity of a variety of products from multiple manufacturers. This open system has changed the way building automation is addressed and facilitates the information flow. Being able to access, monitor, and control data and equipment over the Internet has proved to be a very dexterous tool not only for building owners who have multi-site facilities and who intend to consolidated and manage their facilities themselves, but also for those who outsource facility management to other management companies. The interest level among end-users for remote monitoring and control is already high and is still likely to continue to grow. This integration layer provides great value to end-users who are able to integrate it into their existing infrastructure and leverage all of their assets already contained within the building. This adds further value to those end-users who cannot afford to replace their existing BAS controls infrastructure. Using a middleware layer allows building owners to choose amongst best-in-class vendors, resulting in a significant reduction in cost and time of deployment.

Frost & Sullivan's report F856-19 on Green Buildings, explores the potential of the device-to-enterprise, M2M (machine-to-machine or machine-to-man) market declaring it one of the most rapidly growing segments due to the number of devices and systems that need to be managed. For instance, Middleware Framework is an application development framework that allows companies to build Internet-enabled products for applications such as building automation, access control and energy management. Such programs help OEM manufacturers (such as Honeywell, Invensys, Trane, and Johnson Controls) create an easy-to-install and -configure end product that can communicate via IP networks and serve a rich user experience to a standard web browser. The report summarizes the concept of an open application development framework for smart devices as an entirely new segment, and because it is nascent, market size can't be estimated at this time. This product's emergence in the marketplace is similar to the transition from one-off, custom-built building automation and control operating systems and databases with other software infrastructure (15 years ago), to the operating

systems and databases that can be purchased today. Currently, as discussed in the Frost & Sullivan report F856-19 on Green Buildings, experts believe that the application of Middleware saves time and costs for development and reaching the market.

4.8 Advanced Network Infrastructure

Advances in networking technologies and the Internet have opened the door to a network-enabled world. Automated diagnostics supported by the latest sensors and control technologies can further lead to efficient building operation, as well as to an increased life span for the structure. As this information is also available at remote locations, there is the possibility of achieving predictive fault detection, timely diagnosis, and prognosis. This makes it possible to produce an intelligent building, which provides virtual control of every system from a central location.

The benefits of using IT infrastructure can easily be seen in areas such as data carrying ability and system visualization, and user interface. At the enterprise level, there is need for a common platform that serves as the integrated building management solution. Even at the network level, where the various building subsystems such as lighting, HVAC, security are "talking" to each other, IT serves as the data transporter, as well as a medium that can interpret the technical data into a more presentable form for understanding.

Extensible markup language (XML) and Web services are part of this networking proposition, as are structured cabling and the wireless infrastructure that form the foundation of the network. The dream of interoperability - true plug-and-play - requires that a common set of standards be adopted widely by the industry. Without data standards, convergence cannot occur in any significant fashion. The unique opportunity at present is the availability of a number of data standards that have been developed, primarily by LonMark and BACnet, and currently they are required to be utilized under new rules of convergence, principally to be based on IP, XML, and Web services.

A converged network system approach to monitoring facilities provides building owners with the ability to change underlying infrastructure without changing the enterprise level reporting mechanisms. This allows them to have a heterogeneous infrastructure that creates more competition between vendors. A heterogeneous infrastructure provides a vendor-free or a vendor-independent relationship for building owners.

4.9 The Integration Aspect of Independent Subsystems

Ideally, a building is termed intelligent when its subsystems provide the occupants with productive and comfortable conditions by responding to their requirements and enhancing the workplace environment. Thus, the subsystems of a building greatly influence the perception and measure of an intelligent building.

Frost & Sullivan’s report N321-19 on Evolving Trends in Green & Intelligent Buildings in North America revealed a snapshot of the current dynamics governing the correlated building technology

market segments that are influenced by dynamics in the green products and services market as illustrated in Figure 4.3.

Figure 4.3 provides a snapshot of the current market dynamics by segments.

Market	Size & Growth Trend	Key Imperatives
Energy management	$35.6 billion approx with forecasted CAGR of 6%	Characterized by participants such as utility affiliated ESCOs; EMS companies; equipment ESCOs Escalating back-up power demand; load management; energy efficiency; constrained budgets – key influencers Capital-inefficient peak load assets with T&D upgrades increases capital exposure for utilities – making EMS participation critical and responsive
Water reuse and recycling	$676 million approx with forecasted CAGR of 9.5%	Water reuse and recycling practices has increased momentum in municipal and industrial as well as commercial segments Four other "green" water recycling projects [are] in the pipeline, including one at the LEED gold accredited Solaire project that also commands 5%[percent] higher rent The building generates 25,000 gallons of useable water daily
Performance contracting	$8 billion approx[approximately] with forecasted[del] CAGR of 20%[percent]	HVAC equipment, building control systems, water meters, energy audits, PMC First cost issues has[have] enabled performance contracting to a key role in allowing companies to bypass the capital cost barriers, Potential cost saving – energy-50%; maintenance-20%; avoidance –30%
HVAC equipments	$8.5 billion approx with forecasted CAGR of 7%	Currently accounts for 40% energy usage in commercial buildings Manufacturers, seeing this as an opportunity to remedy, are incorporating efficiencies through improved compressor design, increased effectiveness of heat exchangers, change in refrigerants, etc Energy star program has been a major driver in sustaining demand for these markets
Zone controls	$80 million approx with forecasted CAGR of 6%	Wireless zoning products to gain widespread acceptance as intelligent building gain popularity Energy-saving benefits increases appeal to the energy-conscious user

Fire & security	$2.5 billion with forecasted[del] CAGR of 5%[percent]	Includes OEM size for detection, suppression, alarm, enunciation products Environmentally-friendly products and retrofits are key drivers – flouroketone products (zero GHG and ODP), though high price is a restraint
Indoor air quality	$500 million approx with forecasted CAGR of 5%	Includes entire gamut from changing air filters and purifiers to retrofitting entire HVAC systems Americans spend over 90% time indoors; insurance issue (SBS), IAQ products and services considered largest growth areas for AC contractors and consultants (60% inquiries result in remediation) As per WHO - 30% of all commercial buildings have significant IAQ problems – only 5% address them. Hence, potential market size should far exceed the actual size
Building automation	BAS Systems -$4 billion approx With forecasted CAGR of 5-7% across segments	BAS Systems – Energy Management Control Solutions; Facilities Management Systems; Central control and monitoring systems BAS Protocols – Proprietary; BACNet; Lonworks; TCP/IP; Although the industry is campaigning for open protocols, proprietary segment continues to account for a giant share of the market

Source: Frost & Sullivan

Building control has traditionally been divided into separate and more importantly, disparate systems. With an increase in the trend toward automated buildings, these independent, proprietary technology-driven legacy systems have to be interconnected to constitute an intelligent building. A large stock of buildings offers tremendous potential for integrating stand-alone systems and improving operational efficiencies. The main subsystems of a functional building must be addresses lighting, HVAC, security, fire and life safety, elevators, water management, and AV technologies.

Lighting

Based on the U.S. Department of Energy's (USDOE) estimates, lighting constitutes a substantial portion of the total energy load in commercial buildings, typically in the range of 30 to 35%. Up to 50% of this energy is wasted either by inefficient lighting equipment or careless lighting habits by end-users and sometimes by both. Lighting comprises the second largest energy load in a commercial building and historically is considered the least controlled, with burning hours far exceeding inhabited hours in a building.

Therefore, lighting serves as one of the basic and most challenging, areas to be addressed by an intelligent building. Among system integrators, consulting engineers and operations managers, there is a common understanding that lighting is one of the topmost areas for saving energy in buildings.

Lighting control devices such as occupancy and photo sensors provide a cost-effective and simple route to achieving energy savings.

An intelligent lighting system could serve effectively and productively to provide numerous functions, such as:

- Modification of light levels depending on specific tasks, individual preferences, through phone or computer
- Addressable control of each light fixture controlled through front end software
- Automatic switch on or off capabilities through an array of sensors or based on time schedule
- Optimize energy consumption by self-monitoring room occupancy and adjusting light to suit occupancy status
- Load shedding to reduce demand charges or overall building consumption in response to energy price spikes

Going beyond the basic premise that a lighting control systems is only used to switch lighting on and off on a timed schedule. Individually embedded software and hardware architectures enable lighting controls to control each fixture in a building by assigning it with a unique IP address. With virtually accurate information about occupancy status in a building, lighting control can provide valuable information to easily integrate with BAS systems, and further enhance the functionality of the BAS systems.

Dimming the lights at times of peak energy demand works favorably toward reducing the load of the building. Lighting also adds to the heat load in a building, necessitating a higher demand on the HVAC system of a building, so efficient lighting system also adds to energy savings by the HVAC system.

HVAC

HVAC controls are critical to providing optimum comfort to a building's occupants and are an inherent part of the building automation system. It is also a major area of energy consumption, so efficient handling of the resources will lead to optimum operation.

The contribution from thermal loads associated with the conditioning of the air from either mechanical ventilation or from infiltration can form a substantial part of the total energy budget associated with buildings. According to the USDOE, the energy consumption from HVAC systems accounts for approximately 40% of the total energy used in buildings, hence forms the primary target of property managers who try to save on costs.

The present competitive market for HVAC systems puts a great deal of emphasis on increasing the comfort of building occupants, while decreasing the energy required to maintain that comfort. Personal comfort is a high priority in the market these days in both the retrofit and new construction segments. Air quality, temperature, and humidity play important roles to productivity and are

controlled by setting proper intake and exhaust rates for fresh air that must adjust themselves to the constantly fluctuating conditions outside a building.

HVAC is an inherent part of the building automation system and together can provide the following benefits:

- Adjustable work temperature based on individual preferences
- Distributed control of the indoor comfort conditions at the zone/room level of the building
- Monitors temperature, air quality, air flow speed, and humidity to provide optimum operation facility
- Pre-engineered system optimization strategies to reliably reduce energy consumption

Building automation is no longer just a monitoring business. Instead, engineers and facility managers are looking to also manage and optimize the control systems. The conventional mechanical systems are rapidly being replaced with electronic controls that rely on the intelligence of sensors for increased accuracy and system performance.

Security

Effective security is one of the obvious solutions expected of an intelligent building. This can be achieved by identifying the different types and levels of security to be provided such as access control, surveillance, or intrusion. Again, interdependence, as well as cooperation, is the key to integrating a smart, intelligent, and proactive security system into an intelligent building.

Biometrics and access control are some of the most important security applications that will eventually find their way in the building automation space. Biometrics aims at developing automated methods for identifying occupants based on one or more physical attributes that are unique to every person. Physical attributes such as fingerprints, eye retinas and iris, facial patterns, and hand measurements form the measurement parameters. Even behavioral traits such as signature, gait, and typing patterns are used in the field of biometrics. Access control, with regard to buildings, specifically looks into physical access to a building and designated areas. It is an important system, since the identification of unauthorized personnel is an important aspect of any building. Technologies such as smart cards automatically scan an individual's presence in the building as that person passes through the main gate and internal entry doors. Such technologies take building intelligence to the next level. Most buildings benefit from the advances in all different security technologies, but the key lies in connecting them with the other systems at the enterprise level. A well-integrated building can operate more efficiently, save energy, and guide evacuation in case of unforeseen emergency situations.

Frost & Sullivan's report N3B3-62 on emerging IP enabled Video Surveillance market found that although analog cameras still dominate the video surveillance market at about 90 percent of the total but the advent of IP or Network cameras over the last decade represents the highest growth area for the market. It was expected that network camera installations would exceed analog camera

installations by now but the market failed to meet expectations, mainly due to the absence of infrastructure support, an unwillingness to put videos on the network, and the lack of storage capabilities. The market is growing steadily now, and the installation of network cameras is expected to account for nearly 50 percent of all video surveillance cameras in North America by 2013.

The growth trend in the surveillance market away from analog CCTV toward network based IP video surveillance is well recognized. What might not be as obvious are the dynamics of how the market is evolving and the opportunities that are available for IT oriented companies. Many of these opportunities are underexploited and could represent very good markets for IT and Telecom vendors, service providers and integrators. This could include the addition of new services, forming mutually beneficial partnerships or even developing new integrated technology solutions.

Fire and Life Safety Systems

Intelligent buildings can cope well with the increasing number of stringent codes and norms associated with fire and life safety systems. By achieving integration, facilities managers have more control over fire and life safety system. Rapid and reliable communication has become an essential part of the effort to ensure public safety during an emergency. In the past, fire alarm systems, public alert systems, giant voice systems, speakers, sirens and television broadcasts were used to notify groups of people about emergencies such as a fires, chemical spills, natural disasters, and evacuation orders. However, with the advances in telephony and IP technology, mass notification systems have evolved into a more robust solution.

Elevators

Elevators are yet another building system that needs to closely tie in with the other systems. When taking into account the security aspects, the elevators will be in communication with the security access system. Elevator operation can be controlled by electronic access methods such as proximity cards or biometrics access control. In the event of an emergency such as fire, or natural calamity such as earthquake, the centralized system will shut down its services to avoid use of elevators.

Water Management

Facilities' water management disciplines include water management, wastewater treatment and stormwater management in commercial and industrial buildings. Water-efficient technologies needed both indoors and outdoors combine water management measures with financial incentives for water conservation. Water management systems help building owners increase the overall water efficiency of the building by allowing them to manage, monitor, and control water usage.

Saving a million gallons of water from high-performance fixtures would be favorable to the environment and to water managers, but this may not save more than a few thousand dollars at existing water rates. However, use of water conserving fixtures will mitigate energy costs, that is, less water required to be pumped to bathrooms or less energy required to heat water, and these savings can be significant to control the ever-increasing energy expenses. Additionally, technologies that address energy efficiency, as well as provide other green building benefits, are being utilized, such as green

roofs, as a method of reducing both water and energy resource use that is increasingly being employed, and which also introduces green views to occupants. For example, Ford Motor Company's 10.4 acre green roof at the Dearborn truck assembly plant is the world's largest. Projections are that energy usage will drop by 7% as a result of the green roof, and the lifespan of the roof membrane will double to 50 years. As a stormwater management tool, the green roof is anticipated to retain 447,000 gallons annually, and will assist in the avoidance of capital costs in the range of tens of millions of dollars for a water treatment facility that is expected to be an EPA requirement.

Using water-efficient and reclamation technologies inside and outside of a green building can save water, pre-treatment fees, and energy costs, as well as potential building damage due to irrigation over-watering. These methods also reduce insurance risk, and mitigate municipal need for expansion. Optimal water management technologies also are energy efficient and provide building managers with methods for improved asset management (such as enabling central control of geographically disparate facilities) and enhancing property value.

AV Technologies

Innovations such as video conferencing, digital signage, and integrated controls for lighting and temperature are technologies merging with AV that serves to produce better picture quality for videoconferencing and also lead to integrated rooms and buildings that can improve comfort and user experience. For example, digital signage, also known as electronic billboards, delivers live and on-demand video streaming from a centralized location enabling end-users to reach a specific audience with specific information at a specific time. High Definition (HD) is another advancement in technology that enhances digital signage and teleconferencing experiences. Rich media is emerging as a platform for delivering customized and personalized experiences by connecting a variety of devices such as audio conferencing, video on demand, live video, video conferencing, and Web conferencing to the Internet. AV technologies also provide green benefits not only to a building, but to an entire company across all of its facilities by using the converged network to support teleconferencing and allow company employees in different locations to communicate by using videoconferencing as an alternative to physically traveling to a common location for meetings.

4.10 Communication Infrastructure and Sustainability Aspects of Integration

Intelligent buildings are typified by their innovative qualities, facilitated by the integrated design process. Building owners, developers, and managers are increasingly committed to providing better services to the tenants and occupants by way of increased voice, video, and data integration and communication, and these expanding capabilities not only offer better management of buildings and associated operational costs, but also enhance the well-being of the occupants. Real estate owners can take advantage of a fully converged intelligent information network to create virtual workspaces that provide more flexible and efficient work environments anywhere on the premise.

As technology and connectivity demands continue to spiral, communication infrastructures need to become more intelligent and robust to accommodate these changing needs. An intelligent infrastructure solution provides the foundation of a reliable and high performing communication infrastructure and a strong backbone to power the lifeline of an enterprise. This move requires interoperable, flexible, and open systems to ensure ease of operability in a building. A single platform that can control all these systems can propel growth in intelligent buildings, while also enhancing energy efficiency.

Communication (Voice/Video/Data)

Given the increasingly competitive business environment for real estate, the presence of value-adding network and communications technology may serve as a compelling differentiator in a market increasingly saturated with look- and feel-alike properties. Converged IP technologies, integrated into the conceptual or pre-construction phase of development, may not only increase the value of the property due to sustainability, flexibility, and operating cost savings, but may also be the means by which owners and managers gain a crucial marketing advantage.

A converged voice, video, and data network streamlines the asset allocation, tracking, and management process, which improves security and optimizes flexibility, and improves interaction and integration between the various individual IP-based systems.

Traditional network architecture requires costly and unsustainable construction, installation, maintenance, additional hardware, and waste in order to scale, add to, upgrade, or repurpose systems. In contrast, a converged communication solution complies with the project's original design and is future-adaptable to anticipate and respond to new technologies, process changes, and increased demand without major physical modification.

IP-based systems throughout a facilities infrastructure ultimately serves to not only save operating costs and minimize energy and resource usage over the life of the building, but to also cater services to the user's overall experience, add scalability and extensibility to enable and smooth systems evolution, and reduce environmental impact.

As technology advances, and as information and communication expectations become more sophisticated, networking solutions both converge and automate the technologies to improve responsiveness, efficiency, and performance.

Practically, the communication solutions provide:

- High-speed and quality Internet, as well as intranet
- Video and audio conferencing
- Satellite communication and distant learning
- Remote access to building systems
- Basic voice services such as telephone, intercoms, and television systems

- Single platform, whereby different subsystems can communicate and exchange data and make decisions

Intelligent buildings allow all types of users to not only improve efficiency and reduce operating expenditures, but also create opportunities for unique interaction between buildings and their users.

Structured Cabling, Wiring, and Patching

An intelligent infrastructure solution provides the foundation for a reliable and high performing communications infrastructure and a strong backbone to power the lifeline of an enterprise. The plethora of cabling for HVAC, fire and life safety, security, voice and data, and paging contribute a great deal of complexity to a building's cabling infrastructure. As the technology advances and as information and communication expectations become more sophisticated, networking solutions both converge and automate the technologies to improve responsiveness, efficiency, and performance.

There are several challenges facing IT and facility managers at present. These include increasing bandwidth and performance requirements, the need to utilize network electronics for as long as possible and to move to new technologies with the most minimal possible downtime and disruptions. In addition, there is the need to assist with the continuous requests for MAC to equipment and the environment, such as:

- More bandwidth
- Converging applications and technologies- from multimedia to VoIP to security
- More user policies and regulations
- More demands for flexibility

As technology and connectivity demands continue to spiral, communication infrastructure needs to become more intelligent and robust to accommodate these changing needs. End-users are demanding suitably designed cabling infrastructure, balanced with desired power and cooling thresholds that are reliable, interoperable, and scalable over time. These challenges arise as buildings integrate more sophisticated voice, data, and video equipment into applications.

A converged physical layer infrastructure can lower construction costs, optimize operational expenditures, and eliminate dealing with multiple contractors while simplifying the installation process to minimize potential system conflicts and reduce implementation timelines. The integration of these various applications benefits from a structured cabling system (SCS), providing innovative and less costly connectivity to these types of systems.

Top opportunities for improvement resulting from the induction of structured cabling in a construction or retrofit project are:

- Operational efficiencies
- Reduced infrastructure materials

- Reduced maintenance
- Increased productivity
- Real-time reports and monitoring
- Ubiquitous networking (best of breed)

By consolidating/integrating cabling from multiple stand-alone systems, material and labor inputs can be reduced, thus providing savings in initial construction costs. Empowering a unified team of professionals to implement the cabling process can reduce the time spent in project management. Integrating various systems to reduce complexity can enable quick service provisioning for occupants and tenants, resulting in ease of maintenance and configuration of various outlets and ports.

IP convergence is becoming a reality. The days of separate voice and data networks are becoming history. Adopting open system architecture can significantly increase the lifespan of significant portions of cabling infrastructure in a building, obviating extensive changes or expensive upgrades. Minimized upfront costs due to labor and material savings, increased lifespan and durability, and minimal maintenance costs are various direct/monetary benefits that can be realized. There are several additional advantages to IP convergence, including the relative ease of expandability and adaptability for rapid and easy changes involving minimal disruption, faster ROI, better utilization of installed cabling, and a lower total cost of ownership.

Wireless Applications

The growing support and acceptance of wireless technology has augmented the application of wireless sensors in areas such as building health condition monitoring, lightning, fire and life safety, and so on. Similar to any other developing technology, wireless devices have come a long way. In the future, development with regards to lower cost of sensors per area, as well as the ease of operating an array of wireless sensor-supported subsystems in a building space, will play an important role. Newly developed standards such as ZigBee give flexibility and ease of deployment of wireless systems, as they address the unique needs of remote monitoring and control, and sensory network applications. They also enable broad-based deployment of wireless networks with low-cost, low-power solutions. Wireless devices currently have the ability to run for years on inexpensive primary batteries for typical monitoring applications. Consequently, wireless applications would have a huge impact on installed price points, and opens up major new markets. An example is that wireless can reduce a 7-day installation down to 2 hours. Thus, the possibilities arising from wireless will have a huge impact. This factor is underestimated by most of the major market players.

The integration between building automation systems and a wireless communications backbone can deliver a complete building information management system with significant cost savings. As it costs less to get buildings automated when they are built with wireless network infrastructure, wiring costs can drop by up to 30%, allowing stakeholder's to justify enhanced sensing and control capability for the building. Wireless sensors are here to stay in the building automation world. The technological benefits associated with them cannot be underestimated. Solving the current issues of cost

effectiveness, proprietary solutions, reliability, and packaging, wireless sensor networks will enable building automation to reach new levels of functionality.

4.11 Energy Management Aspect of Integration

Intelligent buildings will help cut down energy consumption by optimizing usage. This is a definite advantage for building owners in terms of reduction in operational costs, as well as for the environment, as 'greener' buildings will help in reducing greenhouse gas emissions. Intelligent buildings manage the various energy sources such as oil, gas, and electricity in a manner that takes into consideration the associated fiscal factors such as soaring oil prices, fluctuations in the economy, and rising cost of operations.

A previous Frost & Sullivan study (A839-19)'s on Energy Markets Performance Contracting excluding green power and operations and maintenance contracts, gives about $4.09 billion for the Canada and United States market estimate for 2006. Including operations and maintenance contracts, with some green power, brings the estimate to $5.7 billion for the energy management market for 2006. Using the green building industry 25 percent compound annual growth rate (CAGR) thereafter, energy management industry revenues are estimated to reach about $12 billion by 2010 for these two countries combined. According to the U.S. Green Building Council and the National Environmental Education and Training Foundation, the green building market's 20 percent reduction in energy costs through applying energy-management principles and technologies would provide net savings valued at over $11 billion by 2010 in the United States. The green buildings sector (as measured by Leadership in Energy and Environmental Design - LEED - registration projections to 2010) is expected to grow 20-30 percent annually to 2010. The American Institute of Architects' goal to reduce fossil fuels in building construction in operations will help drive this enormous industry growth.

Metering, Monitoring, Measurement and Verification

Intelligent features of a building, such as monitoring and control of energy-intensive systems such as HVAC and lighting, can be measured for optimum performance and predictive maintenance needs, reducing both energy usage and operating expense.

Monitoring, measurement, and verification are important in analyzing the information associated with operating equipment. Because the data will help to determine whether equipment is operating incorrectly or inefficiently and to troubleshoot problems, energy saving will be greatly effected. One goal of integration is to transition from a fixed preventative maintenance posture to an event-driven maintenance 'best practice', where software checks the equipment continuously and runs diagnostics on actionable information.

Buildings are constantly exposed to the vagaries of nature. Time, aging of materials, excessive use of the systems, and poor maintenance are the other critical factors that take a toll on the life of a structure. Based on individual requirements of a structure, the type of condition monitoring can be

customized as the sensors and transducers available at present cater to a very wide range of issues, such as:

- Moisture detectors in the building structure provide timely information about health deterioration and can generate timely response
- Monitoring vibrations using seismic sensors for earthquake warnings and identifying effect of change in structural load leads to saving lives
- Monitoring current flow and temperature variations in building facilities such as conductors, switch gears, fuse panels, and transformers help in predictive maintenance and preventing failures

Technologies such as smart metering allow for demand response to be employed on the larger scale at the state and federal level, and on the smaller scale at the individual building level. The goal of a smart meter is to match consumption with generation. Energy tools in the past were unable to provide information on when energy was consumed. Currently, smart metering can be used to measure the information about energy consumption and tie it to different prices for consumption based on the time of the day and the season. A smart meter can be used to set pricing according to on-peak, mid-peak, and off-peak schedules. The smart metering provides real time prices for all users instead of a fixed pricing for the entire demand period. This technology encourages consumers to reduce their energy usage during high demand, high price times.

Demand Response

Demand response offers financial and operational benefits for end-users, load serving entities, and grid operators. These benefits provided by demand response include reduced utility bills and incentive payments earned by customers, market wide financial benefits that lower wholesale market prices, reliability benefits such as operational security and adequacy savings, and market performance benefits that result from mitigating the power supplier's ability to raise power prices above elevated costs.

Intelligent buildings can integrate and automate their building control system with demand response to monitor and control the energy usage within the building. This not only extends the building's ability to be fully automated and integrated, but it also can lead to substantial energy savings as the building controls can reduce energy consumption during peak periods. Demand response augments energy awareness, and then can offer feedback for the consumers on their usage behavior.

This combined automation in demand response can be defined in three ways. First is manual demand response, which involves turning off unwanted lights or equipment. The second is semi-automated response with a person initiating a pre-programmed demand response strategy. Finally, there is the fully automated demand response that does not use human intervention, but instead is initiated remotely at a facility through an external communications signal.

Load Shedding/Peak Shaving

Available technologies are used in intelligent buildings to automate the demand response system in order to detect the need for load shedding, communicate the need to participating users, automate the load shedding, and ensure compliance with the demand response programs. These technology processes can turn off or shut down particular appliances such as heating, air conditioning, or refrigeration. Direct control technologies that allow the electric company to automatically control air conditioning during peak demand is likely to ultimately benefit the user, because they delay consumption until after peak period demands.

Smart Metering

Smart metering technologies allow DR programs to be employed on a much larger scale, beyond individual buildings. The goal of a smart meter is to match consumption with generation. Energy management tools of the past only tracked how much energy was consumed, but were generally unable to provide information on when that energy was consumed. Smart metering can be used to track information about energy consumption, including when it is consumed, and tie it to different price points based on the time of the day and the season. A smart meter can be used to set prices according to on-peak, mid-peak, and off-peak schedules and can provide real-time prices for all users, rather than fixed-rate pricing for the entire demand period.

This technology encourages users to reduce their energy use at high-demand, high-price times, resulting in reduced peak-time load factors and better use of total generating capacity. DR programs also allow utilities to manage supply and demand of power more effectively, reducing the need to access high cost spot power markets during times of peak demand.

Smart Power Grid

Another advancement in the energy production and distribution industry is the smart power grid. A smart grid uses modern communication and computing capabilities to upgrade an electrical grid to make sure that it works more efficiently, reliably, and safely, which can save consumers money and reduce carbon dioxide emissions. For example, Hydro One has a smart grid program for its residential customers where it provides programmable thermostats and, in exchange for reduced energy rates, has the ability to adjust air conditioning temperatures automatically during peak periods, giving the company better control over demand during peak periods.

The smart grid allows power generators and customers to interact in real-time, which reduces the cost to generators by helping to eliminate the peak fraction of demand, decreasing wear and tear, and extending the life of equipment, and allowing users to put their needs first to get more out of the systems.

4.11 Analysis of New and Retrofit Intelligent and Green Buildings

Although much of the focus in the green and intelligent building industry to date has been on new construction, the potential for exponential growth is seen to reside in the existing buildings sector due to the relative industry size. The existing buildings market is where the real energy is consumed, and

is the source of the real measure of buildings' environmental footprint. The ratio of the number of people working in existing buildings and new construction in the United States is about 85:1. Given the effects of greening buildings on productivity, the potential economic benefits of greening the existing building stock are likely to be significant in the current economic environment, where corporations are on the lookout for any cost-effective means of enhancing productivity.

Furthermore, with the current slow down in new construction, there will be fewer short term opportunities for new developments. As a result, the intelligent and green building industry must expand its efforts, targeting existing buildings where there are still significant opportunities for growth. The amount of capital being invested in real estate is decreasing and the price appreciation of buildings has slowed or come to a standstill in many markets, changing the business model for property owners, forcing them to optimize operational efficiencies. A new USGBC portfolio program for existing buildings is being piloted that has the potential to reduce operating costs significantly without the need for certification.

The focus on facilities' energy consumption is driven by the impact this has on the bottom line and the need to find ways of coping with highly volatile energy prices, which have constrained facility management budgets and limited their ability to continue with planned expenditures on maintenance and building repairs. The other challenge for existing buildings is that they operate according to the status quo, but a major building retrofit, using energy models to help finance upgrades and retrofitting, will change this scenario. Performance contracting models can be used as an innovative way to finance the retrofits without significant cost or risk to the building owner. The anticipated rise in energy costs is likely to increase ROI for the performance contractor (PC), resulting in a win-win situation for PC companies and the building owners. In a new construction building, the challenge lies in committing hesitant architects and engineers that often remain entrenched in using legacy systems to adopting intelligent technologies.

4.12 Commissioning and Re-Commissioning

Commissioning is a quality assurance method of optimizing the functioning of new construction and existing building commissioning can provide a return of four times the investment through operations savings over five years. It can take place in the year following new construction or in an existing building (retro- or re-commissioning). Project design, installation, operations, and maintenance are tested and managed to enhance energy efficiency, indoor environmental quality, and occupant health and comfort. A comprehensive system involving field testing, maintenance plans, training, oversight, and monitoring also mitigate operating costs and business risks.

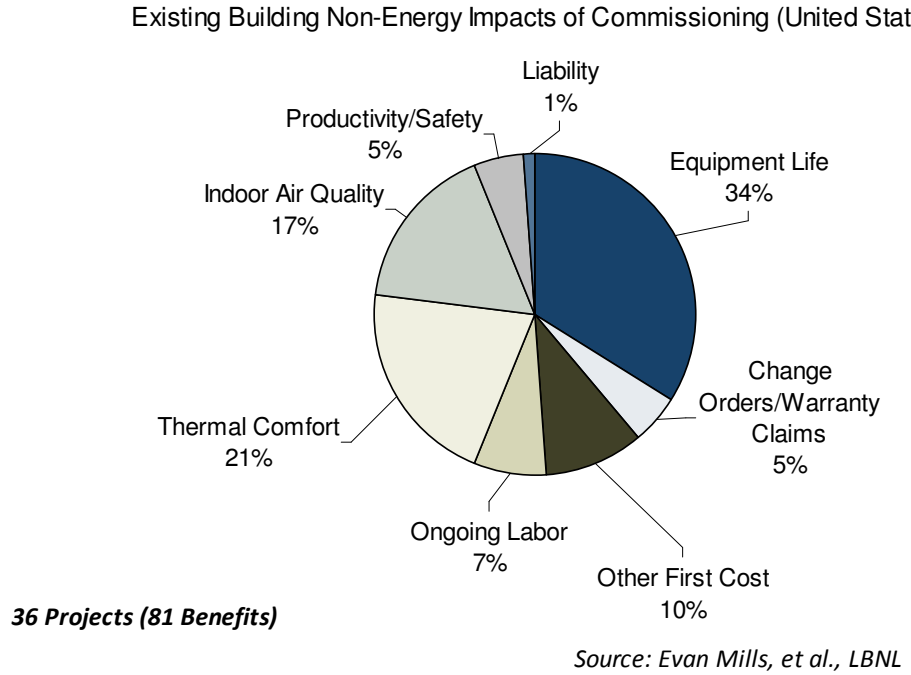
For new construction, the market participants have found that creating an energy-efficient design at the outset is less expensive than installing more costly, high-tech solutions later in order to solve the problems engendered by an inefficient design. First cost issues arise where buildings were not designed to be green *a priori,* and the Integrated Design Process could not be implemented at the outset. The Integrated Design Process entails gathering all stakeholders together from the beginning

(for example architects, building contractors, maintenance personnel, and appraisers), as each of them has a role to play in influencing the design. Although markets have perceived a first cost increment to new construction for high-performance buildings, it seems that this incremental cost decreases with the experience and previous teamwork within the design team and their commitment to engaging in the Integrated Design Process from the outset.

There is a growing need for enhanced IEQ measurements, monitoring and controlling of CO2 levels, as well as performance monitoring of air changes. HVAC usually presents the biggest opportunity for improvement in existing buildings in terms of addressing energy use and reduction. Additionally, employing energy saving technologies, such as a fully implemented energy management controls system for re-commissioning, can lower consumption significantly. The non-energy benefits of commissioning of both new construction and existing buildings have a major impact on building performance and occupant comfort. Since occupant costs command the greater proportion of building life cycle costs in owner-occupied buildings, enhancing occupant productivity in high-performance buildings (even measured through reduced absenteeism and illness) leverages major savings, which can pay for the retrofits.

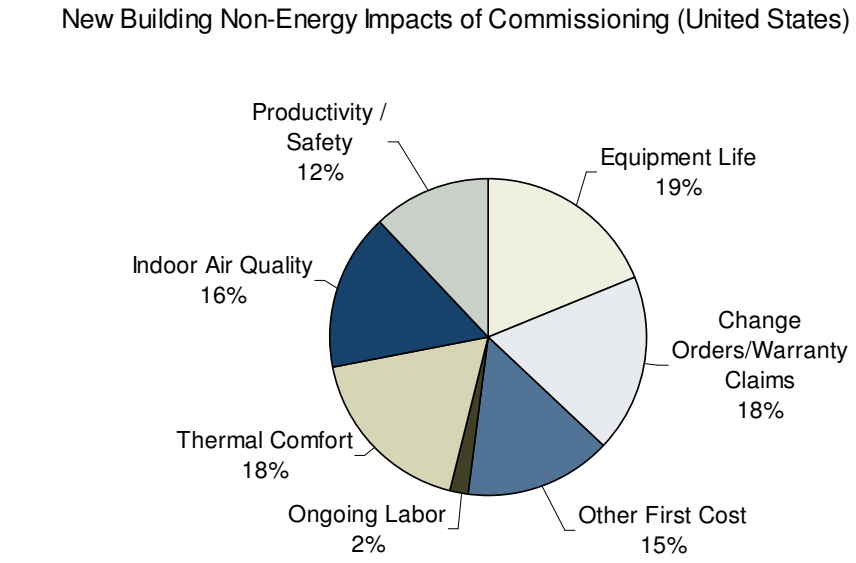
In existing buildings, the industry needs to benchmark economic benefits against higher performance facilities to ensure that as much benefit as possible is derived from retrofitting and upgrades. Chart 4.2 and Chart 4.3 examine the non-energy impacts of commissioning on both existing and new buildings.

Chart 4.2: Non-Energy Impacts from Commissioning on Existing Buildings



Source: Evan Mills, et al., LBNL

Chart4.3: Non-Energy Impacts from Commissioning on New Buildings



Source: Evan Mills, et al., LBNL

A growing strategy among building consultants and integrators, is to approach a portfolio of real estate such as hospitals, corporations, or campus', by going into the buildings and re-commission it to get the energy system back to optimal performance and at the same time make some technology amenity upgrades to be able to monitor all those systems. This enables managers and operators to control and operate each building from a central building operations center. This requires the use of IP protocols and networks which ultimately also reduces the labor cost involved with monitoring the systems. REED is an example of using this approach to lower their property management cost. In an HVAC controls systems there is a series of controllers and at the top level is basically being connected back to an IP network using category 5 or 6 cable with IP protocols as you get closer or deeper to some of the equipment like the sensors are connected in different ways but at least at the top level is connecting back to an IP network.

Performance Contracting

Performance contracting is a way to finance and implement capital energy improvements and is a service offered by qualified energy service companies (ESCO), which facilitates greening through operating budgets. Typically, owners and energy managers have been reluctant to spend on energy efficiency upgrades due to concerns about payback, and want to avoid issues related to the budget dichotomy of purchasing a capital asset that benefits operating expenses. Performance contracting is a potentially viable platform to overcome first-cost barriers to going green for existing buildings. In addition to the incentives to go green that arise out of productivity increases, an owner or energy

manager can utilize performance contracting, which has been found particularly beneficial for government building energy managers.

Performance contracting can allow a manufacturer to pilot a technology where the customer (such as a city government) is risk averse to trying new technologies. Performance contracts, offered by qualified energy service companies, typically include:

- Energy-efficient HVAC equipment
- Lighting systems
- Building control systems
- Variable speed drives
- Water efficient upgrades
- Energy and efficiency audits
- Project design and engineering
- Project management
- Inspection and verification

Frost & Sullivan's report N321-19 on Evolving Trends in Green & Intelligent Buildings in North America revealed that the market segments that will be worth watching out for over the next few years are the Performance Contracting and Integrated Facilities Management markets. Both these segments are poised for some aggressive growth over the next 5-7 year period. The Performance Contracting Market in North America is currently worth $8 billion and is projected to growth at a compound annual growth rate (CAGR) of 20 percent. Facilities management, worth $20 billion, is projected to grow at a CAGR of over 10 percent. There is little likelihood that first cost issues will easily neutralize, and this is expected to keep the Performance Contracting market thriving, as it provides a more cost-effective route to greening. And as building management systems gets increasingly complex and technically integrated, added to the already pronounced energy efficiency concerns, owners and occupiers will inevitably resort to Integrated Facilities Management (IFM) and Operation and Management (O&M) outsourcing, thus keeping the demand sustained.

ESCO activities show that lighting tends to be the most emphasized energy efficiency measure utilized, followed by comfort conditioning HVAC. These projects are favored, because they have shorter payback periods than other retrofits and they are less risky as they can generate significant energy savings in a short period of time. The majority of states have already enacted laws that authorize performance contracting, which encourages green developments in the government sectors.

Building Modeling

Computer modeling of building designs prior to the start of construction can greatly help in planning the whole process and the incorporation of various other technologies required in the building. This

way, clients using the building can perform various customized improvements to their portions of the building. Energy modeling is utilized during the design concept stage using sophisticated computer software to predict the annual energy consumption of a proposed building. The main objective of energy modeling is to identify the energy saving opportunities and obtain operational cost predictions, for new and retrofit projects. Using modeling, clients can experiment with various options and improvements, which allow them to assess ROI opportunities and make informed decisions regarding technologies and processes.

Life cycle benefits of adopting green technologies significantly outweigh the additional initial cost associated with green buildings. Savings are based on energy modeling and match the benefits with the capital costs. Energy modeling also provides a proper operating budget to predict what the budget will be for a new or retrofitted building. In case there is a shortfall, then the developers are typically obliged to make up the difference.

Energy models are used to typically benchmark against the ASHRAE 90.1 standard and in Canada the model national energy code for buildings (MNECB), which is the Canadian equivalent of ASHRAE Standard 90.1-1999.

5

Green Measurement and Rating Systems for Buildings in North America

5.1 Introduction

Induction of intelligent products and technologies in new or existing buildings can enhance energy efficiency in buildings, reduce operating costs, and the burden of environmental dependency of buildings, thereby making them greener. While product and technology vendors are introducing innovative concepts into the marketplace to demonstrate these tenets, it is ultimately important to obtain appropriate 'sustainability labeling and rating' on these endeavors for such initiatives to take on a mainstream proliferation. At the same time, it is important to ensure that such labels and ratings reflect the true characteristics and capabilities of such technologies and how they impact the dynamics of these buildings from a long-term consideration.

Currently in North America, the prominent measurement and rating systems for new construction and existing buildings are:

- LEED® rating system by the U.S. Green Building Council (USGBC)
- GreenGlobes™ tool of the Green Building Institute (GBI)
    - Building Owners and Managers Association (BOMA): Canada uses the Green Globes tool as the basis of its Go Green Plus certification program
- Energy Star® program of the United States Environmental Protection Agency (USEPA) and the United States Department of Energy (USDOE)
- SBTool™ (2007) of the International Initiative for a Sustainable Built Environment (iiSBE)
- Building Intelligence Quotient (BIQ) Tool of the Continental Automated Buildings Association (CABA)

This analysis discusses the influence and advantages these rating systems can potentially represent for intelligent building technologies, and how they can be better positioned such that the potential of these technologies are fully illustrated for industry-wide acceptance.

Prospects for Intelligent Solutions

By enhancing connectivity between building systems and users, intelligent products and technologies help to balance operational objectives and the economic performance of buildings with due emphasis on scalability and changing priorities. These products and technologies, and the buildings they retrofit and sustain over time, stand to benefit from green measurement tools such as those named above in reaching out to the larger marketplace for confirmed acceptance and propagation. Results achieved through the deployment of intelligent products and technologies in buildings make such intelligent solutions imperative to the success of a building's environmental profile and increased adoption.

Active and Passive Designing Measurement Systems

The industry is currently witnessing a significant incorporation of standards underlined in green measurement systems into building codes and design standards. However, accreditation of performance improvement integrating both passive (social and resource based) and active (information and control based) intelligence of buildings together is an aspect yet to receive consensus from all exponents.

A key objective of this research is to explore a more comprehensive middle ground in which the alternative propositions of intelligence and green can be considered and consolidated, delivering the best of both. To this effect, an analysis of these rating systems and their implication on building intelligence is being discussed in his section to explore a modality for their mutual convergence.

5.2 USGBC's LEED® Rating System – Key Highlights

In 1998, USGBC undertook the task of developing and thereafter administering the LEED family of rating systems, focused on appraising sustainable building achievements with an integrated "whole building" approach. This approach combines design, construction, and operation aspects of a building to arrive at an aggregate performance quotient that would render it as a sustainable building or project, where key issues addressed include site, water, materials, indoor environment, and energy.

Ever since the pilot version of LEED-NC (v1.0), pertaining to new construction, was introduced in 2000, the LEED system has become synonymous with sustainable design not only in the United States, but across other countries that have developed Green Building Councils to represent local dynamics. In the commercial building arena, one indicator of the exponential rise of green building practices is the widespread adoption of the LEED system. Clearly some of the reasons for this strong popularity are inherent to the core tenets of the system itself, which includes:

- Consensus-based approach with scope for incorporating stakeholder reviews
- Timely resource for public bodies to reduce inefficiencies in their existing asset-base
- Pioneer for its time - no alternative system addressed as comprehensively what LEED did at the time it was instituted

Overview of LEED

The LEED for New Construction Rating System is essentially a point-based system recognizing a building's overall energy, resource, and environmental performance. Using a 69-point scale (100 points starting in 2009), the system assesses the sustainability of a building by incorporating regionally weighted credits, among others, thus taking climatic and geographical implications into account. The LEED product portfolio is depicted in Chart 5.1.

Chart 5.1 – LEED Portfolio, USGBC, 2008

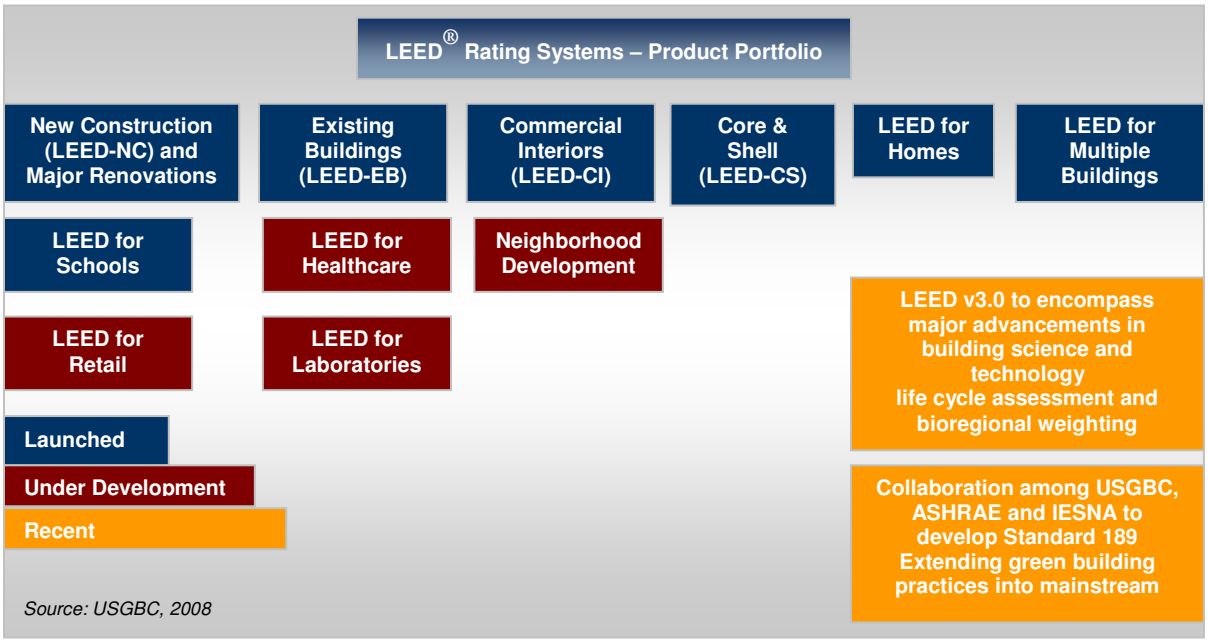


Figure 5.1 depicts the points attainable under various categories of LEED-NC and the range of points that can be acquired under each. The minimum 26 points to achieve the lowest level of LEED certification can be earned using a variety of potential points from LEED's rating system checklist.

Figure 5.1, LEED-NC Categories and Applicable Points, USGBC, 2008

LEED -NC Categories	Current Points/Proposed v3.0 -2009
Certified	26-32 (40-LEED v3.0 -2009)
Silver	33-38 (50-LEED v3.0 -2009)
Gold	39-51 (60-LEED v3.0 -2009)
Platinum	52-69 (80-LEED v3.0 -2009)

Source: USGBC, 2008

Some of the significant announcements include fundamental infrastructure improvements across LEED rating systems, a new LEED for Existing Building Operations & Maintenance (EBOM) Rating System (v2008), free LEED–EBOM registration for New Construction as well as Core and Shell certified projects, and optimized energy credits to reduce a building's environmental impact. The USGBC opened the first public comment period on LEED 2009 in May of 2008. New inclusions cover

an increase in threshold points available from 69 to 110 (as depicted under Figure 5.1), LCA-based point weightings, credit alignment across rating systems, a new mechanism for incorporating bioregional credits and improvements to LEED Online.

Industry Acceptance & Desired Market Positioning

The idea of leveraging intelligence to enhance building performance, either for energy efficiency or occupant comfort, and thereby obtaining credits is acknowledged by USGBC. "The credit system under LEED is geared to recognize building performance that has been enhanced by automation and IT-centric intelligence," states USGBC. The ability to track utility use in real-time basis provides a point in the new construction certifications, and increases the ability of the project team to document compliance with LEED-EBOM. Similarly occupant comfort and air quality can be documented through having a centralized system installed to enhance operational performance, and ultimately ensure LEED certification down the road. LEED-certified new buildings can record information into an environmental monitoring system for the measurement and verification (M&V) credit.

Though the level of prescriptive requirements may not be enhanced, USGBC admits that it will continue to raise the bar on components such as energy efficiency, materials use, and location and density issues, among others. At present, LEED's veracity stands on the fact that high-performance and environmentally sound structures can endure the realities of the marketplace and advocate the fact that intelligence ultimately leads to efficiencies and long-term viability of projects.

For better positioning, the energy credits in LEED can be restructured such that carbon emissions are taken into consideration even more so than the re-weighting in LEED 2009 (which emphasizes credits that help prevent carbon emissions). This will require more detailed information on product life cycle from manufacturers and suppliers involved in the process. Typically, operations-related impacts account for over 80% of life cycle impacts in buildings. LEED 2009 is expected to address the resources going into product manufacture, transport, installation and maintenance for building assemblies. The perception of LEED certification should be enhanced in favor of value associated with long-term ROI from building green, rather than allowing it to be dampened by costs.

Finally, USGBC maintains that innovative demand side management strategies including addressing issues such as thermal storage and backup power are necessary to relieve the stress off our utility grids. This certainly calls for better monitoring and intelligence capabilities in building, thus substantiating that by incorporating intelligence, buildings will be capable of delivering to LEED specifications.

5.3 GBI's Green Globes ™ Rating Tool – Key Highlights

The Green Building Initiative (GBI) is a non-profit organization involved in the propagation of sustainable building approaches for residential and commercial construction to create energy-efficient, healthy, and environmentally sound buildings. In 2004, the GBI adopted the Green Globes rating system through an agreement with a Canadian commercial building assessment tool, based on the

Building Research Establishment Environmental Assessment Method (BREEAM). The GreenGlobes tool, which the GBI purchased the rights to distribute in the United States in 2005, is "interactive, flexible, and affordable, and provides market recognition of a building's environmental attributes through third-party verification." (BREEAM)

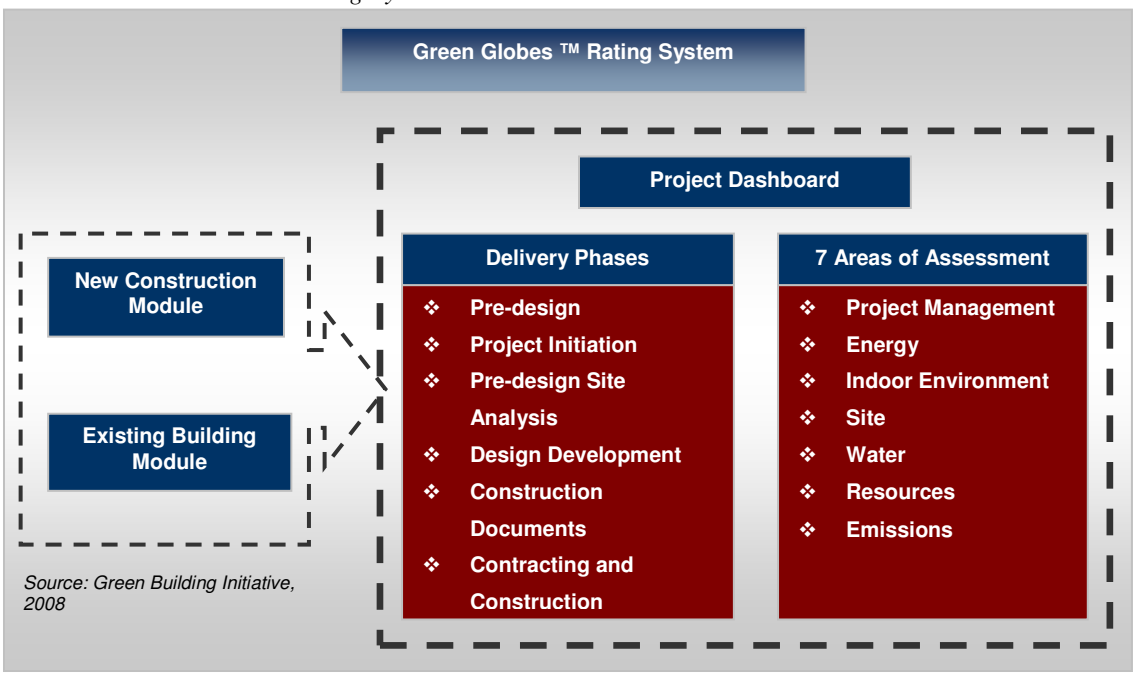
As a tool for building guidance and assessment, Green Globes "integrates a consensus-based, comprehensive environmental assessment protocol, software tools, qualified assessors with green building expertise, and a rating/certification system." (BREEAM) Some of the key advantages of the tool include:

- Uses a comprehensive 1,000 point scale for assessing environmental impact across multiple categories
- Life cycle assessment credits enables an understanding of ecological impact of resources used
- Opportunities to earn from one to four Green Globes makes it suitable for a wide range of construction projects and existing buildings

Overview of GreenGlobes

Green Globes has been developed through continued research and technical reviews by the GBI technical committees, which follow American National Standard Institute (ANSI) protocols. The GBI's Green Globes system includes an assessment process, a rating system and a guide for integrating environmentally friendly design into buildings and continual tracking for new and existing buildings. Projects are awarded points based on their performance in seven key areas of assessment under each module. This project dashboard is divided into seven project delivery phases, with each phase further subdivided into seven assessment areas as depicted in Chart 5.2 below.

Chart 5.2: Green Globes Rating System



Completing an online questionnaire yields a detailed report at each stage, in addition to which project design suggestions aimed at reducing the building's overall environmental impact are offered. Official accreditation is obtained through the submission of required project documentation as well as a project walk-through by regional reviewers. Projects are awarded a final rating of one to four Green Globes based on cumulative point totals as depicted In Figure 5.2. In Canada, the ratings range from one to five Green Globes.

Figure 5.2: Green Globes Tool – Ratings Summary

Green Globes Awarded	Ratings based on Cumulative Points (%)
One	35 to 54
Two	55 to 69
Three	70 to 84
Four	85 to 100

Source: GBI, 2008

Since its introduction only three years ago, the system's user-base has grown significantly with several federal agencies and 14 US states recognizing Green Globes as an essential tool. GBI began by introducing the New Construction module in the United States and later added a module for the Continual Improvement Tool for of Existing Buildings, which already has a successful track record in Canada.

The BOMA in Canada has adopted GBI's Green Globes tool as part of its 'Go Green Plus' program that works as a benchmarking tool to recognize environmental best practices in existing buildings. Go Green Plus is a detail-oriented program that delivers quantified reports on a building's performance, as well as providing very specific questions such as intensity and type of energy use, monthly water consumption and conservation achieved, maintenance schedules, evidence of moving towards targets established, etc. that enable the building manager to look at the components needed to achieve the benchmarks.

Industry Acceptance & Desired Positioning

As a consensus-based standard, created through the involvement of organizations such as the ANSI, Green Globes highlights the fact that careful technical analysis has been taken into consideration to ensure the standard reflects best practices and current trends in the industry.

One of the strengths of the Green Globes system is that it originated in the analysis and the greening of existing buildings, which is one of the biggest challenges faced by the industry globally. Through the involvement of BOMA, who administers the Green Globes system as part of their Go Green Plus Program in Canada, provinces such as Ontario in Canada are using it on the basis of retro-fitting and giving grants. GBI has a memorandum of understanding with BOMA International and has also signed a partnership with the Environmental Protection Agency's (EPA) Energy Star program for benchmarking both new construction and existing building projects.

Green Globes recognizes the impact of construction to the life cycle value of community development through several points awarded for projects. The LCA tool provides detailed impact assessments of building materials in terms of carbon emissions potential, fossil fuel depletion, pollution to air and water, and weighted resource use. In order to design the Green Globes tool more effectively it is important that specific requirements and targets be associated with the assessment process for operational performance. There should be guidelines and stipulations for areas such as energy reduction and use of renewables to achieve measurable reductions in carbon emissions.

As an alternate tool in the market, it does provide clarity over some issues that it addresses better and will perhaps continue to prompt reviews and revisions in competing tools to emerge with more clarity and effectiveness, going forward.

5.4 iiSBE's SBTool™ - Key Highlights

The International Initiative for a Sustainable Built Environment (iiSBE) is an international, non-profit networking organization created to improve the energy and environmental performance of buildings through research and policy. The board represents members from 16 countries and the organization is based in Ottawa. The organization's principal projects include a multilingual Sustainable Building Information (SBI) system, a Sustainable Building Tool (SBTool), and a database of research and development materials submitted by member organizations.

The SBTool is an assessment checklist which provides a means to assess building performance and is tied into regional climate zones, local building codes, and international standards. This system establishes a weighting system for regional parameters such as climate and occupancy. Some of the key highlights of the system as stated by the iiSBE are discussed below.

- A generic framework and toolkit assisting local organizations in rating building performance
- Scope can be modified to be as narrow or as broad as desired, ranging from 6 to 145 criteria
- Weight and parameters addressed can be adaptable to local needs

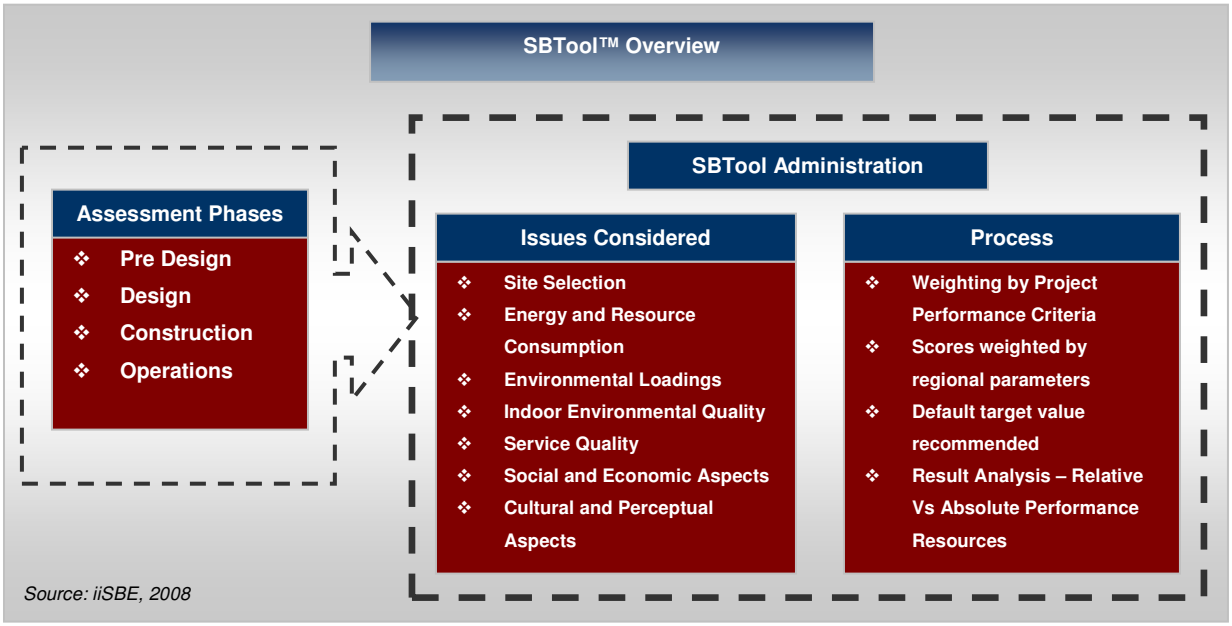
The system permits assessments to be carried out at four distinct stages of the life cycle and provides default benchmarks suited to each phase. Local organizations can select up to three building types out of a total of 18, and apply them separately or in a mixed-use project.

Overview of SBTool

The current system applies to the design phase of a project and includes up to 18 building types, and can be adapted for use by any size project in new construction or in existing building assessments or renovations. There are four distinct phases through which assessments are carried out using a different mix of data for each. These phases include Pre-Design, Design, Construction and Operations. The iiSBE recommends that the projects should be occupied for a period of at least one year before an Operation assessment is carried out. Project teams develop benchmarks through a review of local regulations, analysis of local building performance, consensus by local experts, and regional climate

analysis. SBTool only becomes a rating system when an audit is provided by a third-party reviewer, chosen by the project team or provided by iiSBE. Chart 5.3 gives an overview of the SBTool.

Chart 5.3: Overview of the SBTool



The administering of the SBTool follows the following process:

- Seven main issues are considered covering site selection, energy and resource consumption, environmental loadings, indoor environmental quality, service quality, social and economic aspects, and cultural and perceptual aspects.
- Each issue is subdivided into many categories and criteria. Project performance by criteria is weighted as deficient, minimal, good, or best practice. Criteria are scored according to the following scale:
    - Deficient (-1); Minimum acceptable performance (0); Good practice (+3); Best practice (+5)
- Category scores are weighted by regional parameters. The total score is affected by the regional factors determining design parameters.
- A default value is recommended for each criteria, providing the basis for a green building performance target.
- This tool provides a results analysis which indicates the relative and absolute performance of the project as acceptable, good, or best practice as shown above. These scores reflect comparisons to local benchmarks, as well as international benchmarks for sustainable building practices.

- Cultural assessments, development of projects for accessibility, and the assessments of economic impacts of construction on communities extend the parameters of sustainable design beyond building performance.

SBTool is developed and renewed on a regular basis, primarily at the biannual technical meetings, by members, as well as through continued research initiatives led by the organization.

Industry Acceptance & Desired Positioning

As a tool to provide assistance to local communities developing their own rating systems, the SBTool is designed to acknowledge national, regional, and bioclimatic differences. Users can adjust the weighting of strategies based on specific national or regional priorities, as well as local climate data.

While the comprehensive nature of the tool with comparable international relevance and local sensitivities cannot be overlooked, the SBTool remains a toolkit with few prescriptive requirements for achieving reductions and conservation as far as energy, water and waste, renewable energy and materials, etc. are concerned. The Social and Economic Aspects category takes into account the life cycle value of community development. Points are also awarded for assessments on the impact on climate change and acid rain in the Environmental Loadings category, encouraging the assessment of carbon dioxide. The tool targets the reduction of energy usage and spending by weighting and benchmarking performance ratings by local climate conditions and energy operating costs. Points are awarded for enhanced performance through the commissioning of building systems, as well as in the Service Quality category.

For the SBTool to be positioned more effectively, categories such as Energy and Resource Consumption, Environmental Loadings, Indoor Environmental Quality and Service Quality could be re-modeled with specific goals associated to effect reductions. Components such as the 'required' assessment of green house gas emissions, use of environmentally sound construction materials, reduced energy use, and performance and commissioning of buildings should be added with minimum targets to position the tool as a valuable rating system in the industry.

5.5 Energy Star Program – Key Highlights

Energy Star is a joint program of the U.S. Environmental Protection Agency (USEPA) and the U.S. Department of Energy (USDOE) aimed at achieving environmental sustainability through adoption of energy efficient products and practices. The program was introduced in 1992 as a voluntary labeling program designed to identify and promote energy-efficient products (covering nearly 50 product categories) to reduce greenhouse gas emissions. Since then, the Energy Star label has been extended to include major appliances, office equipment, lighting, home electronics, new homes and commercial and industrial buildings. The program essentially works as a partnership arrangement with over 12,000 public and private sector organizations that are engaged in offering energy-efficient solutions and best management practices.

Based on latest estimates, Energy Star has delivered energy and cost savings across the United Sates to the tune of $16B in 2007 by incorporating practices such as energy efficient lighting, power management systems for office equipment, and low standby energy use, among others. Energy Star's home and building assessment tools enables homeowners and building managers to achieve greater efficiency and cost savings.

Brief Overview

A core part of the Energy Star building rating system is the interactive energy management tool called the Portfolio Manager. This allows building owners/managers to track energy and water consumption across buildings portfolio in a secure online environment. By entering information about their facilities, building owners can use Portfolio Manager to track key consumption, performance, and cost information portfolio-wide; regardless of the types of facilities they own and operate.

The Portfolio Manager can be used to track and benchmark energy use over time for all types of facilities. Energy performance can be rated on a scale of 1 to 100 relative to similar buildings nationwide. EPA's energy performance rating system, takes into consideration impact of weather variations, as well as key physical and operating characteristics of each building. Buildings rating 75 or greater can qualify for the Energy Star.

Based on estimates for 2007, the Energy Star program has managed to successfully penetrate the North American market, with 40 million metric tons of greenhouse gas emissions prevented and $ 16B saved in utility bills. EPA anticipates such savings to nearly double over the next ten years as households and businesses resort to Energy Star for guidance on investing in energy-efficient products, practices, and policies. Building owners and operators have used the system to rate the energy efficiency of more than 62,000 buildings in 2007, representing more than 7.5 billion square feet. Total qualified buildings were more than 4,000 buildings in 2007 representing over 740 million square feet.

5.6 CABA's BIQ Tool – Key Highlights

The BIQ tool is an initiative of CABA and the Building Intelligence Quotient Consortium (BIQC). The Consortium and the CABA Intelligent & Integrated Buildings Council (IIBC) have worked together in developing the framework for the Building Intelligence Certification process. The BIQ is a web-based ranking tool that aims at enhancing the adoption of intelligent building technology among building owners, managers, and the design community through a process of guidance and value demonstration. The objective is to ensure that all aspects are given due emphasis while choosing subsystems and the level of integration desired in a building. As per the BIQC, the main functions of this tool are:

- "Provide a means to evaluate and measure the "value" of intelligent building performance with respect to the goals set"
- "Provide an assessment of a building's integrated intelligence"

- "Functions as a building automation retrofit action planning tool"

Brief Overview

The BIQ is designed for use with existing commercial or institutional buildings of any size. Owners and developers with multiple properties can use BIQ to assess and compare the building intelligence systems in their portfolio. "With the verification of additional buildings, point scores are aggregated in an anonymous database that can enable users to analyze how their building intelligence design performs in relation to the median and to buildings that are similar in terms of size, type and region."

The BIQ design guidance spans across four stages covering; project initiation, design implementation, commissioning, and intelligence evaluation. Upon completion of the online assessment, BIQ generates a report with a point score (up to 1000) and project design highlights. The assessment assigns points in eight areas – "systems overview, power distribution, voice and data systems, connectivity options, intelligent features, facility management applications, degraded mode operation and building automation environment". The report identifies strengths and weaknesses and recommends design or operational improvements, as well as provides links to companies and resource providers that can facilitate upgrades. Overall rating and scores are provided for the following aspects of a building: [7]

- Business case including an operating and maintenance budget
- Building of intelligent building sub-systems; integration of the sub-systems
- Failure and emergency operations
- Support and maintenance including preventative maintenance, and response to requests for services from owner/investor

5.7 Green Ratings Current Overview & Forecasts

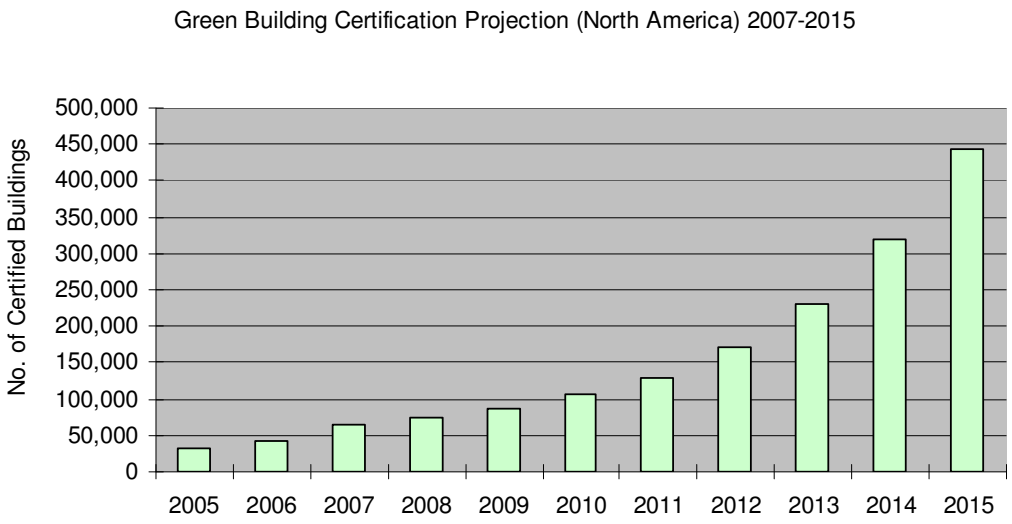
The Green Buildings Ratings and Certification process has gained tremendous momentum over the last few years. Particularly growth in the number of projects certified by rating systems such as Energy Star and LEED has nearly doubled in size during this period. The key drivers fueling this trend are energy efficiency prerogatives and enhancement of buildings' operational performance on the part of building owners and managers. Other factors contributing to this trend include a desire to substitute environmental friendly alternatives, renewable resources, integration and intelligence benefits through incorporating intelligent building solutions.

While there are a few challenges concerning high capital costs, low awareness, and receding economic conditions with a sluggish construction market, green certifications are projected to grow steadily over the next five to seven year period. The drivers are expected to far outweigh the restraining factors, leading to robust growth in cumulative certifications year-on-year by the rating systems currently

[7] CABA BIQ Handout

available. Chart 5.4 depicts the growth in green building certifications 2007-2015 by rating systems such as LEED, Energy Star, Green Globes, and BOMA Go Green.

Chart 5.4: Green Building Certification Projection 2005-2015



Source: Frost & Sullivan

Currently the total number of certified projects by all rating systems taken into consideration is over 64,000 in North America. This is projected to grow at a CAGR of 30%, resulting in over 400,000 projects by 2015. This optimistic growth rate is expected as a result of the industry according significant importance to energy savings, desire to make buildings more operationally efficient and intelligent, and above all better dissemination of awareness on the benefits and cost-savings that environmentally sustainable buildings can deliver.

5.8 Making Green & Intelligence Work Together

Given that rating tools in the industry are heavily focused on operational performance of buildings, it is necessary to bring out the inherently strong competencies of such tools and enhance their framework to support the adoption of intelligent solutions. There is a need for a more organized approach to measuring the investment benefits in green buildings on a wider scale. Currently the LEED rating system does represent a fine balance of both prescriptive and encouraged measures that buildings must advocate to reduce inefficiencies.

To ensure that LEED accords proper credits for enhancements effected in building performance, technology upgrades and retrofits, and overall cost reductions from implementing intelligent technologies, it is necessary to restructure the credit system so that it reflects the best of both green and intelligence. However, this may prove to be more time consuming considering the public review and appeals processes that are involved with the consensus based approach of LEED. Instead, a more productive approach would be to form an alliance with other such systems in the industry that

comprehensively address the intelligence aspect of buildings. CABA's BIQ could be a strong contender in this regard, being the only tool currently available that is capable of measuring operational efficiency generated by active intelligence in buildings.

Such a collaborative effort between LEED and BIQ can potentially result in a much wider and quantifiable scale for measuring green performance. Credits based on productivity and manpower utilization/performance, detailed cost benefit analysis submissions, environmental information management, carbon dioxide reductions, converged integration benefits, O&M cost savings, among others, will be capable of addressing functional efficiencies of buildings more concretely. This will also stimulate valuable data streams to be generated that can be further utilized for more on-going performance assessments of buildings.

The next logical steps to lead to such a comprehensive and unified rating system would include both technical and policy initiatives. The technical category would call for a closer assessment of the collaborative possibilities of both BIQ and LEED, evaluate stakeholder buy-in and the necessary thrust from the wider industry to move this forward. The policy initiatives to be undertaken will involve industry associations, building design, construction and product and technology sectors catering to the building industry and those involved with codes and specifications. Technical and policy categories will have to work cohesively towards ensuring the following:

- Bringing together the established experience of organizations like CABA and the USGBC to address the interdependency of green and intelligence aspects in buildings.
- Expanding the LEED rating system to develop comprehensive performance standards for all building types that covers both environmental, as well as IT-centric intelligence, guarantying energy and operational cost savings.
- Developing standards for automation and systems' interoperability, as well as monitoring and reporting performance information on real time to maintain critical benchmarks for measurements.
- Instigate Public Policy measures and dialogues with government agencies and among key industry organizations such as ASHRAE, CABA, USEPA, USGBC etc., to translate performance standards into enforceable codes and regulations for buildings based on a comprehensive rating system.

6

Investment Justifications for Building Owners

6.1 Developing a Business Case - New and Existing Buildings

In developing a financial justification for investments in intelligent and green technologies, and assessing the potential return on that investment, it is necessary to consider new construction and retrofit projects separately, because the requirements, and therefore the economic fundamentals of the two types of projects are very different.

New Construction

In a new construction scenario, the cost of creating a green and intelligent building is often not that different than the costs associated with creating a traditional building. Certain aspects associated with intelligent technology and applications, such as cabling, are actually less costly than traditional infrastructure – in the case of cabling, labor costs are often lower where intelligent designs are used. However, other technologies and equipment will require additional investment to integrate all of the components of the system. For example, integrating the access controls system with lighting and HVAC systems will cost more up-front than installing disparate systems alone. While every building project is different and final cost comparisons can only be made based on a building's individual requirements, it should not be expected that a green and intelligent building will cost significantly more at the outset than a more technologically traditional version of the same building. In addition, as has been found in all of the case studies examined as part of this research, this initial investment in green and intelligent design and technology generally has a relatively short ROI period when compared to the anticipated usable life of a modern building.

Existing Buildings

In a retrofit or existing building project, the up-front costs and the resulting ROI scenario are different than in new construction and, as a result, a different approach to financial justification must be taken. Retrofits are more frequently driven by the desire to reduce energy costs than anything else. These are often cases where the existing technology or system in a building can be upgraded easily and the payback period is expected to be short. In the United States, the Department of Energy conducted a study of energy-related systems (mostly HVAC) in commercial real estate. This study found that the payback period on re-commissioning those systems was approximately nine months. The largest

challenge facing the industry in reducing energy and improving operations and maintenance practices is the simple fact that, in older buildings, facility managers have very little information on what is currently going on with their systems and, as a result, do not have a clear understanding of the improvements that can be made or the savings that can be generated as a result of induction of intelligent and green technologies. This information is typically gathered, for example in projects where a performance contracting vendor does a survey of conditions before any retrofit, to define the base line operating costs, and then project the savings potential for the project.

Moreover, for both new and existing buildings, as demonstrated in the case studies assessed for this research, the implementation of intelligent technologies will have a lower lifetime cost than traditional technologies, because lifetime operating costs are significantly lower as a result of enhanced operational efficiencies and better control of operating systems. Intelligent features of a building, such as better monitoring and control of energy-intensive systems such as HVAC and lighting, can be measured for optimum performance and predictive maintenance needs, reducing both energy usage and operating expense. Additionally, reporting features assist in making decisions that make the building more efficient and more reliable.

6.2 Financial Justification - ROI

With energy costs continuing to rise and increasing amounts of energy being consumed by the commercial and industrial building sectors; building energy operating costs are expected to continue in an upward trajectory, unless energy consumption is more effectively managed. The costs of energy represent about 30% of an office building's total operating costs (excluding staffing costs). With additional time and effort going into designing, specifying and constructing intelligent and green buildings, the payoff comes when buildings achieve substantially better performance in terms of reduced operating costs. Ultimately, the implementation of intelligent technologies will cost less than traditional technologies, because lifetime operating costs are significantly lower and labor costs are also likely to drop significantly.

To examine the various levels of intelligence for buildings and the impact on green technologies and processes (new and retrofit), this research includes case studies that document success stories demonstrating the real life ROIs in the implementation of intelligent technologies and processes and the "green" results.[8]

- The State of Missouri was spending $300M annually to operate and maintain approximately 32 million square feet spread across numerous facilities in its real estate portfolio. Through the collaboration of companies and technologies, an enterprise asset management and building information management system was successfully deployed that enabled the State of Missouri to manage its portfolio of approximately 1,000 buildings from a total cost of ownership perspective. This project resulted in annual savings from the combined projects in excess of $35M per year, creating an ROI of less than one year.

[8] More details on these case studies are included as an appendix to this research service.

- Prior to embarking on the energy retrofit with automated lighting controls, the Rogers Centre facility, a world class sports and entertainment complex in Toronto, had an electricity bill exceeding $3M annually. By the time the project is fully completed, when compared with baseline performance, the project is expected to generate a 76% savings in energy expenses from lighting using addressable lighting solutions. Based on interim assessment and the third party M&V process, cost savings reached $325K annually after phase two, generating an ROI of about two-and-a-half years.

- Faced with rising energy costs and aging infrastructure, the Providence Newberg Medical Center (PNMC), a 175,500 square feet facility with a 40-bed hospital and medical offices, was conceived of as a replacement for Providence Newberg Hospital. The primary factors driving the adoption of HVAC controls included escalating energy prices, environmental concerns, and emphasis on air quality and comfort. The integrated HVAC system reduced overall energy consumption by 26% compared to ASHRAE 90.1, providing a very favorable ROI. The solution has also improved IAQ, resulting in improved occupant safety, comfort, and productivity.

- A newly constructed 39 storey high rise condominium "The Verve", in downtown Toronto, differentiates itself from other buildings by promoting its green image to ensure the success of its sales program and provide additional value for purchasers. Energy efficient equipment, energy management systems (EMS), M&V, and individual metering & billing, are expected to facilitate 35% annual energy savings compared to local energy code and generate LEED premiums payback in seven years or less.

- Kwantlen Polytechnic University constructed a new high-tech facility in Cloverdale, British Columbia. The new campus entails three major building blocks with classrooms, workshops, and academic facilities totaling up to 185,177 square feet. With an integrated BAS platform, designed based on HVAC controls, Kwantlen is capable of controlling interior and exterior lighting, all integrated to enhance performance and reduce operating costs. Kwantlen' Cloverdale campus is able to produce about 30% annual energy savings compared to energy code ASHRAE 90.1 -1999, as well as improve occupant comfort, productivity, interaction, and collaboration.

In addition to the information highlighted in the case studies, other technologies assessed for this research demonstrate that use of telecom-enclosure (TE) cabling could save 38% on material and labor costs, and integrated building automation system (IBAS) infrastructure could save 33% on material and labor costs, when compared to conventional buildings.

Adopting open system architecture can significantly increase the lifespan of significant portions of cabling infrastructure in a building, obviating extensive changes or expensive upgrades. Minimized upfront costs due to labor and material savings, increased lifespan and durability, and minimal maintenance costs are various direct/monetary benefits that can be realized. Several additional advantages are the relative ease of expandability and adaptability for rapid and easy changes involving

minimal disruption, the logical outcome is faster ROI, better utilization of installed cabling, and a lower total cost of ownership.

6.3 Substantiating Non-energy and Additional Benefits

It is clear that building owners are unlikely to invest in green or intelligent building technology unless it has a clearly defined, low risk ROI. What is not very clearly defined is what elements should be driving the ROI calculation. The non-energy benefits of intelligent and green buildings have a major impact on building performance and occupant effects. Although intangible and difficult to put a value on, high satisfaction ratings from tenants and visitors, and reports of increased employee productivity will ultimately benefit building owners, developers, and managers. Developers that have mitigated cost increments, financial incentives, and enhanced community image, are rewarded for building green. Reduced churn, quicker lease-up, and higher re-up rates all work to reduce operating costs and enhance building asset value, although it is more difficult to empirically measure the value of these factors.

Occupant Productivity and Comfort

Occupant productivity, especially in owner-occupied buildings, has a significant measurable impact on the ROI calculation. Staffing costs represent a significant expense and any improvement here will have a very high impact on the bottom line. A variety of studies have demonstrated productivity benefits in commercial and industrial settings. For example, office worker productivity on an average increases between 2 and 18% in green buildings, according to the U.S. Green Building Council (USGBC).

Productivity gains shorten the ROI period on energy capital costs considerably in owner occupied buildings. Given that energy costs represent about 1% of the overall cost of doing business and investment expenses are about 10%, staffing costs can represent up to 85% of the total cost of doing business. Any improvement in productivity can therefore have a significant positive financial return. Interface Engineering has noted that relative building operating costs per square foot can be:

- O&M: $1.35
- Total Energy: $2.00
- Rent: $20.00
- Net Income: $16.65
- Salaries: $200 to $600

In the above example, even if a building generates a saving of 50% on buildings operations, the net income goes up by $1.67. If the productivity increases by 2%, then the benefit to the owners is between $4 and $12. This is a significant rationale for enhancing productivity in national economic

environments, where all opportunities to increase productivity are being sought. Business owners are motivated by several factors, including:

- Factory owners can show increased production
- Retailers can increase sales per square foot
- Hospitals can discharge patients two-and-a-half days earlier
- Students' school test results can show an improvement of as much as 20%

Where the building is a commercially leased property, resultant increased occupant productivity in turn provides building differentiation through image, and improves lease-up and renewal rates, while reducing vacancy rates and churn. Where the owner is the occupant, the benefits of increased productivity can far outweigh those for reducing operating costs as seen in the example above.

Furthermore, pressures to improve indoor environmental quality (IEQ) include the significant increase in the cost or the complete withdrawal of building insurance coverage for problems resulting from molds and other airborne contaminant health and security risks. The National Energy Management Institute in the United States identified a potential of $20B to $200B non-health productivity gains and $25B to $58B in health gains from enhancing indoor environmental quality. This potential is enough to justify at least a serious look, if not unconditional adoption of intelligent and green technologies in new construction and existing buildings.

6.4 Life Cycle Benefits

In developing a business case for intelligent and green technologies, a building owner/manager must be convinced that by implementing the technologies, the payback period is significantly less than the expected working life of that asset. Beyond the direct reduction in operating costs, technologies applied in intelligent buildings also improve the building's environment and its functionality for occupants. While these benefits are often less economically tangible, they provide an improved ROI and return on assets with increased leasing possibilities and higher values. For example, the US EPA's Energy Star program notes that owners investing in energy upgrades can enhance building asset value by two to three times the amount invested. Furthermore, where a building's energy usage is reduced by 30%, NOI and building asset value are increased by about 5%.

Building owners and managers need to take into consideration how resources will be used in the future. The efficient use of water, heating, and electricity will assist in stabilizing long-term economic growth, while simultaneously lowering lifetime utility costs for individual owners and tenants. Intelligent buildings help the owners to significantly reduce operating costs as a result of more efficient operations and control. Intelligent features of a building, such as monitoring and control of energy-intensive systems including HVAC and lighting, can be measured for optimum performance and predictive maintenance needs, reducing both energy usage and operating expense.

By enhancing connectivity between building systems and users, intelligent buildings help to balance the operational objectives and economic performance of buildings with emphasis on scalability and changing priorities. In an endeavor to provide a comfortable and reliable environment, intelligent buildings essentially help achieve a reduction in energy consumption, use resources more efficiently, and explore renewable alternatives that enable them to be financially, as well as environmentally sustainable assets over time. Reducing operating costs enhances a building's asset value.[9]

Although there has been a great deal of emphasis on implementing sustainable techniques for new buildings in the planning stages, it is the bulk of the existing facilities in the market that have less than optimal energy efficiency standards, and therefore, have a much greater environmental impact. This offers a tremendous business opportunity for industry participants and building owners alike.

6.5 Environmental Footprint

Property owners are under pressure to provide detailed accountings of their GHG emissions. Investors are concerned about the risks and opportunities associated with changes in temperature and weather patterns, as well as from impending taxation proposals (as in California) or legislation intended to limit or tax emissions of carbon dioxide and other gases. Many companies will also be buffeted by changes in consumer preferences and demands resulting from increased awareness of climate change risks. If stakeholders can show that they are green and socially responsible, it can improve business efficiency, creating a different ROI equation where value adds become much broader than just energy savings. This issue has become so critical that most global corporations are issuing annual CSRs, typically signed by the CEO.

Approximately 44% (785 companies) of top 1,800 companies globally issued sustainability reports between 2005 and 2007. About 40% of the companies used external standards provided by the Global Reporting Initiative (GRI). Reporting practices varied by region, but the trend of adopting CSRs as a means of projecting the corporations' environmental credentials is growing at a very rapid pace. The worldwide growth of socially responsible investment funds, investment rating systems such as the DJSI and investment policy disclosure requirements also have put financial pressures on companies to make these non-financial disclosures.

According to industry experts, building owners in general are concerned about the impression people have about their buildings; if the building owner is trying to rent out space then it's the impression the tenants have; if it's a school district or hospital it's the impression the community has; if it's a corporate building then it's the employees. This is further substantiated by owners looking to be envisioned as environmentally conscious and doing the right thing. The evidence of that happening is clear if one considers that 20-25% of buildings have some involvement with LEED.

As the environmental awareness grows, these green policies will continue to expand, making greening a defensive move at this stage of the industry life cycle, as illustrated in the example in Figure 6.1.

[9] The total annual savings divided by the capitalization rate equals the augmented asset value

Figure 6.1: Example of CSR Impact Scenario on ROI as indicated by the Financial Community

Company	2008 Investors Contribute	2009 Government Issues Regulations on Carbon Emissions and Use of Non-renewable Resources	Investment Required to Comply	ROI
Company A Regulates own carbon emissions; uses technologies that conserve resources; utilizes built-in scalability to integrate changing environmental needs	$100M		No additional investment needed to meet guidelines	**Positive Financial Returns**
Company B No environmental objectives	$100M		Significant investment required to avoid serious penalties and fines	**Loss**

Source: Frost & Sullivan

In the example above, the financial community is more likely to invest in Company A, and either stay away from Company B or make the cost of financing higher.

The majority of information on which assurance currently is being provided in the industry is non-financial, quantitative performance measures. For example, Price Waterhouse Coopers and KPMG provided assurance on the following measurements:

- Energy efficiency
- Carbon dioxide emissions
- Regulatory, health, safety, and environmental performance

Organizations have come to realize that meeting stakeholder expectations is as necessary a condition for sustainability as the need to achieve overall strategic business objectives. While maximizing shareholder value continues to be an overriding concern, companies will not be able to do that over the long term if they do not address the other key interests of stakeholders. To create transparent reports that provide accurate and reliable data, and a fair picture of overall performance, many companies are currently reporting results across the "triple bottom line" of economic, environmental, and social performance. Triple-bottom-line reporting involves reporting non-financial and financial information to a broader set of stakeholders than just shareholders. The reports inform stakeholder groups of the reporting organization's ability to manage key risks.

7

Conclusion

This research identified the exciting developments taking place on the technology front and analyzes their implications for intelligent and green buildings, highlighting examples of "best in class" buildings employing green and intelligent technologies. These buildings are dynamic environments that respond to their occupants' changing needs and lifestyles. This research provided documented evidence to educate and influence end-users, building owners, architects, and contractors that a "greener building" can be achieved using intelligent technology and that this "greening" will provide a tangible and significant return on investment.

However, experience demonstrates that the best or most advanced technologies fall by the wayside if not financially viable. Induction of intelligent and green products and technologies in new or existing buildings can enhance energy efficiency in buildings, reduce operating costs, and reduce the burden of environmental dependency of buildings, thereby making them greener. Ultimately, the implementation of intelligent technologies will cost less than traditional technologies, because life-time operating costs are significantly lower and labor costs are also likely to drop significantly. This concept – intelligent, green and profitable – is what we call a bright green building. Building owners and managers are realizing the multifold financial benefits of building bright green technologies, including:

- Lower energy costs
- Lower maintenance costs
- Lower repair and replacement costs
- Increased occupant comfort and satisfaction and the resulting productivity benefits

All of these factors are providing the cost justifications that have long been needed to warrant end-users making significant investments in the installation of integrated building automation systems. Whether from a green building or energy management perspective, intelligent buildings provide owners with the means to increase efficiency and meet their business objectives by controlling costs and potentially extending the life of a building.

Integration Equals Transparency, Building Efficiency, and Faster ROI

Perhaps no other technology has had as profound an impact on the building automation technologies market as the Internet and the benefits provided by ubiquitous IT and standards such as Ethernet,

Transmission Control Protocol/Internet Protocol (TCP/IP), and XML. Bringing together open communications protocols for control devices and IT provides customers with options and functionality at cost levels that were never possible before. The goal is to create an open infrastructure that supports real-time control systems, enterprise applications, and information flow.

The fundamental technologies required to develop a converged network are available in the market at present. There are companies and technology suppliers delivering the various components, technologies, and services, as well as total solutions, which make a building both intelligent and green from concept to operation. With a unified approach to monitoring, buildings can change the underlying infrastructure without changing the enterprise level reporting mechanisms. This heterogeneous infrastructure creates more competition between technology vendors, begins to generate savings more quickly, and can generate an ROI payback of two to three years rather than over the course of a decade. The goal is to provide executives, managers, and staff with the information necessary to make better decisions more quickly and on a real-time basis. Integrating utility bills into the enterprise asset management system can further provide diagnostic information to facility managers, enabling them to take immediate action. In order to conserve energy (and money), it is imperative that proper information management architecture is in place, which makes the information actionable and definable.

Building owners can save energy by enhancing connectivity and visibility to all of the applications in use. Using an IP network to connect all of the key elements of building services and communication systems such as telephony, core networks and their applications, and wireless connections offers tremendous potential for cost savings and improved functionality. Integrating intelligence is not only desirable, but is becoming a mandatory requirement to provide clients with the best solutions and the simplest connections to real-time, web-based data, and the corporate enterprise.

In the State of Missouri case, for example, by integrating individual systems and buildings in to a common user interface level, operational activities in the various subsystems can be monitored to detect inefficient operating conditions and corrective action can be taken to bring the system back to normalcy. This visibility over facilities and assets has enabled the State of Missouri to achieve the annual savings in excess of $35M per year meeting the ROI within a year. With the right equipment and solutions, building owners and facility managers have the ability to embrace the diversity found in buildings and provide a near future-proof integration infrastructure. Figure 7.1 shows the key benefits on the bottom line from an integrated enterprise.

Figure 7.1 – Bottom Line Analysis of Integration

Revenue Enhancement	Cost Reduction	Efficiency Improvement
Compelling differentiator in a market increasingly saturated with look-alike properties Higher resale value or lease rates Improved long-term economic performance Facilitate revenue-generating differentiable services, such as digital signage and multimedia presentations	Optimized asset management and better space utilization Reduced cost for moves, adds and changes (MAC) Reduced capital costs including cabling, administration, training, and project management Reduced construction and demolition waste Reduced energy and water usage	As a means of improving efficiency, the benefits of integration include streamlining business processes and a faster workflow, eliminate database redundancy More efficient use of O&M
The bottom line: a building that is more productive, profitable, agile, and socially responsible		

Source: Frost & Sullivan

Building Life Cycle Analysis

Currently, buildings need to exhibit higher operational efficiency and lower cost with respect to factors such as energy consumption and operational costs, life cycle benefits, management of resources, and legislative requirements. Ongoing operating costs typically represent 50-80% of a building's total life cycle costs over an estimated 40-year life span. The anticipated rise in energy costs is likely to increase the ROI on energy and operational efficiency.

The aim of an intelligent building is to provide operational excellence and ease in maintaining the functionality of individual system by continuously monitoring, diagnosing, and taking preventive actions with scheduled maintenance. Operating costs are significantly lower as a result of more efficient operations and better control, enhancing a building's asset value.[10] Intelligent features of a building, such as monitoring and control of energy-intensive systems such as HVAC and lighting, can be measured for optimum performance and predictive maintenance needs, reducing both energy usage and operating expense.

Keeping in mind that intelligent technologies are installed to deliver effective payback and long-term returns, it is critical for such systems to incorporate LCA. Depending on how LCA is addressed, this enables facilities and organizations to achieve long-term sustainability goals by developing environmental monitoring systems that generate pertinent data.

[10] The total annual savings divided by the capitalization rate equals the augmented asset value

Benefits of Comfort and Productivity

The non-energy benefits of green and intelligent buildings have a major impact on building performance and occupant comfort. Since occupant costs command the greater proportion to an owner-occupied building, enhancing occupant productivity buildings leverages major savings, which can pay for the retrofits.

Due to the relative size of staffing expenses as compared to other operating expenses, building owners can leverage effective energy management retrofits to produce significant administrative savings. Reduced churn, quicker lease-up, and higher re-up rates all work to reduce operating costs and enhance building asset value, although it is more difficult to empirically measure the value of these factors. But since occupant costs command the greater proportion of building life cycle costs in owner-occupied buildings (as much as 85%), enhancing occupant productivity in high-performance buildings – often measured through reduced absenteeism – can result in major operational savings.

Corporate Social Responsibility

If stakeholders can show that they are green and socially responsible, it can improve business efficiency, creating a different ROI equation where value adds become much broader than just energy savings. For instance, facilities managers can help ensure that occupants' physical surroundings are optimized based on a perspective combining whole building solutions with environmental stewardship and these have been demonstrated to enhance productivity in a variety of venues.

Also, the DJSI and other investment industry participants have begun to distinguish corporate achievement related to green matters, and investors' incorporation of environmental and social risks into business value assessments is growing, demonstrating the increased triple-bottom-line value of these properties. As investors and community members insist on seeing what a company is doing to be environmentally responsible in its activities, greater transparency will become the norm. Companies that do not participate in this collective greening process will lose their market positions.

New Construction and Existing Buildings

In a new construction scenario, the cost of creating a green and intelligent building is often not dramatically different than the costs associated with creating a traditional building. Certain aspects associated with intelligent technology and applications, such as cabling, are actually less costly than traditional infrastructure – in the case of cabling, labor costs are often lower where intelligent designs are used. For example, by resorting to a single network and avoiding unnecessary and redundant cabling characteristic to conventional campus design, the Ave Maria University has optimized both capital budgets and time to achieve an outcome that is truly smart, scalable, and financially beneficial over time. As a result, Ave Maria University saved over $1M in building costs by eliminating the redundant wiring and cabling of multiple isolated building systems.

Lighting tends to be the most emphasized energy efficiency measure utilized followed by comfort conditioning HVAC. These projects are favored, because they have shorter paybacks than other retrofits and are less risky; they can generate significant energy savings in a short period of time. The

anticipated rise in energy costs is likely to increase ROI for the performance contractor, resulting in a win-win situation for ESCO companies and the building owners. For example, by combining addressable networking technology in conjunction with advanced control hardware and software, the Rogers Centre facility retrofit project enabled lighting energy savings of $325K annually after phase two, generating an ROI of about two-and half years.

Commissioning and Re-commissioning

Building commissioning can provide a return of four times the investment through operations savings over five years. Ongoing operating costs typically represent 50-80% of a building's total life cycle costs over an estimated 40-year life span. Project design, installation, operations, and maintenance are tested and managed to enhance energy efficiency, indoor environmental quality (IEQ), and occupant health and comfort. A comprehensive system involving field testing, maintenance plans, training, oversight, and monitoring also mitigate operating costs and business risks.

Commissioning keeps a building's operating costs to a minimum by detecting inefficient operating conditions and taking corrective action to bring the system back to normalcy. Ideally, commissioning is facilitated by integrated systems, providing operational excellence ease in maintaining the functionality of individual system by continuously monitoring, diagnosing, and taking preventive actions with scheduled maintenance. Owners' operating costs are significantly lower as a result of more efficient operations and better control, enhancing a building's asset value.

Integrated Design Process

Using an Integrated Design Process (IDP) entails gathering all stakeholders at the table from the beginning (for example architects, building contractors, maintenance personnel, appraisers, "green" consultants) as they each have a role in influencing the design. When the design of a building is in its infancy, stakeholders should decide to use IDP to allow for optimum integration of technologies and solutions to enable a high level of connectivity and visibility and address occupants' comfort needs, maintenance costs, energy costs, and future expansion capabilities. The degree of intelligence a building has will depend on the extent to which there is consensus to include the various available technologies.

For example, in the case of Kwantlen Polytechnic University, the goal was to achieve integration of technologies, engineering expertise, and solutions to allow for a high level of connectivity and visibility using IDP while the design of the project was still in its infancy. To design for an intelligent and green facility that could provide improved occupant comfort, interaction, and collaboration, the IDP team was tasked to design how students and faculty circulate inside and outside throughout the campus. The results were energy savings from the day of installation and impact of the technology on the overall productivity and comfort for the student and professor environment.

Performance Contracting

Performance contracting is a potentially viable platform to overcome first-cost barriers to going green and intelligent for existing buildings. Performance contracting can allow a manufacturer to pilot a technology where the customer (such as a city government) is risk averse to trying new technologies, unlike universities for example, which seek to attract top students and faculty and use innovation as a means of differentiation. The majority of states have already enacted laws that authorize performance contracting, which encourages green developments in the government sectors.

The potential for energy savings and the restructuring of facilities with performance contracting, at no risk to building owners, has been estimated to save up to 30% through cost avoidance. In the State of Missouri, for example, under performance contracting with guaranteed savings of about half the energy and operation costs, Johnson Controls played the role of the energy service company (ESCO), and accepted the performance risk to achieve the sustainable goals set forth by the State of Missouri. In federal retrofit performance contracting, funds to support the performance contracts come out of non-capital budgets for utility payments or operations and maintenance. This method obviates the need to seek congressional approval for capital purchases, a process which could take several years. In this situation, Johnson Controls not only obtained the financing but also guaranteed the savings, which reduced the State's risk.

Green Measurement Rating Systems Driving Intelligent Buildings

Motivated by a desire to appear environmentally conscious, many commercial facilities have adopted "Green technologies" in order to get "Green and Sustainable" certifications. The Green Buildings Ratings and Certification process has gained tremendous momentum over the last few years. Particularly, growth in the number of projects certified by rating systems such as Energy Star and LEED has nearly doubled in size during this period. The key drivers fueling this trend are energy efficiency prerogatives and enhancement of buildings' operational performance on the part of building owners and managers.

While there are a few challenges concerning high capital costs, low awareness, and receding economic conditions with a sluggish construction market, green certifications are projected to grow steadily over the next five to seven year period. Currently the total number of certified projects by all rating systems taken into consideration is over 64,000 in North America. This is projected to grow at a CAGR of 30%, resulting in over 400,000 projects by 2015. This optimistic growth rate is expected as a result of the industry according significant importance to energy savings, desire to make buildings more operationally efficient and intelligent, and above all, better dissemination of awareness on the benefits and cost-savings that environmentally sustainable buildings can deliver.

The idea of leveraging intelligence to enhance building performance, either for energy efficiency or occupant comfort and thereby obtaining credits is acknowledged by USGBC. "The credit system under LEED is geared to recognize building performance that has been enhanced by automation and IT-centric intelligence," states USGBC. The ability to track utility use in real-time will increase the ability of the project team to document compliance with LEED. Similarly occupant comfort and air

quality can be documented through having a centralized system installed to enhance operational performance and ultimately ensure LEED certification down the road.

By enhancing connectivity between building systems and users, intelligent products and technologies help to balance operational objectives and the economic performance of buildings with due emphasis on scalability and changing priorities. These products and technologies, and the buildings they retrofit and sustain over time, stand to benefit from green measurement tools such as the those named above in reaching out to the larger marketplace for confirmed acceptance and propagation. Results achieved through the deployment of intelligent products and technologies in buildings makes such intelligent solutions imperative to the success of a buildings' environmental profile and increased adoption.

Ave Maria University an Independent Case Study

CASE STUDY SNAPSHOT

The concept of 'Convergence' in the building industry has evolved considerably, moving beyond traditional and often isolated co-functionalities that made two or more building systems work together from a maintenance and management standpoint. In today's convergent buildings, it is not sufficient to merely integrate the air-conditioning with lighting, or physical security with access control. Going beyond randomly chosen systems, advanced technological capabilities are now enabling components such as HVAC, lighting, security cameras, fire alarms, electrical, building-access control systems as well as voice and data communication to be integrated and controlled intelligently and seamlessly from a single network.

This is the type of emerging best practice in convergence that characterizes the Ave Maria University Project in Florida. This case study profiles the objectives and key highlights of the design approach and accomplishments documented by this project. Spanning more than 900 acres in the township of Ave Maria, Florida, this project shows how careful planning and consideration in combining building-systems and information technology (IT) functionalities can be managed centrally over an Internet Protocol (IP) network, allowing owners to optimize capital expenditure for guaranteed long term savings.

PROJECT OVERVIEW

Situated on a 908-acre campus in Ave Maria, Florida, the Ave Maria University campus has 500,000 square feet of facilities, serving nearly 500 students and 200 faculty and staff. The campus development has been conceived with state-of-the-art design elements and integration of technological systems to result in operational efficiencies and cost savings. To the owners, converging various technologies made sense from both a construction and ongoing operations standpoint and this proved to be a key deciding factor in choosing single party technology contracting to design, install and oversee the management of multiple systems throughout the campus. From IT to facility operations, the infrastructure encompasses nearly 23 systems that were proposed to be converged and made interoperable on a single IP network.

GUARANTEED SAVINGS

By resorting to single party technology contracting, integrating systems management into a single network and avoiding unnecessary and redundant cabling characteristic to conventional campus design, the Ave Maria University has optimized both capital budgets and time to achieve an outcome that is truly smart, scalable and financially beneficial over time.

By entrusting responsibility of facility systems management and information technology functions to a single department – the Office for Systems and Engineering – Ave Maria University has been able to staff their operations more efficiently. The integrated infrastructure has enabled the project team to exercise management capabilities that would not have been possible under a conventional design framework.

Savings Summary

- Saved over $1 million in building costs by eliminating the redundant wiring and cabling of multiple isolated building systems
- Reduced staffing costs by enabling IT to assume tasks of building maintenance staff with an estimated US$350,000 savings annually in human resource costs
- Enabled significant efficiencies in utility usage with an estimated US$600,000 in annual savings

PROJECT OBJECTIVES

The key objectives that were guiding the project initiative included the following:

- Achieve cost reductions by avoiding the installation of separate and proprietary mechanical, electrical and communications systems.
- Minimize human resource dependency by reducing physical monitoring and maintenance of separate systems across the 908-acre campus.
- Monitor utility usage and expenses, avoid power spikes and excess supply issues while seeking financial reconciliation for discrepancies with utilities.
- Manage nearly 23 facility and IT systems on campus from a single network operations center

The key challenges that the project team at Ave Maria University faced, like most similar scale developments included:

- **Capital Cost Outlay**: Managing budgets for mechanical and electrical installations for each separate system, both for facility operations and IT, and carefully allocating costs for each system's network of wires and cabling as well as proprietary protocols for control and communications.
- **Anticipation of Incremental Manpower Costs**: Human resource allocation across departments such as IT, Life Safety and Operations to monitor and manage tasks for each isolated system on campus meant an incremental cost exposure for hiring technically qualified manpower.
- **Management Challenges**: With separate external communications connections for each system under a conventional setup, the operations team would be required to manually monitor the operations of each system. This challenged the ability to detect problems in real time and avoid damages and secondary impacts.

SOLUTION PLATFORM

In view of the above challenges, the project team at Ave Maria University realized that the best way to achieve the end objectives was to centralize operations and management of all systems over a single network. The solution was to seek out consultants, contractors and vendors who would embrace the university's vision. Towards this objective the project team decided to work with Smart Buildings – a professional engineering and consulting services company, engaged in the area of designing integrated building technology systems for cost effectiveness and functionality.

Smart Buildings designed a solution that encompassed lighting control, power management, HVAC control, data networks, voice networks, audio-visual systems, video distribution, video surveillance, access control and facilities management. To put the design concept into action, Smart Buildings worked closely to assemble industry experts who would be delegated with specific functionalities, based on the expertise they bring to the table.

PARTNERING FOR EFFICIENT DELIVERY

The partnership model for service delivery was based on the 'Technology Contracting' approach as opposed to traditional contracting with multiple subcontractors installing separate proprietary systems. This approach involved entrusting the responsibility for planning, designing, installing, integrating, commissioning and servicing technology systems throughout the project footprint to a single provider. "*Picking one contractor to do this project saved an enormous amount of not only money, but something more costly, being time. That's because we were able to reach out to one partner, consolidate all of the project management, mobilization and overhead costs into one platform,*" *states Mehaffey.*

Johnson Controls Inc, who was appointed technology contractor for the project, supervised the design and installation of an IP infrastructure and the technology that resides on the network.

Technology Contractor – Johnson Controls Inc.

- Provided Building Automation and Access Control Security System
- Designed and installed IP infrastructure and technology that resides on the network.
- Adopted LonMark open data protocol that allowed equipment from various vendors to be installed and integrated on the same infrastructure, avoiding unnecessary networks and cabling.
- Systems installed included - Johnson Controls Metasys® building management system and P2000 security management system, Cisco data equipment, Notifier fire panels, GE lighting, IClass smart cards, HID proximity readers, HVAC components, a Maximo maintenance management system, an AVI audio/visual distribution system, and servers among other equipment and applications.

Information Network Partner – Cisco Systems Inc.

- Deployed a campus-wide intelligent information network based on Cisco solutions linked together across a rapidly scalable and reliable optical network
- Installed interfaces and sensors into all building systems to connect with a Cisco end-to-end network
- Equipment: CISCO system switches, fiber-optic wireless and IP telephony equipment
- Built a 24-hour network operations center on campus that controls and monitors all university communications and building operations from one location

Equipment Providers

- Data Center: 5-rack-mount servers in the main center and another 10 in the back-up center – housed in APC InfraStruXure enclosures that handle battery back-up, cooling and security.
- Software: Microsoft Windows, SQL Server and Active Directory
- Electrical System: by Eaton Corporation

Intelligence at Work

All systems on the campus were installed in such a manner that they could be managed from the network operations center. The Metasys system helped operators manage and mechanize the campus's HVAC setup, chiller plant, indoor air quality, air flow, lighting and lavatories, in addition to carrying out power management and asset tracking. Other systems monitored from the center include Internet, email, fire panels, digital video monitoring, and security and access control via the Johnson Controls P2000 system. Systems being web-enabled, operators can monitor and control them from their smart phones.

"The Metasys system allows operators to react to temperature fluctuations and make HVAC equipment adjustments with a click of a mouse. Integrated occupancy sensors activate lighting in rooms and lecture halls and airflow adjustments as needed. Integration benefits fire and life safety as well. If the fire alarm system detects a fire, Metasys signals the HVAC system to stop delivering fresh air to the area and pressurizes the path of egress, clearing it of smoke. The access control system will unlock doors along the route, and train surveillance cameras on the fire to give responders a live feed." Johnson Controls Inc. [1]

[1] Case Study, Ave Maria University: Source – Johnson Controls Inc.

The Cisco® end-to-end intelligent information network was deployed from the optical network connecting the campus and town buildings to the switches and wireless access points in each building, up to the IP phones on desks and in study rooms. This network was installed keeping future scalability in mind to extend to the township of Ave Maria, catering to high speed data and voice transfer and Internet access requirements of retail business owners in the area.

"With the advanced Cisco intelligent information network, the town's businesses can also have unprecedented opportunities to implement advanced capabilities available on the Cisco Human Network, from visual communications such as TelePresence, to Unified Communications for enhanced collaboration, to mobility for anywhere, anytime." Cisco Systems Inc[2].

In lieu of wiring and cabling for each proprietary system, a single IP network running over Ethernet cabling was installed and all systems, devices, and sensors interface to this Ethernet network. This helped reduce capital costs while increasing system collaboration tremendously. "*I feel the university is as future-ready as it could possibly be because of what we've accomplished with Johnson Controls help," says Bryan Mehaffey, Vice President of Technology and Systems Engineering at Ave Maria University.*

REAPING A SMART HARVEST

Four years after the commencement of this project, the occupants at the Ave Maria University campus are enjoying the benefits of a seamlessly connected environment. The state-of-the-art, nine-building campus has a fiber-optic network that links each building, with WiFi access throughout the campus. Maintenance is fully mechanized with temperature control and pressure readings all taken care of by staff members through simple mouse clicks and keyboard adjustments. All devices from HVAC, fire, security to lighting are remotely managed and monitored.

There is a 900-square-foot network operations center with wall-mount LCD TVs, for the staff member to monitor the campus' IP surveillance cameras and view real-time data from building systems. *"When on campus, they can view security cameras and system management software from their BlackBerrys and smart phones. For physical and logical access, students and university staff members swipe wireless smart cards by proximity readers at doorways to gain access to buildings and computer labs. An identity management database lets the IT team manage users' privileges and monitor access. The card also doubles as a debit card, letting students buy books and food or* make copies at copy machines on campus. The library system uses them as well, to check out materials." *The Angelus*

[2]Customer Case Study – Ave Maria University; Cisco Public Information: Source – Cisco Systems Inc.

[3] The Angelus, The Voice of Progress for Ave Maria University and Town, May-June 2008

LANDMARK IN BUILDING SYSTEMS INTEGRATION

The Ave Maria University project is a clear landmark in the area of intelligent building management, demonstrating that beyond integration, smart building technologies can ensure elaborate monitoring that can sense the pulse of the building. By allowing systems to effectively communicate with one another, operational expenses can be driven downwards through enhanced efficiencies and functionalities. The savings generated establishes the financial attractiveness and long-term sustainability of the project. As Jim Sinopoli, Principal of Smart Buildings points out, "The project establishes a new paradigm for the design and integration of building and communications systems and provides us the opportunity to achieve unprecedented new capabilities while drastically reducing costs." This project reflects the evolution of the building systems to an IP network, the financial advantages for building owners to integrate their systems, and the important role of the building systems in controlling energy usage and costs. *"This project reflects the evolution of the building systems to an IP network, the financial advantages for building owners to integrate their systems, and the important role of the building systems in controlling energy usage and costs", adds Sinopoli.*

INSTILLING FAITH IN SMART BUILDINGS

Fruitful results and the promise of on-going benefits documented by Ave Maria University project, marks an important step in the integrated building industry. With examples like this, the proponents of smart and integrated buildings can adopt this concept for definite returns. This project proves that smart technology integration used to manage our buildings will not only meet current needs and expectations but will also deliver future scalability and cost advantages. With the right project plan and service provider involved, such projects can go well beyond merely performing routine tasks; they could very well be the catalyst for addressing climate change.

CityStars of Cairo
A Cisco Connected Real Estate Project

CASE STUDY OBJECTIVES

Networks provide the platform for converged data, voice, video, and other services that create a unique experience for building residents, employees, and guests. Real estate owners, developers, and managers increasingly rely on Unified Communication solutions to differentiate their properties and respond to changing technology demands over time. This case study of the CityStars mega-complex in Cairo, Egypt, will demonstrate how Cisco® Connected Real Estate delivers superior service through intelligent building solutions: a safer, more comfortable and productive environmental for work, shopping, and leisure; exceptional revenue-generating and cost-saving opportunities; long-term flexibility to scale up and reassign networks across properties; and a new framework for minimizing environmental impact through innovative IP platforms.

The case study describes the project's viability in terms of both startup and lifecycle costs relative to differentiated and value-added services and assesses the impact of the chosen technology on other less tangible factors, including robust communication infrastructure, occupant comfort and productivity, and improvements to the working environment. Specifically, the Cisco Unified Communication platform offers:

- Quality high-speed Internet and web-hosting services
- Ethernet-everywhere, enabling wired and wireless network access
- Audio-and video-conferencing
- Satellite communication
- Remote access to building systems
- IP telephony and intercom
- Broadcast-quality video-on-demand and digital signage
- Single converged platform, whereby different subsystems can communicate and exchange data

PROJECT OVERVIEW

CityStars is the first and largest integrated project of its kind in the Middle East. With a total built-up area of 750,000 square meters, the project is the twelfth largest shopping and

entertainment center in the world and the second largest outside of North America. Cisco deployed its Unified Communication platform to meet the networking and value-added service demands of the unique project. The solution included 45,000 Ethernet ports for 6800 IP phones and 40 media convergence servers, a state-of-the-art data center including 24 Cisco Catalyst® 6500 series switches and 1200 Cisco Catalyst 3524 series switches, 500 Cisco media players, and training for 18 Cisco-certified engineers to manage the network.

The complex includes:

- Three international hotels with more than 1,500 rooms and suites
- Shopping center with 550 retail units
- Entertainment complex
- Medical center
- Residential towers with 266 apartments, duplexes, and penthouses
- Six buildings with 70,000 square meters of office space
- International exhibition centre with 20,000 square meters of floor space

Figure 1 – CityStars of Cairo

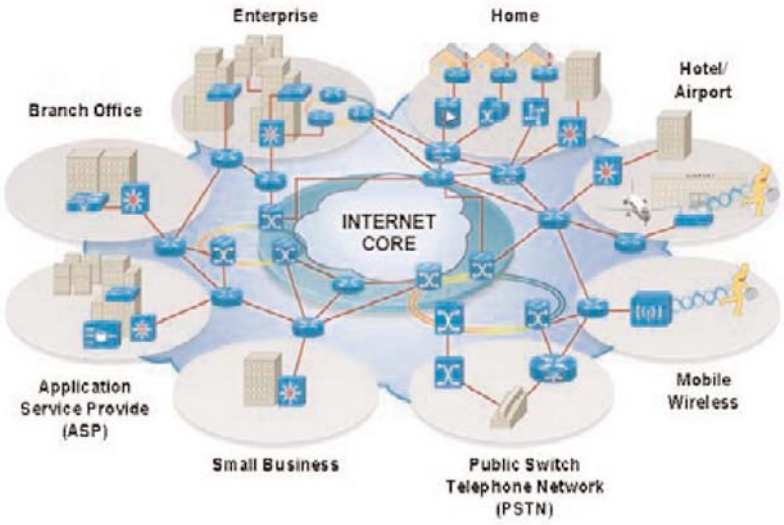
The mega-complex is equipped with some of Cisco's most advanced infrastructure and multimedia systems, which enable CityStars to both smootly integrate and manage all of its communication and information networks and offer value-added services, such as wireless connectivity and media-on-demand to all of its residents, visitors, merchants, and customers. Moreover, Cisco has helped the project establish its own internal technology service provider, which can phase in additional networking solutions to the converged platform without need for further construction or hardware. This future-proofing simplifies any change process required by new demand or repurposing and minimizes the environmental impact.

PROJECT RESULTS

Cisco Connected Real Estate boasts a single cabling platform based on open standards, offering a robust framework for all communication and information. The converged voice, video, and data network streamlines the asset allocation, tracking, and management

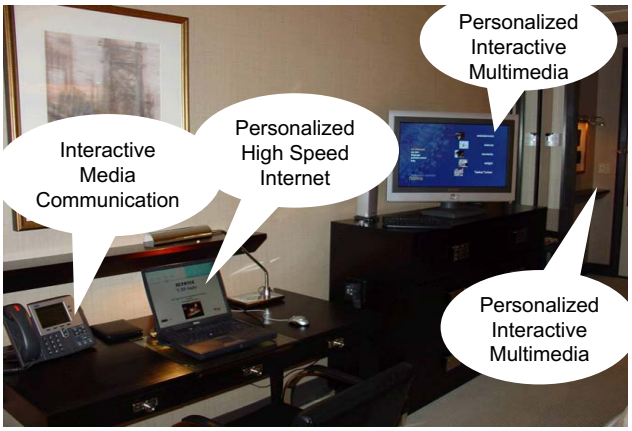
process, which improves security, optimizes flexibility, and improves interaction and integration between the various individual IP-based systems throughout the precedent-setting project. Cisco's intelligent real estate design and implementation not only saves operating costs and minimizes energy and resource usage over the life of the project, but also caters services to the user's overall experience, adds scalability and extensibility to enable and smooth systems evolution, and reduces environmental impact. Unlike traditional network architecture that requires costly and unsustainable construction, installation, maintenance, additional hardware, and waste to scale, add to, upgrade, or repurpose systems, Cisco's Unified Communication solution complies with the project's original design and is future-adaptable to anticipate and respond to new technologies, process changes, and increased demand without major physical modification.

Figure 2 – Cisco Real Estate Convergence Roadmap to IP-enabled Infrastructure



In terms of competitive edge, CityStars became the destination in Cairo for communications- and multimedia-ready business. Egypt's vast desert expanse has historically made it a difficult site for information technology proliferation, including access to basic Internet services. Although the project's initial design and vendor guidelines aimed to meet the immediate voice, video, and data needs of its intended clientele, Cisco's vision and ability to anticipate the increasing demand for complex, integrated networking and communications services helped CityStars add value and build out its offerings. By the project management's own estimates, Cisco's Unified Communication solution helped CityStars double its revenue related to technology services and cut its voice, video, and data costs by 30 percent.

Figure 3 – Intelligence as a Way to Differentiate: Improving Guest Experience while Improving Cross-selling Opportunities

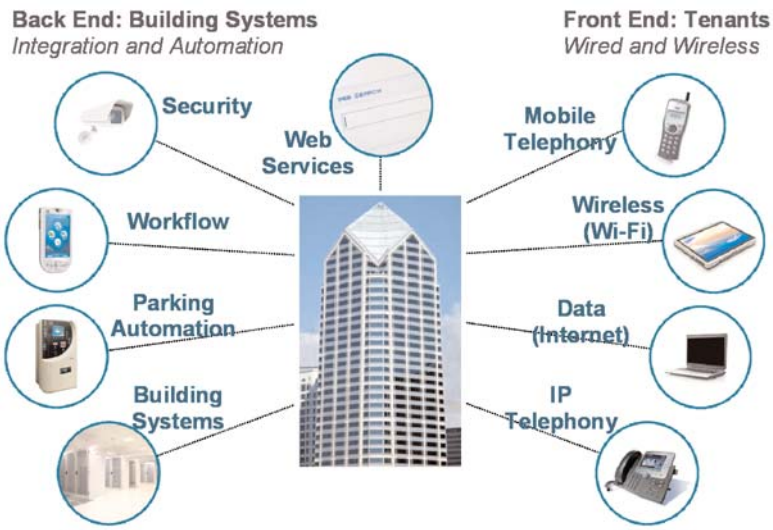


This value creation was felt by most participants in the project, resulting in new profits for CityStars owners, developers, managers, and merchants, high satisfaction ratings from tenants and visitors, and reports of increased employee productivity. Over time, the infrastructural soundness, technological flexibility, and staff output improvements derived from Cisco Real Estate Industry solutions will account for major savings related to a 95 percent portion of total operating cost. Moreover, the high quality of Cisco's services and the desirability of its IP network help CityStars and its tenants cut costs and increase revenue related to partner management, speed of service delivery, systems control, systems maintenance, and resource replacement. More importantly, CityStars' Cisco Unified Communication network has the flexibility built in to both scale up services to encompass additional properties and to integrate additional revenue-generating differentiable services, such as digital signage and multimedia presentations.

THE NEXT BIG THING

Today's building goes beyond the simple provision of shelter to serve as a dynamic environment that responds to occupants' changing needs and lifestyles. Accordingly, the greatest transformation has occurred as a result of new technology and the processes technology allows. As technology advances, and as information and communication expectations become more sophisticated, networking solutions converge to improve responsiveness, efficiency, and performance. In the recent past, buildings were considered wired when they offered Internet connectivity and multimedia systems. However, intelligent buildings now combine data, voice, and video with security, HVAC, lighting, and other electronic controls on a single IP network platform that facilitates user management, space utilization, energy conservation, comfort, and systems improvement. Fully networked systems transcend integration to achieve interaction, in which the previously independent systems work collectively to optimize the building's performance and constantly create an environment that is most conducive to the occupant's goals. Additionally, fully interoperable systems in intelligent buildings tend to perform better, cost less to maintain, and leave a smaller environmental imprint than individual utilities and communication systems. As a result, tenants, merchants, and consumers will pay a premium for intelligent real estate because it improves the user experience and minimizes resource utilization, as opposed to simply responding to needs.

Figure 4 – Network as the Platform for Converged Services



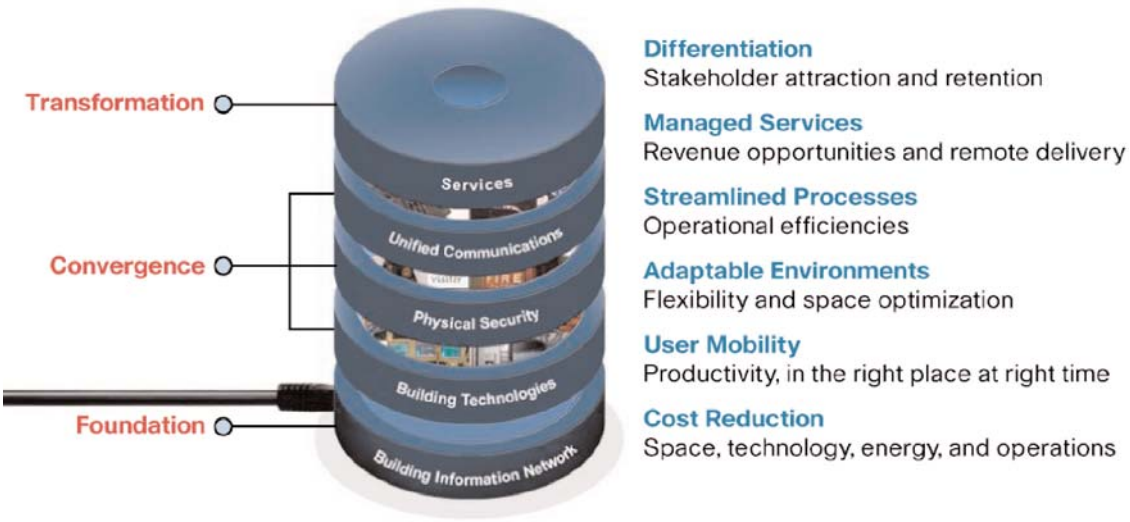
Given the increasingly competitive business environment for real estate, the presence of value-adding network and communications technology serves as a compelling differentiator in a market increasingly saturated with look-alike properties. Converged IP technologies, integrated into the conceptual or pre-construction phase of development, not only increase the value of the property due to sustainability, flexibility, and operating cost savings, but also are the means by which owners and managers gain a crucial marketing advantage. Dynamic services made possible by Cisco's converged network solutions set apart real estate properties in ways that more traditional, static, or aesthetic differentiators cannot. More importantly, Cisco Real Estate solutions offer merchants, tenants, and consumers differentiated services that they value and can monetize. For example, the hospitality industry can generate more revenues from en suite wireless and connected video that keeps travelers linked to business priorities than from plush lobbies and ornaments. An apartment complex's state-of-the-art converged data, utilities, and media systems help tenants work from home and control their living environments remotely. In the retail setting, digital signage that interacts with parking, security, lighting, sound, and merchant-generated data can drive customer flow throughout a shopping mall more cost-effectively and with better results than traditional advertising, because the Cisco Real Estate solutions integrate dynamic, real-time information.

Office buildings that allow convergence multiple data, communication, and security functions on a single platform allow organizations to capture, manage, and distribute knowledge dynamically, which reduces the cost of doing business. The CityStars experience has demonstrated that all these approaches are not only viable, but profitable in practice.

REDEFINING THE RULES

Cisco's converged network and services for intelligent real estate set new standards for the interaction between systems. Intelligent buildings allow all types of users to improve efficiency and reduce operating expenditures while creating opportunities for unique interaction between buildings and their users. Cisco's Unified Communication solution for CityStars in Cairo created a platform for the buildings' individual systems, which minimized the resource needs of each and stimulated a multiplier effect for all. The centralized platform permits owners, managers, and tenants to monitor, maintain, and control many properties' systems simultaneously, irrespective of location. Cisco's technology also helps these factors drive some of the business functions of the buildings' occupants as a value-added service, both differentiating through service and creating revenue-generating opportunities that previously did not exist.

Figure 5 – Cisco Connected Real Estate Value Foundation



The wave of network convergence spearheaded by Cisco in Cairo and around the world creates new opportunities for key stakeholders in the building value chain. Building systems have historically been constructed and operated in a very static and discrete manner, restricting functional interaction and increasing waste. Traditional building design requires proprietary networks to manage telecommunications, data, security, HVAC, utilities, lighting and several others individually. Cisco Connected Real Estate, on the other hand, creates a platform that lowers installation and construction costs, reduces operating costs related to maintenance, upgrade, replacement, and scaling; and decreases retrofit costs for property reassignment. More importantly, as seen in the CityStars project, Cisco's intelligent real estate solutions also simplify otherwise complex networks, improving management and control through automation and single-platform convergence within and between buildings. Cisco Unified Communication creates new revenue-generating opportunities, and minimizes environmental impact for real state.

Development of the King Abdul-Aziz Endowment Project

CASE STUDY OBJECTIVE

Traditional buildings have been beset by problems that are often considered the usual suspects in an IT setup such as security, robustness, manageability, reliability, maintainability and redundancy. The evolution of the Internet has resulted in the steady application of the convergence approach to effectively integrate and cost-effectively manage building automation systems and services resulting in increased savings and reduced capital expenditures.

In examining the intelligent technologies and features from CommScope's Intelligent Building Infrastructure Solutions (IBIS) at the King Abdul-Aziz Endowment Project, this case study demonstrates how a converged physical layer infrastructure provided operational excellence as well as ease in maintaining individual system functionality, minimized upfront costs due to labor and material savings, increased lifespan and durability and reduced maintenance costs resulting in various direct/monetary benefits. An additional benefit is the relative ease of future expandability involving minimal disruption, the result of which is a faster Return of Investment (ROI), better utilization of installed cabling and a lower total cost of ownership.

PROJECT OVERVIEW

BT Applied Technology (BTAT), based in Saudi Arabia with a growing global reach, specializes in providing software, hardware and building management integration using network technology. BTAT was the design engineer and technology integrator for the development of the King Abdul-Aziz Endowment Project.

From conception to planning and implementation to operation, BTAT was responsible for selecting and leveraging the cooperative efforts of companies involved in delivering an integrated network solution. In order to move away from the conventional physical infrastructure design to a more integrated approach, BTAT reached out to CommScope and it's IBIS solutions to help in the supply chain and product delivery of a converged physical layer infrastructure. The cabling design had to follow international industry standards with consistency of planning and implementation across subsystems and projects, making for a predictable and efficient workflow.

PROJECT OBJECTIVES

Capital expenditures (CAPEX) are expenditures creating future benefits. A capital expenditure is incurred when a business spends money to buy fixed assets or add to the value of an existing fixed asset with a useful life that extends beyond the taxable year. An

operating expenditure (OPEX) is an ongoing cost for running a product, business or system. It is a common understanding that the cost of communication wiring in an intelligent building project may be over 15 percent of the total cost, often caused by separate and proprietary cabling installed for several control systems and data communication. Ultimately, this translates into more CAPEX and significantly more post installation OPEX for maintenance and upgrades. The project was to reduce CAPEX and OPEX using a converged physical layer infrastructure using CommScope's IBIS solutions.

- Reduce CAPEX:
    - Converged physical layer infrastructure, consolidated cabling – all using Unshielded Twisted Pair (UTP) cabling, except Fire, Life, Safety (FLS) and Public Address (PA) system
    - Converged backbone versus a separate backbone for each separate system
    - Common containment space versus separate containment space if separate infrastructure had been deployed
    - Common data equipment to serve multiple systems versus multiple different equipment to serve each system
    - Installation costs are reduced based upon familiarity of the physical layer infrastructure used
    - Architecture allows for seamless introduction of new Internet protocol (IP) systems and solutions
- Reduce OPEX:
    - As many IP systems as possible – easier to manage
    - Easier remote access and monitoring via Web-based solutio
    - 12 IT people managing all IP systems in the following::
        - 11-story podium (that will ultimately support 7 towers) with commercial space
        - A 34-story tower
        - Two 44-story towers

FACILITY

Project name: The King Abdul-Aziz Endowment Project located in Makah, Saudi Arabia

Overall project size:

- Planned total of seven towers, the highest reaching 531 meters
- Towers range from 34 stories to 90 stories (four towers built and three towers to be built)
- Approximately 40 rooms per floor
- All towers sit on an 11-story podium that houses commercial space (Restaurants, shopping center, clothing stores, etc.)

Physical Layer:

- 9,000 kilometers of SYSTIMAX® Cat 6 UTP copper cabling
- 100,000 RJ45 outlets (all managed, using CommScope's SYSTIMAX iPatch® System of Intelligent Building Infrastructure)
- 10,000 kilometers of fiber
    - Single mode (fiber backbone)
    - Single mode & multimode (OM3) in the data centers

Space:

- Total built up area of 1.4 million m2
- Supports up to 75,000 tenants
- Two network operating centers (NOCs)
- Nine building distribution rooms (BDRs)
- 531 floor distribution rooms (FDRs)

RESULTS

The project resulted in a highly integrated intelligent building using a converged physical layer infrastructure.

IP everywhere solution:

- IP Telephony, IP Pay Phones, IP FAX, IP DATA, IPTV, IP ATM, IP Point-of-Sale terminals (POS), IP Access Control, IP Video Surveillance, IP Door Locks, IP Audio

- Digital signage - Advertising screens throughout the buildings, including in the elevators

CAPEX

- Estimated 33 percent reduction in cost due to avoiding redundant cabling and containment space (and labor, scheduling, commissioning, etc.)

OPEX

- One system administrator (IT) versus ratio of seven administrators (CCTV, Advertisement, TV, Public Address, Data, Access Control, and Telephone)

- Reduced cost in Operation Administration & Maintenance (OA&M) and Moves, Adds, and Changes (MAC) work using SYSTIMAX iPatch Intelligent Building Infrastructure behind every outlet

A building today utilizes many different systems, including (but not limited to) close circuit TV's, HVAC (heating, ventilation and air conditioning), advertisement displays, data networks, access controls, lighting control and telephones. In the past these various systems had their own administrator and took up a large amount of space. In the King Abdul-Aziz Endowment Project, these various systems connect on a grid and converge into a single integrated system. The key to integrating these systems is the facility's common IP backbone. The various systems are connected to the IP backbone enabling easy communication and control of the plethora of systems through what BTAT calls a unified outlet.

The ultimate goal of this project was centered on the Fourth Utility Concept. The first three utilities are water, electric and HVAC. IP, the fourth concept, is a new advancement for building technology. The fourth concept consists of IP-enabled systems over a common cabling infrastructure as the center for integrating telecom, office automation and building automation systems. This project set out to implement the Fourth Utility Concept in the integration of the building by reducing CAPEX through consolidation of all UTP cabling, except the fire/life/safety and the PA systems, and then reducing OPEX by using native IP and intelligent patching throughout the buildings.

To realize the Fourth Utility Concept through the integration of the different systems there needs to be materials within the infrastructure to support it. The towers contain 100,000 outlets, which are all managed using SYSTIMAX iPatch Intelligent Building Infrastructure with both copper and fiber cabling. There are 10,000 kilometers of fiber cabling containing single mode fiber backbones, single mode and multimode (OM3) fiber in the data centers, and 9,000 kilometers of SYSTIMAX Category 6 UTP copper cabling.

CONVERGED PHYSICAL LAYER INFRASTRUCTURE OVER IP

The evolution of the Internet, apart from spawning consumer Web powerhouses, also has resulted in the steady application of networking principles to integrate and manage building automation and management services across Wide Area Networks (WAN) and even Metropolitan Area Networks (MAN). Initially perceived simply as a passive purveyor of information, the Web has assumed an integral role in the functioning of enterprise tools such as Enterprise Resource Planning (ERP), Material Resource Planning (MRP), Customer Relationship Management (CRM), Remote Monitoring, Web Services and Cloud Computing. These and other customized tools have resulted in a significant increase in the exchange of dynamic data, redefining the way in which people interact with their IT systems.

The key components and benefits of a converged physical layer infrastructure and IP are:

- Easier deployment and commissioning of Building Automation Systems (BAS) using Ethernet/IP
- IP-based communications over Ethernet is replacing proprietary BAS interfaces and protocols
- Lower implementation cost
- Reliability and interoperable (LAN and WAN)
- Relatively simple to design, install and maintain
- Scalability: Ease of migration to higher data rates
- Familiar management tools and common skills base requiring minimal retraining when converged onto the IT infrastructure
- Provide lower operational and maintenance cost by using the Internet (via Web browser) as opposed to leased lines
- Logical and Physical addressing
- Ethernet is ideally suited for structured cabling
- Provides enhanced Quality of Service (QoS)
- Ability to encrypt voice, data and building system data as needed
- Additional fault tolerance due to TCP/IP stack services and higher layer services

IP convergence is becoming a reality and the days of separate voice and data networks are becoming a thing of the past. Adopting open system architecture and implementing ISO specifications, CommScope can significantly increase the lifespan of significant portions of

cabling infrastructure in a building obviating extensive changes or expensive upgrades, enabling various office systems like telecommunication systems, office automation systems, and building automation systems to dramatically minimize the cost of upgrades dramatically. These added functionalities result in simplified administration and maintenance processes which enable cost-effective responsiveness to increasing building and occupant needs.

Minimized upfront costs due to labor and material savings, increased lifespan and durability and minimal maintenance costs are various direct/monetary benefits that can be realized. By adding the relative ease of expandability involving minimal disruption, the logical outcome is faster ROI, better utilization of installed cabling and a lower total cost of ownership. Traditional buildings have been beset by problems that are often considered the usual suspects in an IT setup such as robustness, reliability, redundancy, security, manageability and maintainability. CommScope realizes this as an opportunity to achieve significant financial and operational benefits for building owners and managers.

IP BASED VERSUS TRADITIONAL SOLUTIONS

There are elemental differences between the employment of IP-based technology versus traditional technology in a building's infrastructure, data equipment, system operation and maintenance, installation cost, remote access and monitoring, compatibility, redundancy and future expansions.

- With respect to the physical layer infrastructure, the traditional approach requires separate cabling for each system, while IP allows for a single cabling solution for all systems.
- Data equipment is only used to serve the Internet with traditional systems, while with IP it can serve all the systems.
- In system operation and maintenance, a traditional solution uses one support team per system, but with IP there is one support team for all systems, which lowers OPEX.
- The installation and commissioning costs are higher for traditional solutions because of multiple subcontractors and vendors, and it is lower than traditional systems when using IP because there can be one system integrator.
- Remote access and monitoring would need extra equipment while lacking flexibility if a traditional solution is used, but with an IP-based solution it only uses a web-based solution.
- Compatibility varies from one vendor to another within traditional solutions through its use of proprietary technology, but there are open standards in IP solutions.
- Redundancy within traditional solutions varies from one vendor to another with its use of propitiatory technology, where IP solutions are fully redundant.

- The future expansions of a building using traditional solutions would necessitate new equipment, cabling and civil works, but an IP-based solution provides easy expansion and hardware upgrades and software.

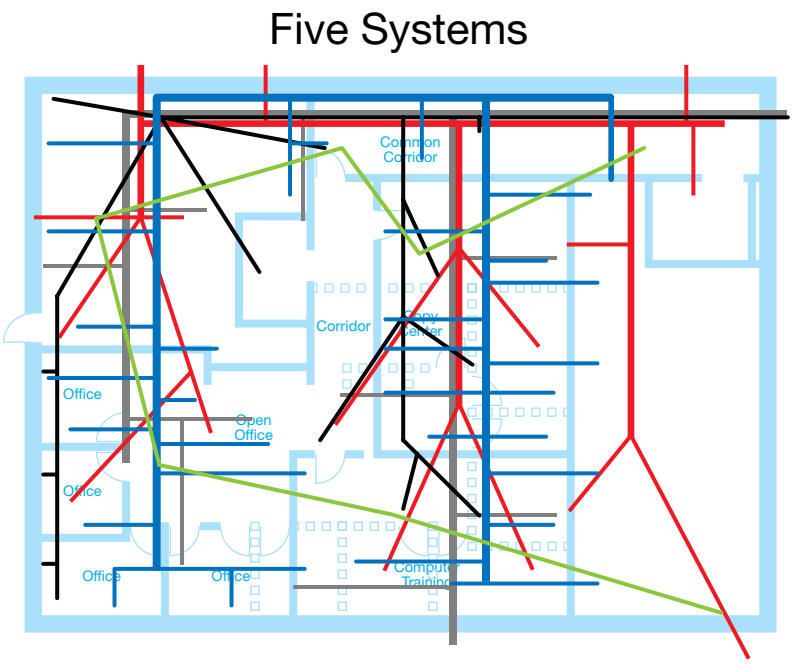
By consolidating/integrating cabling from multiple systems, material and labor inputs can be reduced, thus providing savings in initial construction costs. Empowering a unified team of professionals to implement the cabling process can reduce the time spent in project management.

COMMSCOPE INTELLIGENT BUILDING INFRASTRUCTURE SOLUTIONS (IBIS)

Traditionally, amidst all the typical gadgetry and high-tech equipment in a building infrastructure, cabling has been considered as another mundane element comprising the physical network. With the explosion of the Internet becoming an integral part of most buildings and the subsequent advent of video and multimedia content, video conferencing, telepresence and complex high-bandwidth applications, buildings increasingly require more robust communication infrastructures. By integrating HVAC, lighting, video surveillance, access control and other integral components, the management and maintenance of these systems have become vastly simplified. This integration, however, has brought to the forefront the vulnerability of the underlying infrastructure.

In a typical large building, there are multiple low voltage systems, which may seem a nightmare for the average IT/ facilities manager. As shown in Chart 1, the plethora of cabling for HVAC, fire, life safety, security, voice and data, and paging alone can contribute a great deal of complexity to a building's cabling infrastructure.

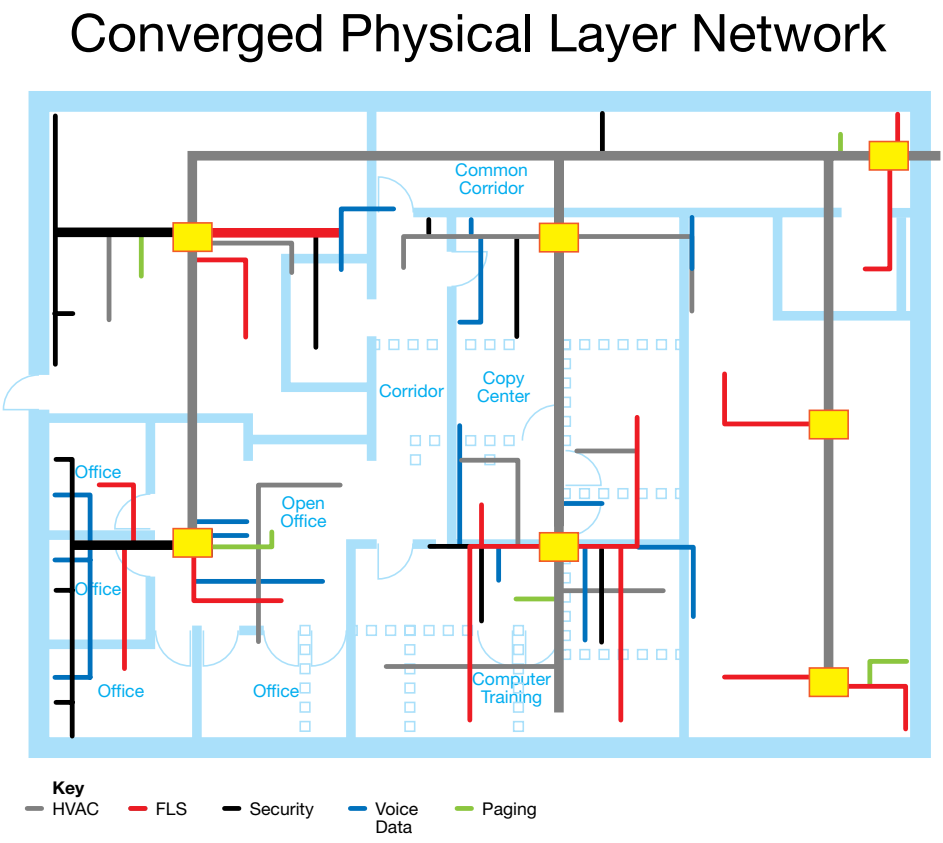
Chart 1 - Building Cabling Wiring Showing a Typical Super-Imposition of Five Cabling Systems



In the example, each cabling system is seperately installed by different contractors not coordinating or collaborating together upfront. This frequently leads to expensive redesigns and time consuming changes throughout the building's life cycle.

In contrast, as seen in Chart 2, an IBIS system provides the same level of connectivity with much lower complexity in installation, maintenance and redesign/modification. This ease of operation generates substantial savings and makes a strong business case for building owners and managers to consider such options based on first cost and lifecycle costs.

Chart 2 - Building Cabling Diagram Showing an Intelligent Building Infrastructure Solution (IBIS) Implementation



Engineers involved in maintenance or modifications to building wiring infrastructure understand and value the facts that maintenance windows are shorter than ever, and any change to the network must be made quickly and accurately. Considering the impact of network outages on the productivity of internal customers or external interfaces like transactional web sites for the general public or customer-focused intranet, any change or modification has to be right the first time, every time. When downtime can cost millions of dollars per hour and the subsequent potential loss of goodwill and reputation, it is imperative to minimize the possibility of any connectivity related downtime.

CONSIDERING A ROBUST BUILDING INFRASTRUCTURE

Seamless access to the corporate network is necessary for today's corporations, and this inevitably makes various MAC demands on the network. To ensure valuable time and resources are not lost, misplaced or misused, significant effort and manpower resources are required to administer them. Typically any MAC changes prompts questions for the engineers/technicians like:

- Are you in control of your network infrastructure?
- How many hours are consumed chasing down the unknown?
- Can you report switch capacity accurately?
- Are you in compliance with IT policies and other regulations?
- Can you prove it?
- Do even simple changes cause downtime? How quickly can you recover?
- How much does it cost to do an annual audit? Do you know?

Satisfactory response to such questions realistically depends on the infrastructure the building owners, managers and engineers have in place in their buildings. Dealing reliably with system and component failures when compared to existing solutions is very important as conventional techniques fail to provide effective resolution and are incapable of problem isolation. The solution has its roots in areas such as ensuring sufficient redundancy in cases where individual controllers can work even after a loss of communications with the main controller, enhancing design-tool integration and developing effective automated diagnostic tools. This is an area where SYSTIMAX iPatch Intelligent Building Infrastructure solution excels.

To successfully overcome the concerns and meet the efficiency objectives facing IT and facility managers, the right solutions need to be focused on addressing the following challenges:

- Bandwidth capacity
- System robustness
- System reliability
- Network security
- Network manageability
- System and network maintainability

Revenue generation from properties depends on these critical capabilities, and has to be a top priority for people responsible for making certain every asset has a positive impact on the bottom-line.

CONSOLIDATED ENTERPRISE IT NETWORKS

Enterprise IT networks need to be agile and nimble to cope with the rapid pace of change associated with organic growth, acquisitions or implementation of new applications. As corporations expand, bandwidth capacity, reliability and security of the infrastructure become potent issues that require thoughtful consideration. The SYSTIMAX iPatch Intelligent Building Infrastructure System can empower IT and facility managers with the visibility and control over their network, reducing scheduled and unanticipated downtime, increasing revenues by incorporating high-speed applications and increasing productivity with better management of MACs. Consolidation drives the need for quick, accurate changes along with more effective planning tools. As more computing power and storage is concentrated in mission-critical data centers, reliability, availability and security become paramount.

INTEGRATED STRUCTURED CABLING INFRASTRUCTURE

A converged physical layer infrastructure can lower construction costs, optimize operational expenditures and eliminate dealing with multiple contractors while simplifying the installation process to minimize potential system conflicts and reduce implementation timelines.

Benefits resulting from consolidation of the structured cabling in a construction or retrofit project are:

- Operational efficiencies
- Reduced infrastructure materials
- Reduced maintenance
- Increased productivity
- Real-time reports and monitoring

By consolidating/integrating cabling from multiple standalone systems, material and labor inputs can be reduced, thus providing savings in initial construction costs. Empowering a unified team of professionals to implement the cabling process can reduce the time spent in project management. Integrating various systems to reduce complexity can enable quick service provisioning for occupants and tenants resulting in ease of maintenance and configuration of various outlets and ports.

Facility owners would take advantage of lower financing costs because of a faster occupation rate as a result of faster commissioning. Also, facility owners can typically command a premium on rent based on the ease and flexibility afforded by the infrastructure in deploying technologies to suit customer needs. In addition, by following and implementing industry-approved standards, outlets are standardized to simplify upgrade opportunities. Standardization also ensures multi-vendor compatibility, thus promoting competition between various suppliers resulting in price competitive product or solution offerings. Furthermore, by adopting zone-based architecture (as supported by the TIA/EIA 862 standard), BAS equipment can be centralized to optimize location spaces.

Another major advantage to zone-based architecture is that it's application independent and expansion-friendly. If there are changes in building usage resulting from tenant mobility or re-layouts, a minimal amount of cabling is removed thereby restricting the disruption, the subsequent wastage and hence containing the cost.

INTELLIGENT BUILDING INFRASTRUCTURE SOLUTIONS

As technology and connectivity demands continue to spiral, communication infrastructures need to become more intelligent and robust to accommodate these changing needs. An intelligent infrastructure solution provides the foundation to a reliable and high-performing communication infrastructure and a strong backbone to power the lifeline of an enterprise. The solution delivers a complete end-to-end physical layer solution, including cables and connectivity, enclosures, intelligent software and network design services for business enterprise applications. Typically, cost of communication wiring in a building automation project may be over 15 percent of the total project cost.

The converged physical layer infrastructure at the The King Abdul-Aziz Endowment Project demonstrated how a converged infrastructure provided operational excellence as well as ease in maintaining individual system functionality, reduced CAPEX by approximately 33 percent, increased lifespan and durability, and minimized OPEX by lowering maintenance and administration costs. By adding the relative ease of future expandability involving minimal disruption, the logical outcome is faster ROI, better utilization of installed cabling and a lower total cost of ownership. The advantages of these IP-based solutions allow for efficient integration within the building while also providing for easily executed future expansions and improvements.

CONCLUSION

In addition, to all the other benefits outlined in this case study, a converged physical layer infrastructure is a greener approach to cabling new buildings and retrofitting existing buildings. The green benefits achieved from this approach are:

- Reduced infrastructure materials
- Faster installation, fewer contractors, less site disruption – smaller carbon footprint
- Reduced maintenance – smaller carbon footprint
- High recycle content (copper)

This case study demonstrated how BT Applied Technology and CommScope brought a new approach to intelligent building infrastructure design by converging a building's many systems, from security to lighting to communications, onto a common infrastructure backbone. This convergence approach to network infrastructure, offered through the SYSTIMAX brand of offerings enables building owners to more efficiently and cost-effectively manage building operations resulting in increased savings and reduced business expenses.

Kwantlen Polytechnic University's Trade & Technology Centre in Cloverdale a Delta Controls Project

CASE STUDY OBJECTIVES

In examining the implementation of Delta Controls' integrated building automation system (BAS) at Kwantlen Polytechnic University Trade and Technology Centre campus, in Cloverdale, BC, this case study will explore how the BAS enables Kwantlen to easily monitor and control mechanical equipment and lighting systems to ensure peak performance and energy efficient operation. By utilizing Delta Controls' technology and the Delta Partner's engineering expertise, Kwantlen has been able to achieve significant energy savings and associated cost avoidance. The case study will assess the following factors on intelligent and green measurements:

The case study will assess the following factors on intelligent and green measurements:

- Integrated design process (IDP)
- Integrated BACnet lighting, HVAC, security, and third party systems
- Tracking and monitoring of system performance
- Student and faculty surroundings and comfort
- LEED Gold

THE FACILITY

This project leveraged many systems to deliver a complete facilities management solution to meet the sustainability goals set out by Kwantlen. The environmental approach to construction at the Cloverdale campus benefits everyone concerned. Not only will the facility save energy costs up front, but it will also be assured that significant savings will continue for the life of the building. The goal of deploying Delta's integrated BAS was to bring rapid and quantifiable cost savings and to provide facility managers with the information they need, on a real time basis, to take smart decisions.

Kwantlen Polytechnic University in Cloverdale develops bachelor's degrees and other applied credentials to successfully meet the evolving needs of regional and global employment markets. Kwantlen currently offers several bachelor's degrees, with many more under development. Kwantlen students have a unique opportunity to bridge certificate and diploma credentials into bachelor's degrees, creating the option of academic and professional enhancement of applied and technical programs. Some of the bridging options link trades programs offered on this campus to Kwantlen's business degrees.

In 2001 Kwantlen Polytechnic University committed to reduce energy consumption by 45 percent in electricity, 25 percent for natural gas, and reduce total greenhouse gas (GHG) emissions by 20 percent per square meter by 2010. The focus of this case study is on Kwantlen Polytechnic University's Cloverdale campus, a new high-tech facility and LEED Gold candidate:

- Three major building blocks with classrooms, workshops and academic facilities
- 185,177 square feet
- Project value $42.3 million
- Officially opened in April 2007

PROJECT OVERVIEW

Meeting student and faculty needs, reducing maintenance and energy costs, and allow for future expansion were the main objectives for this project. The campus includes multiple buildings that require monitoring and control, including classrooms, office areas, workshops and laboratories. Kwantlen wanted a cost effective building management system that will save energy from the date of installation. To be able to meet the requirements of its growing community, Kwantlen has made environmental sustainability an integral part of its building operations. Kwantlen's Executive and Energy Management Team commissioned Delta Controls partner, ESC Automation, with several priorities to ensure:

- Optimization of energy consumption
- Reduction of carbon footprint
- Achieving LEED Gold Standard
- Total cost of ownership principles for energy and resource efficiency
- Exceptional environmental experience for students, employees and the community
- Tracking, monitoring and reporting capabilities

While the design of the project was still in its infancy, Kwantlen decided to use the integrated design process (IDP), where stakeholders, including the owner, architects, design team, and cost consultant, and the commissioning agent together discussed the design objectives including energy efficiency and student comfort. In the IDP, the goal was to achieve integration of technologies, engineering expertise, and solutions to allow for a high level of connectivity and visibility.

To design for an intelligent facility that could provide improved occupant comfort, interaction, and collaboration, the IDP team was tasked to design how students and faculty circulate in and outside the campus. There were four key partners involved in the design stage of the project, namely:

- Kwantlen's Capital and Construction Team, Energy Management Team and building operators
- Consultants
- Commissioning agents
- Delta Controls Partner, ESC Automation

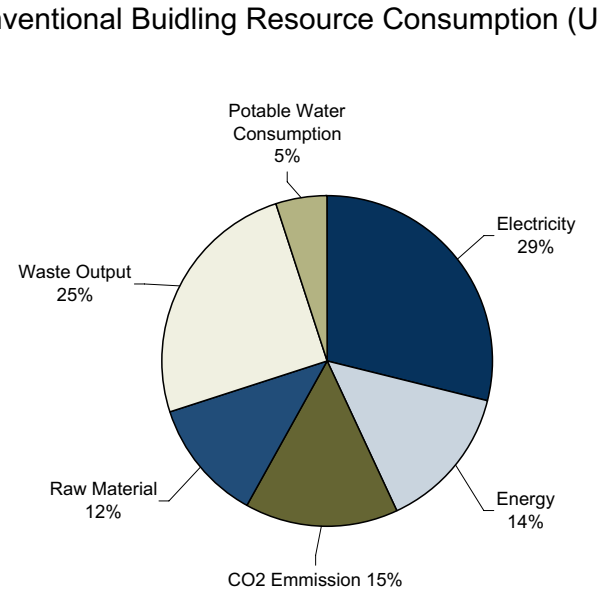
Kwantlen's Executive and Energy Management Team have a strong commitment to improving energy efficiency. A culture of conservation is keenly felt and supported at all levels of the organization. Kwantlen has significantly reduced its electricity and natural gas consumption through proactive energy management and has committed to a program of continuous improvement, dedication and effort. To successfully endorse and fulfill a project of this scope, it was imperative that sustainability be embraced by the project team and at the client level. This imperative led Kwantlen to embrace BAS as a commitment to its environmental stewardship.

ESC Automation using Delta Controls products was selected as the building controls contractor for the team, managing the project controls design and process to allow the facility to realize its optimum performance on energy efficiency, reduced carbon footprint, and provide high-quality environment. Delta Controls' integrated HVAC and lighting, products are designed to work together and make installation easier and less time consuming. ESC Automation was involved from early stages of design through final commissioning, training and service. ESC Automation installed and serviced Delta Controls' building control systems at the Cloverdale campus. As the construction arm of Delta Controls, ESC implemented the Direct Digital Controls (DDC) for control, integration and monitoring the facilities' performance optimization.

MODELING FOR GREEN AND ENERGY SAVINGS

Energy modeling reviews the potential effect of mechanical and electrical system impact on future predicted energy efficiencies. Energy modeling also provides predictive operating budgets to forecast the budget for a new building. The model helps to target areas of the building that are large consumers of energy such as HVAC and lighting.

Chart 1 – Resource Consumption Breakdown of a Typical Building

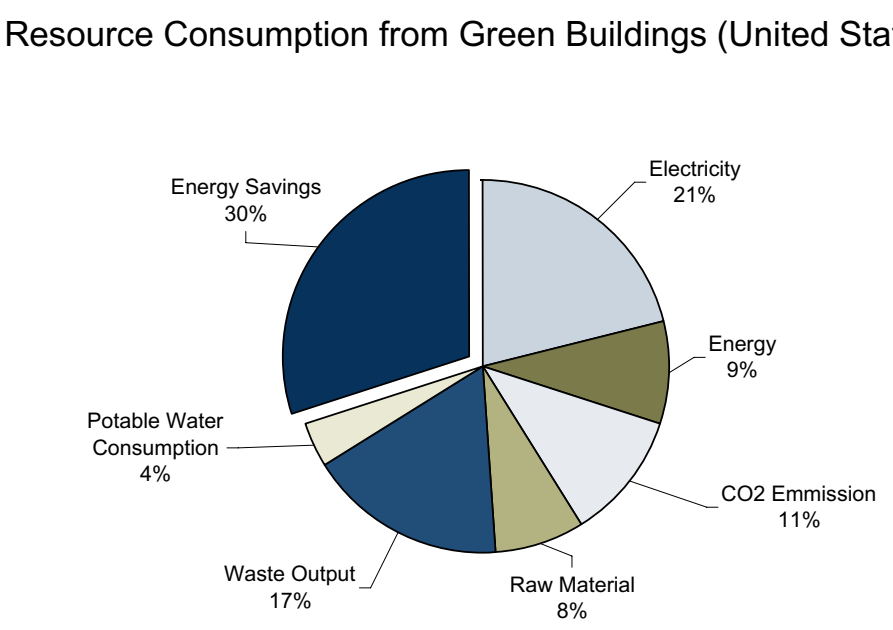


Source: U.S. Green Building Council (USGBC)

Energy modeling is utilized during the design concept stage and involves the use of sophisticated software to predict the annual energy consumption of a proposed building. The model is used to analyze the cost and energy impacts of various energy efficiency upgrades. The model becomes a powerful tool allowing the building owner to choose which energy efficiency measures provide the best financial return. Life cycle financial benefits of adopting green technologies significantly outweigh the additional initial cost associated with green buildings.

The United States Green Building Council (USGBC) estimates that green buildings, on average, currently reduce energy use by 30 percent, carbon emissions by 35 percent, and water use by 30 to 50 percent, and generate waste cost savings of 50 to 90 percent. In addition, green buildings can help foster stronger communities and provide important benefits to human health and productivity.

Chart 2 – Resource Consumption Savings from a Green Building Compared to Conventional Buildings



Source: U.S. Green Building Council (USGBC) and Frost & Sullivan

RESULTS

Additional time and effort goes into designing, specifying and constructing a green building. The payoff comes with buildings that not only achieve substantially better performance with regard to the environment, but also in terms of reduced operating costs. The results come in the form of:

- Annual greenhouse gas reductions due to energy efficiency measures
- 30 percent annual energy savings compared to energy code ASHRAE 90.1 -1999
- Occupant comfort and productivity, and improvements to working environment
- Building differentiation via green image, resulting in better occupancy rates

DELTA CONTROLS' PRODUCT SHOWCASE

Some of the key technologies installed include building controllers integrated with lighting occupancy sensors, isolation dampers for rooms with scheduled operating times, digital networked thermostats for precise control and feedback, VFD pumping, boiler controls, motor controls, occupancy sensors triggered by sound in addition to movement, new building management system (BMS), control of exhaust systems, and awareness and training programs.

Interoperability is a key element of the Delta BAS, which can integrate with third party products. Catering to the unique needs of the Cloverdale campus, Delta's system provided intelligent control and comprehensive monitoring of system components, including:

- Natural ventilation
- Heat recovery
- Radiant floor
- Demand ventilation
- Control exhaust systems
- Motion sensors
- Daylight sensors
- High efficiency lighting system
- Condensing boilers
- Security systems

Delta Controls' platform, designed based on HVAC controls, is capable of controlling interior and exterior lighting, all fully integrated, to enhance performance and reduce operating costs. For example, in this facility, the welding hood exhaust systems are automatically shut off when the room's lights are turned off. Motion sensors are used to control the associated lighting and HVAC equipment. The operation of the equipment is cycled based on occupancy.

The Delta platform is BACnet interoperable fully integrated and operated from a single workstation. By incorporating the same core technology and operating software in HVAC and lighting, Kwantlen Polytechnic University's Trade & Technology Centre is able to integrate and easily adapt to ever changing operational scenarios. Delta Control's freely programmable, and open-protocol, BACnet platform supports peer-to-peer data communication, which enables the system to initiate requests for data across different applications and sub-systems directly. Delta Controls hardware is a "Native" BACnet system, making it easy to add to other vendor's BACnet implementations.

The Delta Controls platform provides an operator friendly, integrated system that is able to improve efficiency, productivity, and cost effectiveness. The entire system can be controlled from a single seat workstation or any remote site with Web access. Intelligent building technology such as that developed by Delta Controls is a fundamental requirement for green, sustainable buildings. The requirement of Kwantlen`s green-building systems to interoperate and make automatic adjustment based on dynamic environmental and operating conditions, mandated the installation of an advanced building control system. The key to the solution was the innovative system programming that was developed by the integrated design team, and implemented in the automation system by ESC Automation. Innovative solutions such as those in place at Kwantlens Polytechnic University lie at the core of any intelligent, green building's operation.

LEED GOLD

The Leadership in Energy Efficient Design (LEED) ranking system is the current benchmark for multiple aspects of building quality such as indoor environment quality, energy efficiency, and environmental impact. It is widely accepted that green buildings using the LEED rating system cost anywhere from less than 1 to over 10 percent more than conventional buildings in terms of initial expenditure. However, these buildings are also capable of generating savings worth $50 to 75 per square foot over a 20-year period. As per USGBC, they are able to recover the costs within the first one to two years of the building lifecycle.

The LEED for new construction rating is a point-based system recognizing a building's overall energy, resource, and environmental performance. Using a 69-point scale, the system assesses the sustainability of a building by incorporating regionally weighted credits, such as climatic and geographical implications. For the new construction rating, buildings are awarded points on a 69-point scale and classified as certified (26 to 32 points), silver (33 to 38 points), gold (39 to 51 points) or platinum (52 to 69 points). Where design to a LEED level is required, costs for new construction certification have often been deemed beyond the budget capacity in part due to the commissioning requirement.

The challenge with LEED is that although designing for the first two levels (certified and silver) does not require significantly expensive solutions, designing to gold and platinum levels can require a much more technologically complex and innovative approach that can be far more costly to design and implement. However, following the integrated design process (IDP) approach, building owners can get most of the benefits of LEED without an added premium to construction cost. In designing for LEED, it is imperative to perform a cost-benefit analysis for each LEED point. Then the Integrated Design Team can take suitable decisions as it targets the appropriate LEED certification level.

CONCLUSION

By integrating and simultaneously employing information and energy management strategies in one seamless system, Deltas' BAS has helped eliminate wasted energy at the new Kwantlen campus. In addition, Kwantlen has become a sustainable corporate citizen in its community, providing lasting intangible benefits to the University by combining enhanced efficiencies in energy and resource consumption to achieve lower economic cost, while, also mitigating environmental impact. BAS provides building owners and operators with the ability to save and manage their energy demand, and also reduce their environmental impact by reducing green house gas emissions.

Such positive results and the promise of on-going benefits mark an important step in the integrated BAS industry. With the right project plan and service provider, the proponents of integrated design process and intelligent buildings can be adopted by others for definite returns, as seen in the example of Kwantlen's Polytechnic University Trade and Technology Centre campus.

Providence Newberg Medical Center a project by Trane, Inc.

CASE STUDY OBJECTIVES

In examining the implementation of Trane's Tracer Summit® Integrated Building Automation System at the Providence Newberg Medical Center, this case study will demonstrate how this technology supports the goal of developing an intelligent and green building. It will look at the financial viability of the project both in terms of start-up and life cycle costs and will assess the impact of the chosen technology on other less tangible factors including improvements, to the working environment and the impact of the technology on the overall productivity and comfort for the occupants.

PROJECT OVERVIEW

Faced with rising energy costs and aging infrastructure. In early 2002, Providence Health System decided to invest in building a new medical center, including a 40-bed hospital and medical offices. From the beginning, the approach to design, architecture, and systems selection took an intelligent and green perspective. A major objective of the project was to reduce energy costs over the life of the building by using energy efficient technologies in every facet of design, construction, and operation.

After extensive discussions with architects, designers, consulting, specifying engineers, and green building consultants and a thorough vetting process, Trane was selected to integrate all the HVAC equipment and systems using its Tracer Summit system. The primary factors driving the adoption of HVAC controls included escalating energy prices, environmental concerns, and emphasis on air quality and comfort.

PROJECT RESULTS

Providence Newberg Medical Center was the first Leadership in Energy and Environmental Design (LEED) Gold Certified hospital in the United States west coast. The HVAC system implemented by Trane allowed PNMC to reduce overall energy costs, providing a very favorable return on investment. Occupancy sensors control lighting and HVAC equipment, cycling down systems when they are not in use. The ventilation system does not recycle air inside the building, but brings in 100 percent fresh air, improving indoor air quality (IAQ), and adding to the occupant's comfort and safety.

THE FACILITY

Designed by Mahlum Architects with a total budget of $70.6 million, the Providence Newberg Medical Center (PNMC) is a replacement facility for Providence Newberg Hospital. PNMC is a regional, state-of-the-art medical center featuring the following services:

- General medical
- Surgical
- Diagnostic imaging
- Obstetrics and gynecology
- Pediatric
- Sleep disorders
- Emergency

The facility includes a total area of 175,500 square feet spread over three primary buildings including the Medical Office Building, the Patient & Community Services Building and the Medical Center. The Medical Center occupies 138,000 square feet over three-stories and is connected to the medical offices and administrative building by two, two-story walls of glass. The lower level houses support services including materials management, engineering, housekeeping, bio-med and dietary.

The first floor provides surgical services and outpatient procedures such as laboratory work or diagnostic imaging. Diagnostic imaging equipment includes MRI, CT, nuclear medicine, radiology and fluoroscopy. Surgical Services offers three operating rooms, 18 short-stay rooms and sterile processing. A 15-bed emergency department and a retail pharmacy are also located on this floor.

The second floor includes the main inpatient area of the hospital consisting of a 27-bed medical surgical unit; an eight-bed birthing center (complete with spacious rooms and jacuzzi tubs); and a four-bed intensive care unit. The floor is designed to expand with patient demand. For example, the ICU can expand to eight-beds and the birth center can flow into the medical surgical unit, if necessary. Patient rooms can easily convert into "step-down" rooms for those who require a level of care between the ICU and the general nursing unit. Also located on this floor is inpatient rehabilitation.

THE TECHNOLOGY

To determine the solution it required, PNMC identified several challenges that had to be addressed by the HVAC controls systems.

- Rising energy costs
- Environmental concerns

- Indoor air quality
- Occupant comfort

To meet these challenges, PNMC turned to Trane, which offered several technologies that addressed the facilities challenges and met its goals of building an intelligent and green medical center. The technologies chosen include:

- Tracer Summit System, which forms the heart of the BAS
- CenTraVac™ centrifugal chillers and VariTrane™ air terminal units
- Other support equipment to complete the system

TRANE TRACER SUMMIT SYSTEM - INTEGRATED HVAC SYSTEM

The HVAC system, which typically is responsible for a large percent of the energy expenditure, was the focus. Trane provided digital controls for the entire range of PNMC's HVAC applications. Trane's systems that were installed in this project included CenTraVac centrifugal chillers and VariTrane air terminal units, along with the Tracer Summit System Building Automation System (BAS). The HVAC system is key to providing optimum comfort level to building occupants. It is also a major area of energy consumption and, therefore, efficient handling of the resources will lead to optimum facility operation. The Trane Tracer Summit system is an inherent part of the BAS and provides

- Integrated DDC system solution
- Integrated HVAC and ancillary equipment – two CenTraVac chillers, variable flow chilled water system, eight custom air handlers, over 150 VariTrane air terminal units, over 150 Triatek air valves, pump control, and boiler control.
- Air distribution controls and zone pressure control
- Real time, on demand, temperature control by zone
- Electrical gas, and water metering using industry standard communication interfaces
- Pressurization control for sensitive spaces (surgical suite)
- Audit trail
- 100 percent outside air for improved indoor air quality-
- Alarm management and notification
- On site training
- Commissioning and Energy Conservation Measures (ECM)
- Integration with other systems and devices using open, standard communication protocols

Catering to the unique needs of PNMC, pressurization controls are provided in surgery suites, sterile rooms, and other areas, where there is a need for positive or negative pressure depending on specific requirements. Accurate zoning controls and very tight pressure envelopes are critical requirements of the hospital environment. Additionally, Joint commission audit trails and on-demand reports are required for healthcare organizations. The Tracer Summit System makes it easy to set up trends for multiple data points , providing easy-to-use data logs for historical data and requisite audit trails.

HVAC ENERGY EFFICIENCY GAINS

According to the United States Department of Energy (DOE), energy consumption from HVAC systems accounts for approximately 40 percent of the energy used in commercial and residential buildings, and therefore, represent a major energy expense to focus on when property owners are looking to reduce costs. As a result, the contribution from thermal loads associated with the conditioning of the air from either mechanical ventilation or from infiltration can be a significant proportion of the total energy budget associated with buildings.

HVAC is the key to providing optimum comfort to building occupants. Tracer Summit is an inherent part of the building automation system and provides:

- Adjustable work temperature based on individual preferences
- Distributed control of the indoor comfort conditions at the zone/room level of the building
- Monitored temperature, air quality, air flow speed, and humidity to provide optimum operation facility
- Pre-engineered system optimization strategies to reliably reduce energy consumption

This is a definite advantage for the owner in terms of reduction in operational costs as well as for the environment, as ‘greener’ buildings will help in reduction of greenhouse gas emissions. Additionally, it will help in reducing heat loss in winter and similarly, heat gain in summer, which will ultimately lead to efficient use of energy and sustainability.

Occupants care about their comfort and safety, whereas building owners and managers typically want to maintain a reputation for quality property at a reasonable cost. Facility managers and staff often get caught in the middle, trying to control operating and maintenance costs, while still keeping occupants safe and comfortable.

Energy savings are tangible costs that can be estimated at the end of each month, whereas IAQ and its impact on employee productivity and well-being are less apparent and sometimes overlooked in favor of low operating energy costs. Good IAQ and energy efficiency are often distinguished as being conflicting aspects of a building design.

Trane's integrated HVAC approach shows how good IAQ and energy efficiency in a building are not mutually exclusive. Trane's TRACE™ 700 software facilitates building load and energy analysis, aiding in the proper design of HVAC systems and controls. If a system is properly designed and maintained, the efficiency created will reduce energy consumption sufficiently to compensate for increased ventilation rates and/or lower temperatures and humidity levels in buildings, and still conserve energy. Additionally, any associated higher first cost of the system is more than made up by the energy savings that are generated.

INDOOR AIR QUALITY - COMFORT AND FINANCIAL BENEFITS

Studies have shown significant reductions in worker performance and productivity due to poor indoor air quality. The United States EPA and Department of Energy have estimated that 3 to 20 percent productivity losses can be accounted for by IAQ problems. This represents annual losses of billions of dollars. Sick building syndrome contributes to almost $60 billion in lost productivity and illnesses annually, according to the EPA. Both absenteeism and occupant morale have been shown to be enhanced by dealing effectively with IAQ and noise.

Air quality, temperature, and humidity play an important role to productivity. The air distribution system from Trane is designed to provide 100 percent outside air, improving IAQ to facilitate an optimum patient healing environment, and doing this while being energy efficient.

Poor IAQ has been observed to trigger a wide range of symptoms including:

- Headaches
- Skin irritation or rash
- Sneezing, cough, and/or nasal congestion
- Sore throat
- Eye irritation
- Fatigue
- Nausea / Dizziness
- Shortness of breath
- Allergic reactions
- Depression

In terms of health impacts caused by poor IAQ it is important to note that different people can have different reactions to certain indoor air pollutants. While some people get affected in a particular environment, others may not be so. This inconsistency makes it difficult to identify the sources of IAQ complaints due to the varying levels of sensitivity among occupants.

People with lower immune systems tend to have higher vulnerability to poor IAQ. Trane's Tracer Summit system enables adjustable features for user preference, monitors temperature, air quality, air flow rates, and humidity to provide improve indoor air quality for occupants.

Proper IAQ in a hospital environment is much more critical than in the typical workplace environment because the patients often have a compromised immune system or are just in a weakened physical state which causes them to be highly susceptible to IAQ issues. Due to this, the healthcare industry is extremely vigilant in its efforts to reduce nosocomial, or hospital-acquired, infections. It has been shown that approximately one-third of all hospital acquired infections are caused by airborne pathogens. The use of 100 percent outdoor air in the HVAC system, as well as proper temperature, humidity, and pressurization control help increase IAQ, and reduce the incidence of hospital-acquired infections.

This is especially important in the surgical suite, where favorable patient outcomes, and surgeon comfort are critical to both the reputation and the financial success of a hospital. Surgical equipment, such as those used for cardiac surgery, requires tightly controlled environmental conditions. Orthopedic glues cure faster and more reliably at specific temperatures and humidities. Providing a comfortable work environment helps with the recruitment and retention of top surgeons and surgical teams. Besides, proper control of temperature and humidity provides the ability to quickly modify the surgical suite's environmental conditions in preparation for different surgeons, or surgical procedures, which allows a hospital to maximize the number of procedures that can be performed every day.

Trane's products, ranging from Trace 700, to its wide variety of HVAC equipment, and its Tracer family of building automation controls, provides hospitals with the ability to safely, comfortably, and sustainably run their facilities

INTEGRATE TO OPERATE

The Tracer Summit System has enhanced the visibility of energy conservation practices at PNMC and has improved the facility's ability to actively manage electricity and gas usage. The availability of real-time information provides the necessary intelligence to monitor usage and makes it possible to drive efficiency benchmarking. The powerful software system also monitors the isolation room's pressure control system and the medical gas systems. This monitoring provides multiple points of information and is capable of notifying personnel by email and pagers in the event of exceptions or emergencies. The Tracer Summit System works in concert with the fire/life safety system to provide smoke management and secondary annunciation. For example, in the event of a fire, the Tracer Summit System can quickly shut down fans to restrict air flow and thereby help to contain the fire and/or smoke. It can also coordinate other control sequences in response to other events from the fire alarm system. A Tracer Summit BAS (Building Automation System) consists of a Building Control Unit (BCU) and a PC Workstation that is powered by the Tracer Summit Software. As the nerve center, the Tracer Summit BAS is capable of managing climate, lighting, metering of water, electricity, and gas; thus significantly boosting the building intelligence.

Interoperability is a key element of the PNMC system, and a distinguishing feature of the Tracer Summit System which effortlessly integrates with other vendors' products, namely TriaTek air valves and Haakon custom air handlers, Aaon packaged rooftop units, Belimo PICCV valves, Caterpillar diesel generators, and Multi-mod boiler controllers. The Tracer Summit chiller plant control application provides intelligent control and comprehensive monitoring of system components, including:

- Multiple chillers
- Related pumps and valves
- Cooling towers and ice storage tanks

The chiller plant control application balances system efficiency and equipment runtime to optimize system performance. The application also provides status information that can help with troubleshooting. The status information indicates the status of the chiller plant as well as what to expect next, based on current operating conditions.

WASTE MANAGEMENT

Trane recognizes that inefficient operations and neglected maintenance may result in wasted energy and that aggressive ongoing operations and maintenance is essential to maintaining the facility's LEED Gold status, maintaining comfort, decreasing operational inefficiencies, and preventing a "green" building from turning "brown". Recognizing the fact that continuous improvement and energy efficiency is an integral part of PNMC's sustainability, Trane's Trace 700 and Tracer Summit systems play a vital role in energy modeling, ongoing performance tuning and maintenance, and evaluation of various Energy Conservation Measures (ECMs). These have resulted in closer scrutiny of cooling tower and chiller optimization routines to expand temperature set points and implement reset routines. This has also helped in highlighting the benefits of integration and right-sizing HVAC equipment.

A LEED APPROACH TO HEALTHCARE

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ is the current benchmark for multiple aspects of building sustainability, such as indoor environmental quality, energy efficiency, water efficiency, and environmental impact. Based on LEED-NC v2.2 and the Green Guide for Healthcare, LEED for Healthcare is being developed to meet the unique needs of the healthcare market including inpatient care facilities, licensed outpatient care facilities, and licensed long-term care facilities. LEED for Healthcare addresses such issues as increased sensitivity to chemicals and pollutants, traveling distances from parking facilities, and access to natural spaces.

The PNMC new construction project has achieved the first LEED Gold Certification for a hospital on the U.S. west coast. For mechanical systems, PNMC turned to Glumac International consulting engineers and Trane. Glumac has several years of experience in designing for energy efficiency and sustainability and has completed 20 LEED-certified projects with many more in progress.

As the nation's first 'green' and LEED Gold certified hospital, PNMC relies extensively on the Tracer Summit BAS to efficiently manage its facilities and provide comfort and safety to its personnel and patients. Staff and patient comfort, energy efficiency, enhanced building intelligence, and total system control are the tangible results that the Tracer Summit System has helped provide on this project.

TOTAL ROI AND LIFETIME COST SAVINGS

Trane's technologies will provide PNMC with ongoing annual energy cost savings, and a corrresponding reduction in GHG emissions, resulting in a smaller carbon dioxide footprint for the facility. The solution has also improved IAQ, resulting in improved occupant safety, comfort, and productivity.

By utilizing Trane's engineering expertise and technology, PNMC has also been able to reduce operations and maintenance costs, increase comfort levels for staff and patients, and provide a safer and healthier environment to its stakeholders. In addition, PNMC has become a sustainable corporate citizen in its community, providing lasting intangible benefits to the hospital.

The environmental approach to construction at PNMC benefits everyone concerned. Not only will the facility save energy costs up front, but it will also be assured that significant savings will continue for the life of the building.

GREEN FUNDING

PNMC secured funding in the form of grants, incentives, and tax credits. Energy Trust of Oregon approved a grant for $199,858 through its new Building Efficiency Program, while Pacific Gas and Electrics's Earth Advantage Program has approved a $156,000 proposal to fund the upgrade of generators in return for distributed generation capacity. A $15,000 grant for building commissioning from the Northwest Energy Efficiency Alliance will qualify the hospital for a $141,000 Business Energy Tax Credit through the Oregon Office of Energy. In conclusion, it can be stated that the increased first costs associated with Providence Newberg's LEED Gold certified green and intelligent hospital is offset by the anticipated annual savings realized during its lifetime, making a win-win situation financially and as a socially responsible corporation.

Rogers Centre
a project by Encelium Technologies

CASE STUDY OBJECTIVES

Given that commercial/institutional and industrial buildings account for about half of the total national energy consumption, energy price increases have significant effects on these sectors' operating costs.

In examining the implementation of Encelium's addressable lighting control system at the Rogers Centre, a world class sports and entertainment complex in Toronto, Canada, this case study will demonstrate how this technology supports the goal of developing an intelligent and green building. It will look at the performance criteria for the building including dollars per square foot of electricity, physical performance of the facility, and optimum lighting levels without wasted energy. According to United States Department of Energy (USDOE), lighting typically constitutes 30 to 35 percent of a buildings total energy load. Encelium's integrated lighting control and energy management system has demonstrated lighting energy costs reduction of 50 to 75 percent and average payback period from saved energy of three to five years. The case study will explore the integration of lighting systems with energy management systems and how this integration facilitates intelligent building capabilities, provides a substancial ROI, and green results.

The key aim of this retrofit project was to provide operational excellence using embedded personal control capabilities and enhanced flexibility to facilitate continuous monitoring, diagnosis, and preventive maintenance of the lighting system.

PROJECT OVERVIEW

The Rogers Centre facility management commissioned Encelium's engineering group with several priorities that included:

- Reduce overall lighting energy consumption by 50 percent and deliver a simple payback from energy savings in less than five years
- Provide computerized control of lighting from a central software application
- Providing office staff with personal control of lighting from their desktop PC
- Improve light levels and provide control in all stairways, luxury boxes, walkways, concourses and parking garage areas
- Provide global control of lighting loads in order to manage peak demand

The design approach comprised the following components of the facility:

- Parking garage
- Concourses and stairways
- Offices/media lounges
- Luxury boxes

The retrofit involved changes in these designated areas as shown in Figure1.

Figure 1 - Design Approach, Rogers Centre Project

Area	Design approach
Parking garage	Occupancy sensor based switching control on a zone basis. Additionally 8 ft T-12 96 watt lamps were replaced with 4 ft T-8 32 watt lamps and electronic ballasts
Concourses and stairways	Combination of occupancy sensing and time-scheduled switching (based on building events) was employed. The existing 175 watt metal halide fixtures were retrofitted with two 32 watt T-8 lamps and standard electronic ballasts
Offices	Personal lighting control, time scheduling, daylight harvesting and occupancy sensing technologies. All existing fluorescent fixtures were retrofitted with new dimming electronic ballasts
Luxury boxes	Involved control of lighting and television circuits by time schedule based on the scheduled events in the facility

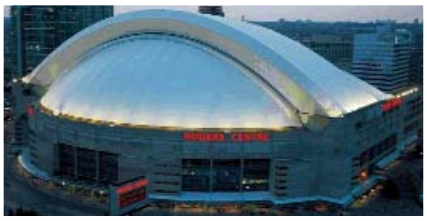
Source: Encelium Technologies

Prior to embarking on the energy retrofit with automated lighting controls, the Rogers Centre facility had an electricity bill exceeding $3 million annually. By the time the project is fully completed, when compared with baseline performance, the project is expected to generate a 76 percent savings in energy expenses from lighting.

The Energy Control System™ (ECS™) from Encelium represents an innovative solution in the area of lighting control and energy management technology. By combining addressable networking technology in conjunction with advanced control hardware and software, the ECS™ was designed to maximize energy savings and provide an ROI that exceeds customer expectations.

THE FACILITY

Rogers Centre, One Blue Jays Way, Toronto, is a world class sports and entertainment complex. Since its opening in June 1989 it has hosted more than 2,000 events with more than 50 million visitors. Formerly known as Skydome, the facility was renamed the Rogers Centre in February 2005.



The facility is capable of accommodating a variety of events such as sports events, concerts, trade shows and conventions, with capacities from 5,000 to 60,000 spectators. The complex contains approximately 7,000 light fixtures distributed over a total area of 1.4 million square feet.

RESULTS

Encelium considers the Rogers Centre project to be its biggest lighting retrofit to date, and the energy savings that are expected to be delivered at the end of the project are significantly large when compared to any other retrofit project. Based on interim assessment and the third party measurement & verification (M&V) process, cost savings reached $325,000 annually after phase 2. With energy reductions of 3,731,000 kWh annually, the project will have reduced its dependency on the energy grid equal to the energy required to power over 400 homes in Toronto.

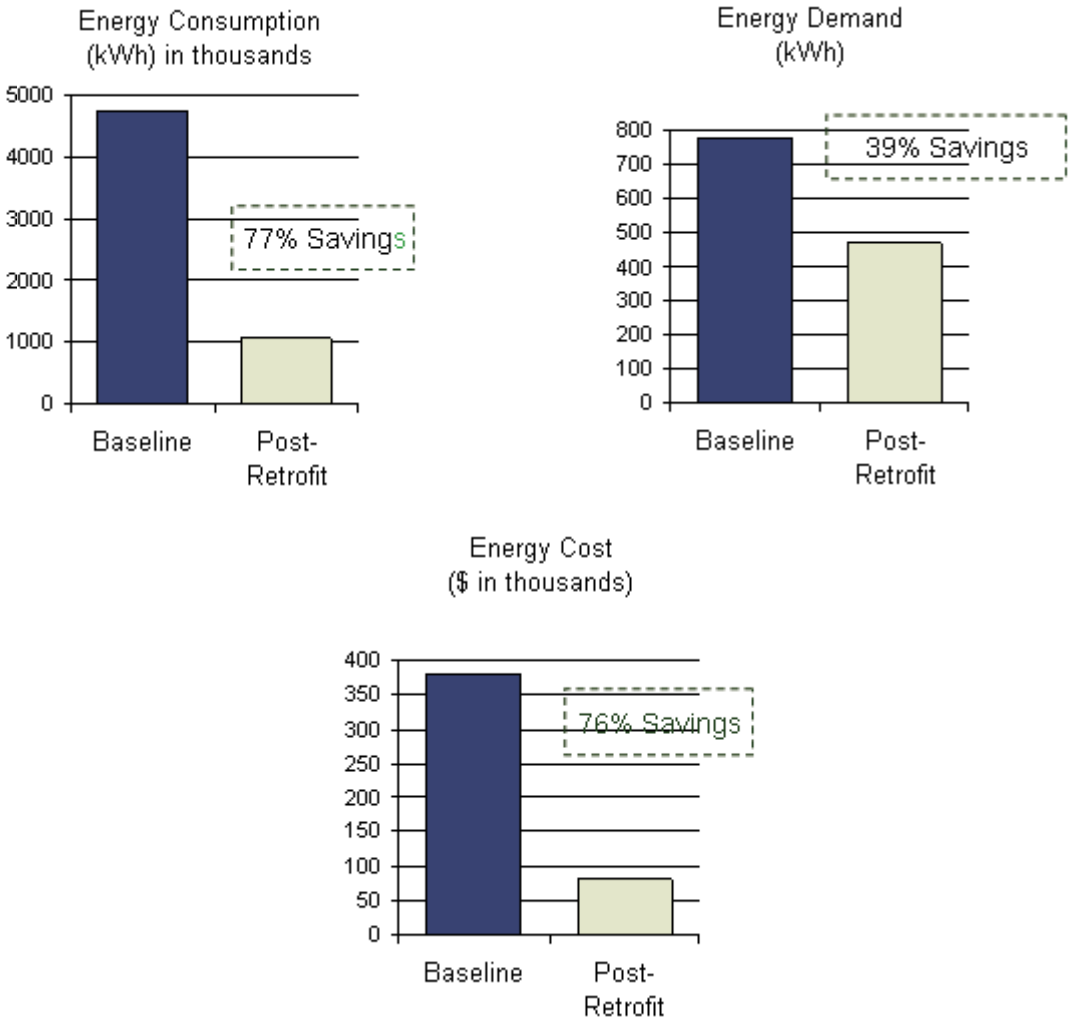
Figure 2 - Costs and savings associated with the Rogers Centre Project

Rogers Centre Project	Project Cost ($)	Annual Savings ($)	Average Payback
Phase 1	370,000	125,000	3 years
Phase 2	500,000	200,000	2.5 years

The project is eligible for rebates and subsidies administered by the Building Owners and Managers Association (BOMA) of Toronto and funded by the Ontario Power Authority, whereby companies can receive $400 for every kilowatt they can reduce during summer peak hours. Subsidies from Ontario Power Authority could offset the capital costs associated with this project by up to 40 percent. The project is expected to act as a signature case in conservation that will prompt other building owners to take on similar endeavors.

At the end of phase 3, when compared with baseline performance, the project is expected to generate a 77 percent savings in terms of energy consumption in kilo watt hours from lighting which translated to a 76 percent savings in terms of energy costs post retrofits, based on data validated by Toronto Hydro Energy Services. Chart 1 depicts the energy savings realized after phase 3 in the Rogers Centre Project.

Chart 1 - Energy Savings Post Retrofits at Phase 3



To document the project's outcome and actual savings and payback generated, a third party audit and verification process was initiated. Toronto Hydro Energy Services was contracted by Rogers Centre to undertake an M&V program to verify energy savings resulting from Encelium's lighting control retrofit program. Pre- and post-retrofit measurements of energy use and power demand were recorded and compared. Current data loggers were used to provide a means of verifying all lighting control strategies.

ENCELIUM ECS™

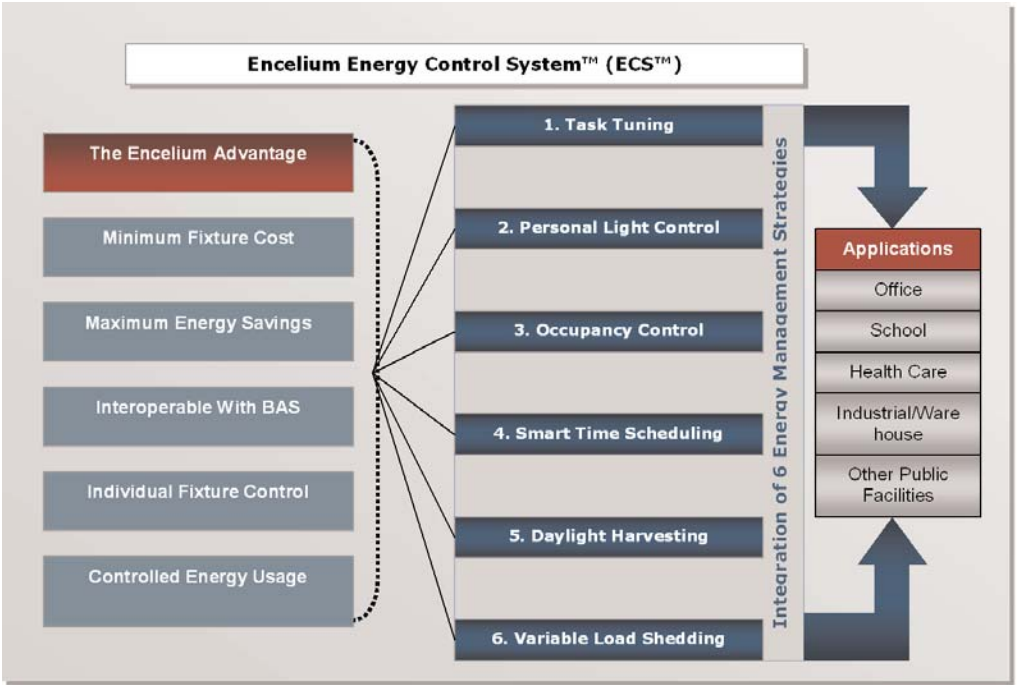
The Energy Control System™ (ECS™) represents an innovative solution in the area of lighting control and energy management technology, by:

- Maximizing Energy Savings
- Optimizing lighting quality and workplace ergonomics
- Providing ease of installation through a simplistic design
- Demonstrating ROI
- Centrally controlling each light fixture in the facility from one software interface

In light of the existing industry dynamics and legislative drivers, the Encelium ECS™ has a very time critical and responsive delivery platform that combines the niche requirements of the market, presents competitive cost advantage and, most importantly, documents the highest energy savings for both new and retrofit applications.

Personal lighting control capabilities, occupancy sensing and addressable dimming are key issues currently driving the interface market. Among system integrators, consulting engineers, and operations managers, there is a common understanding that lighting is one of the topmost areas for saving energy in buildings. Deployment of occupancy and photo sensors provides a cost-effective and simple route to achieving that savings. Going beyond the basic premise that a lighting control system switches light on and off as per a preset schedule, ECS™'s individually embedded software and hardware architecture enable it to control each fixture in a building and assign it with a unique IP address. By taking advantage of low-cost standard components such as analog dimming ballasts, as opposed to proprietary digital ballasts, and connecting an input/output device to make it digital and addressable, the ECS™ provides the same functionality and value to the end user at a reduced cost.

Chart 2 – ECS™ – Integration of 6 Energy Management Strategies



The Energy Control Unit (ECU), an embedded processor, automatically addresses each input/output module in the network of ballasts and sensors using proprietary communication technology called GreenBus™. The ECU collects and processes information received from the sensors and distributes commands to individual ballasts. The distinct advantage of the technology lies in its front-end software, the ability of the system to deploy the six energy management strategies across larger facilities, and unique occupant control capabilities at a comparably low cost, when compared to proprietary protocol-based digital dimming systems such as those using Digital Addressable Lighting Interface (DALI).

Encelium's GreenBus™ communication technology is a bus system designed specifically for controlling lighting to achieve maximum energy savings and optimum lighting comfort. GreenBus™ enables cost-effective, individual dimming control of thousands of fixtures in a building and integrates peripheral devices, such as occupancy sensors, photo sensors, relay-based controls, and low voltage wall controls into a complete, programmable lighting control system. GreenBus™ provides low voltage power to all devices on the network, eliminating the need for external power supplies and power packs for devices such as occupancy sensors. The need for associated installation labor for line voltage wiring and conduit is eliminated. GreenBus™ allows flexible daisy chain wiring topologies and the ability to add fixtures or control devices in-circuit at any time.

The system's functionalities are optimized by liberal deployment of occupancy sensors across the controlled footprint. If occupancy sensors do not detect any activity in a particular part of the building, the system can bring down illumination levels to minimum levels; rather than switching the lights off completely resulting in occupant discomfort.

ELIMINATING ERRATIC ENERGY CONSUMPTION PATTERNS

Lighting generally comprises the largest energy load in a commercial building and is historically the least controllable, with burning hours far exceeding inhabited hours in a building. Dimming the lights at times of peak energy demand works favorably towards flattening out the load profile of the building.

As the peak load requirement of utilities far exceeds the average load growth and the subsequent capital inefficiency of the transmission and distribution (T&D) infrastructure, utilities are adhering to the stipulations of the National Energy Policy that calls for resorting to a 'time of use' pricing schedule. Under such conditions, ECS™ is able to selectively shed as much as 50 percent of a building's lighting load (15 to 20 percent of total building load) over a 15 minute window in a manner that is generally transparent to building occupants. Load shedding can be initiated either in response to a demand response signal, a utility pricing signal, or to shave peak demand and flatten a building's load profile.

INTEGRATION WITH OTHER BUILDING SYSTEMS

A major feature of ECS™ is its ability to integrate with and share data with other building systems such as HVAC, fire, security and card access systems. Encelium's BACnet® IP interface enables the system to share lighting and control status with the building automation system (BAS) in a building. ECS™ not only operates autonomously to control lighting but also shares lighting status, lighting levels, and energy usage through BACnet® for use by other building systems. As part of its continued development and innovation, Encelium has recently launched a driver that is compatible with Tridium middleware, thus

providing interoperability in coherent distributed architectures within a Niagara AX framework. ECS™ can share data and be controlled through the Niagara AX platform or share data across other similar frameworks.

With virtually accurate information about occupancy status in a building, ECS™ can provide valuable information to easily integrate with BAS systems. In a traditional setup, BAS systems by themselves are programmed based on estimated occupancy time schedules, whereas with real time occupancy information, transmitted and shared by the ECS™ with BAS infrastructure, the functionality of the BAS systems is further enhanced. It may be noted here, the ECS™ software is currently being embedded on CISCO IP phones to enable them to control lighting through the CISCO phone interface.

LIGHTING THE WAY

The North American trend in new construction and the retrofitting of existing buildings is essentially combining enhanced efficiencies in energy and resource consumption with a sound asset and capital plan to achieve lower economic cost while, also mitigating environmental impact. It is estimated that optimizing energy use in a building could reduce incremental demand for electricity by 80 to 90 percent. An effective way of achieving this milestone is the integration of lighting controls into a building's operational framework. Lighting currently constitutes a substantial portion of total energy load in buildings, typically in the range of 30 to 35 percent according to the United States Department of Energy's (USDOE) estimates.

Prior to embarking on the energy retrofit with automated lighting controls, the Rogers Centre facility had an electricity bill exceeding $3 million annually. By the time the project is fully completed, when compared with baseline performance, the project is expected to generate a 76 percent savings in terms of energy costs from lighting.

By integrating and simultaneously employing six key energy management strategies in one seamless system, ECS™ has helped eliminate wasted energy from lighting in the facility. From being the least controllable load in a building, lighting can currently be transformed to a "controllable" energy load with ECS™, thereby enabling similar facilities to incorporate lighting as part of a portfolio wide energy management strategy to achieve results that are sustainable in the long term.

Lighting controls provide building owners and operators with the ability not only to save and manage their energy demand, but also reduce their environmental impact by reducing green house gas emissions. Electricity is identified as the single largest contributor to green house gas (GHG) emissions, with buildings accounting for the highest consumption, with future growth projections of nearly 37 percent by 2030.

While demand reduction and energy savings are being prioritized, cost of ownership associated with implementing such techniques can prove to be a deterrent. However, recent industry research indicate that the relatively low-cost abatement potential associated with incorporating advanced lighting controls and integrating lighting controls with the larger building automation network along with demonstrated financial payback can make it an acceptable norm in the building industry.

The State of Missouri a project by Johnson Controls, Inc.

CASE STUDY OBJECTIVES

With approximately 32 million square feet and hundreds of buildings in its real estate portfolio, the State of Missouri spends $300 million annually to operate and maintain existing buildings. As a result of increasing energy costs, escalating real estate costs, and an ever increasing deferred maintenance backlog, the State announced, in 2005, a plan to reduce Statewide energy consumption by 15 percent by 2010.

Under performance contracting with guaranteed savings, Johnson Controls, Inc. (JCI) was commissioned to project manage the design and implementation of people and technologies to deliver a sustainable design plan to optimize the State's real estate portfolio. The task was to upgrade facilities and control and information management systems in approximately 1,000 buildings into a shared Building Information Management System using a portal that can bring disparate applications together.

This case study will examine the following elements of the project:

- Program and project management
- Integration of existing and new systems
- Real-time communications infrastructure
- Portal, dashboard, analytics, and control technology
- Financial viability of technologies and solution using ROI and energy savings
- Impact of the chosen technologies on energy and other less tangible factors

This case study will explore how the integration of systems can provide operational excellence as well as ease in maintaining individual system functionality by continuously monitoring, diagnosing and taking preventive actions remotely or from a centralized system.

PROJECT OVERVIEW

In early 2007, Johnson Controls and TEAM CO-OP (a consortium of companies that brought technology and application elements to the bundled solution) began the implementation of a $24 million contract to upgrade facilities and control and information management systems in approximately 1,000 state-owned and operated buildings. Phase one of the project included a facilities assessment program to provide the State with a first ever comprehensive look at its real estate portfolio. To facilitate this portfolio assessment and

enable optimum management of facilities, a program needed to connect various silo systems and applications, such as:

- Utility bill management system
- Facilities communications infrastructure
- Building automation controls system
- Energy management system
- Asset condition management system
- Business process and capital planning management system
- Work order system
- Portal system for remote monitoring

Coupled with the installation of Web-enabled building control systems and a low-cost, wireless communications network, the project was guaranteed to save the State $9.5 million for the state every year through reduced energy usage, process improvements in facility automation, monitoring and management, and more efficient real estate portfolio management. On the environmental side, as a result of streaming building control and utility data into a shared network, the State can calculate its carbon footprint, regain control of the costs associated with their portfolio, and generate significant cost and energy savings.

RESULTS

By integrating individual systems and buildings at a common user interface level, operational activities in the various subsystems can be monitored to detect inefficient operating conditions and corrective action can be taken to bring the system back to normalcy. This visibility over its facilities and assets enabled the State of Missouri to achieve the following results:

- Annual savings from the combined projects surpassed $35 million per year (equal to 370 percent of the guaranteed savings of $9.5 million per year)
- Expected payback on investment is about one year
- Reduction in Carbon footprint by:
    - 205,210,232 pounds of carbon dioxide
    - 307, 933 pounds of nitrogen oxide
    - 583,539 pounds of sulfur oxide

PROJECT SCOPE

The overall scope of the project was to implement devices and systems that would allow for a much higher level of monitoring, measurement, management, verification, communication, and interoperability across the entire portfolio of buildings. A new system needed to enable the State to manage its portfolio of facilities from a total cost of ownership perspective and provide executives, managers, and staff the right information on a real time basis. The first task required was to understand how much energy is being used and collect information about expenses and resources and create a total life cycle model around decisive building assets.

Legacy system's incompatibility, outdated information, a lack of historical data, proprietary systems architectures, and dysfunctional operating processes were some of the hurdles which were resolved by the following aspects of the project:

- Integration of existing and new systems
- Design and development of real-time communications infrastructure
- Portal, dashboard, analytics, and control technology deployment

The integration between building automation systems and a wireless communications backbone helped deliver a complete building information management system to the facilities department. As it costs less to get buildings automated when they are built with wireless network infrastructure, wiring costs dropped around 30 percent, allowing Johnson Controls to justify providing enhanced sensing and control capability for the building. The building automation system greatly improved the interaction of mechanical subsystems in the buildings and lead to optimum energy consumption, cost-effective building operations, and improved occupant comfort.

GUARANTEED SAVINGS

Under performance contracting with guaranteed savings, Johnson Controls played the role of the energy service company (ESCO) and accepted the performance risk to achieve the sustainable goals set forth by the State of Missouri. In guaranteed savings contracts, the customer leases the equipment from the financing company (who thereby absorbs this risk). The State's lease payments are assured through the savings guarantees by Johnson Controls. Thus, if savings are less than lease payments, Johnson Controls would make up the difference to the State, and extra savings are retained by the customer.

In retrofit performance contracting, funds to support the performance contracts come out of non-capital budgets for utility payments or operations and maintenance. This method obviates the need to seek approval for capital purchases. In this situation, Johnson Controls not only obtained the financing but also guaranteed the savings, which reduced the State's risk. Consequently, performance contracting can allow energy efficient technologies to be implemented without necessitating capital outlays.

JOHNSON CONTROLS AND TEAM CO-OP

As the program and project manager, Johnson Controls was responsible for selecting and leveraging the cooperative efforts of companies involved in delivering the technology solutions to the State of Missouri. The Team CO-OP alliance was formed under Johnson Control's leadership to deliver a complete building information management system to the State's facilities department including a dashboard of information about their facility operating costs, capital spending and energy spending.

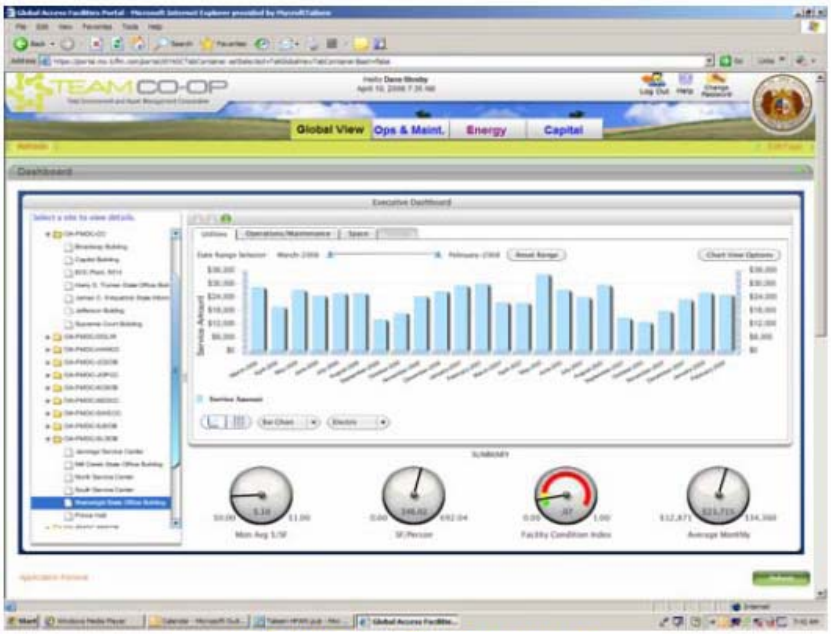
Team CO-OP direct partners for the State of Missouri project include

- ISCO International
- Talisen Technologies
- GridLogix
- Appian
- Johnson Controls, Inc.

The Team CO-OP solution, ESCO 2.0 (Enterprise Sustainability Contract), is a visionary approach to managing a portfolio of facilities from a global and total cost of ownership perspective. The integration of technologies and solutions allowed for a high level of connectivity for a variety of products from multiple manufacturers. Integrating intelligence is not only desirable but also becoming a mandatory requirement to provide clients with the best automation solutions, with the simplest connections to real-time data, Web-based data, and the corporate enterprise.

The key to the solution was to provide executives, managers, and workers with the information they required, on a real time basis, to make smart decisions. Using device networking technology and system integration, an intelligent building can be created, allowing control over virtually every system from a remote location. Based on their respective roles and access granted to individuals, detailed information can be viewed on a particular site, facility or function (that is, energy). Data and control information flow from a wide variety of software applications and Internet-enabled devices that are connected through secure communications to a user portal. Remote location access to all building systems is one of the boons of an intelligent building.

Chart 1 – State of Missouri Facilities Dashboard



There are many technologies that this project leverages to deliver a complete enterprise asset management capability and building information management system. The integration of technologies and solutions included a variety of products from multiple manufacturers, including:

- Talisen Secure Portal
- VFA Condition Assessment and Capital Planning software.
- IDS Energy Witness software
- Archibus CAFM and Space Planning software
- Appian Process Management and Orchestration software
- Armstrong SteamStar
- Microsoft SQL Server
- Cisco Systems IPICs
- Gridlogix EnNet Framework
- Dell Servers
- Sprint PCS Broadband
- Johnson Controls Metasys

Of course, an enterprise-wide project of this magnitude doesn't happen all at once. The deployment of these technologies was staged over the course of two years, delivering more value as the level of integration across the various technologies increased and facilitated the delivery of portfolio-wide facility data. Starting with the implementation of a software platform to provide facility condition and space planning information, the state of Missouri was able to rationalize their space requirements and justify the energy savings retrofit program with real data on the condition of all the major energy-consuming infrastructure in their portfolio. With the energy retrofit program came the deployment of technologies like Metasys for improved building automation and control, as well as the EnNet Framework, Energy Witness Software, Talisen Secure Portal and other IT technologies that would create the integrated system platform to provide real-time information on water, gas and electric utility usage, maintenance spending, capital investments and more. And through the creation of this platform, the state now has all the information they need to measure and verify the savings that were guaranteed by Johnson Controls as part of the overall project. This added benefit not only reduces typical measurement and verification costs, but provides the state with the information that they need to ensure that long-term energy, capital, real estate and maintenance costs remain under control and within budget.

MEASURED RESULTS

The State of Missouri is considered by many as the most comprehensive North American green and intelligent project in the industry at present today in terms of scope, size, depth, and results. The project proves that with the required level of commitment and strategy significant cost savings and other benefits can be realized, such as:

- $35.6 million in annual savings from real estate, operations, construction, and utilities budgets
- Total Johnson Controls project cost $18.5 million, of a total project cost of $24 million
- Missouri's ESCO 2.0 Project had a return on investment of about one year.
- Reduction in Carbon footprint, including:
    - 205,210,232 pounds of carbon dioxide
    - 307, 933 pounds of nitrogen oxide
    - 583,539 pounds of sulfur oxide

With approximately 32 million square feet in its real estate portfolio, Missouri spends some $300 million annually to operate and maintain existing buildings. Johnson Controls guaranteed to save the State $9.5 and facilitated savings of $35.6 million by reducing energy usage, while ensuring process improvements in facility automation, monitoring and management, and more efficient real estate portfolio management.

PILOT 1

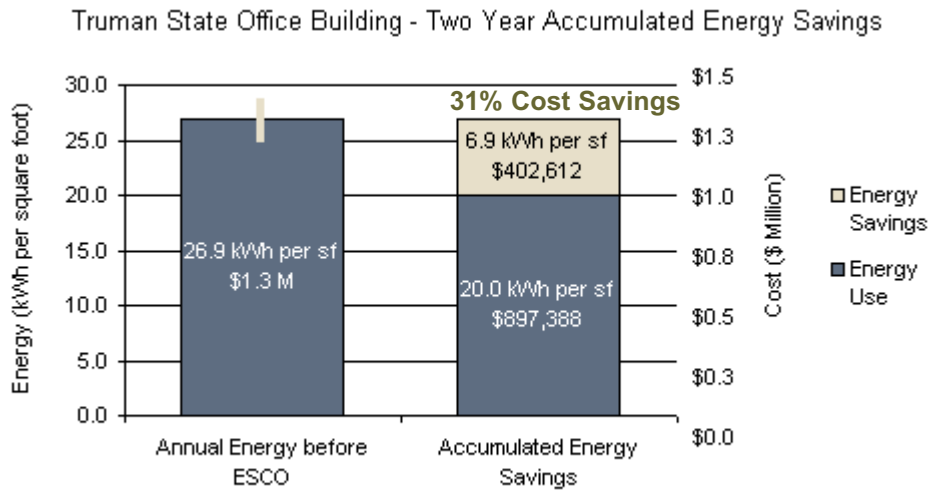
Truman State Office Building, Jefferson City, Missouri

775,000 square feet - the State's biggest office building

31 percent energy savings after two years (versus a guarantee of 17 percent)

In the base line year (the year before the ESCO), annual energy consumption for the Truman building was 26.9 Kilowatt hours per square foot or $1.3 Million in energy costs. The first year after ESCO, annual energy consumption dropped to 21.2 Kilowatt hours per square foot or $986,220 in total energy costs, generating savings of $313,780. In the second year, annual energy consumption was down to 20 Kilowatt hours per square foot and generated accumulated savings of $402,612, almost double of the guaranteed energy savings. Due to the savings and efficiency improvements achieved, the Truman State office building is now an Energy Star building.

Chart 2 – Truman State Office Building reduction in energy consuption after two years



PILOT 2

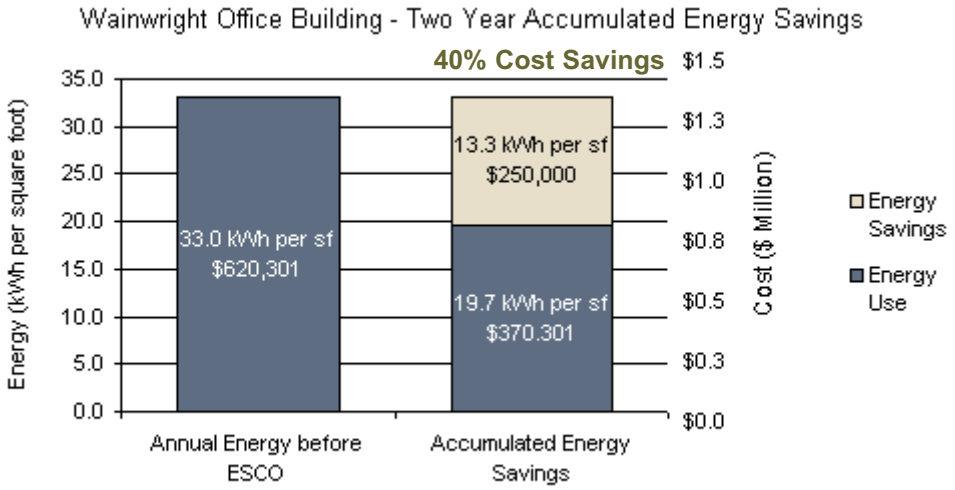
Wainwright Office Building, Downtown St. Louis, Missouri

234,000 square feet

40 percent energy savings after two years

In the base line year (the year before the ESCO), annual energy consumption for Wainwright office building was 33 Kilowatt hours per square foot or $620,301 in total energy costs. Two years after the ESCO, the annual energy consumption dropped to 19.7 Kilowatt hours per square foot and saved $250,000 in energy costs, $45,000 above the guaranteed savings anticipated.

Chart 3 – Wainwright Office Building reduction in energy savings after two years



The technologies, in conjunction with a few traditional energy conservation measures, have result in more annual savings than expected from the project. In the beginning, under performance contracting, Johnson Controls guaranteed on both buildings a total of $330,000. The State was actually able to save more than $400,000 on the Truman building alone.

The aim was to integrate all these systems into an intelligent system that can provide operational excellence as well as ease in maintaining individual system functionality by continuously monitoring, diagnosing, and taking preventive actions with scheduled maintenance. With the advancement of technology across all of the independent systems of a building, building control capability will continue to improve. Advances in networking technologies and the Internet have opened the door to a network-enabled world. Automated diagnostics supported by the latest sensors and control technologies can further lead to efficient building operations as well as to improvements in the life span of the structure. As this information is also available at remote locations, there are possibilities of achieving predictive fault detection, timely diagnosis, and prognosis. All these, in turn, makes it possible to create an intelligent building, which provides virtual control of every system from a central location.

The State of Missouri an Independent Case Study

CASE STUDY OBJECTIVES

The State of Missouri Enterprise Asset Management project is considered to be the most comprehensive North American green and intelligent project in the industry in terms of scope, size, depth, and results. This project leveraged many technologies to deliver a complete enterprise asset management solution to meet the sustainability goals set out by the State of Missouri.

State of Missouri was spending $300 million annually to operate and maintain approximately 32 million square feet spread across numerous facilities in its real estate portfolio. This case study will explore how the collaboration of companies and technologies enabled the State of Missouri to manage its portfolio of approximately 1,000 buildings from a total cost of ownership perspective. The goal of this project was to bring rapid and quantifiable cost savings and to provide executives, managers, and staff with the information they need, on a real time basis, to take smart decisions.

This case study will explore how the integration of systems has enabled the State of Missouri to have a dashboard of information about their facility operating costs, capital expenditures, and energy expenses at their fingertips, so they could make better decisions about how to manage their entire portfolio.

PROJECT OVERVIEW

In the face of increasing energy costs, escalating real estate costs, and an increasing deferred maintenance backlog, in 2005, the State of Missouri announced plans to reduce state-wide energy consumption by 15 percent by 2010.

Driven by a new administration committed to a statewide sustainability program, the State of Missouri consolidated its real estate portfolio by integrating operations, maintenance, lease management, real estate management, design and construction services, and capital planning. The goal of the new administration was to manage its portfolio enterprise and lower the cost of ownership by addressing energy efficiency, cost of deferred maintenance, operating cost, space utilization, and asset management.

The aim of this project was to bring rapid and quantifiable cost savings in five key areas, namely:

1. Utility bill management
2. Automated enterprise monitoring
3. Facilities communications infrastructure
4. Portal collaboration
5. Business process management implementation and improvement

To manage its portfolio and reduce cost of ownership, the State had to determine what it owned in terms of facilities, locations, conditions, value, office space (both leased and vacant), capital needs utilization, energy usage, and cost of energy. Integrating buildings and systems at a common user interface level enabled operational activity monitoring to detect inefficient operating conditions and allowed corrective action to be taken to bring buildings back to normal performance patterns. Legacy system incompatibility, outdated information, a lack of historical data, proprietary systems architectures, and dysfunctional operating processes were some of the challenges which needed to be addressed.

On the environmental side, as a result of streaming building control and utility data in to a shared network, the State of Missouri, is currently able to calculate its carbon footprint, regain control of the costs associated with its portfolio, and generate significant cost and energy savings.

RESULTS

By integrating individual systems and buildings in to a common user interface level, operational activities in the various subsystems can be monitored to detect inefficient operating conditions and corrective action can be taken to bring the system back to normalcy. This visibility over facilities and assets has enabled the State of Missouri to achieve the following results:

- Annual savings from the combined projects in excess of $35 million per year
- Expected ROI of about one year on the investment
- Reduction in carbon footprint:
    - 205,210,232 pounds of carbon dioxide
    - 307, 933 pounds of nitrogen oxide
    - 583,539 pounds of sulfur oxide

PROJECT SCOPE

To efficiently manage its asset portfolio, manage its utility budget, project costs, and integrate accounting and work order system, the following technology parameters were deployed:

- Condition assessment opportunities covering the entire 32 million square feet of real estate
- Energy management system covering approximately 16.8 million square feet (not all facilities have control systems)
- Work order system and CAFM covering 24 million square feet of real estate

The State of Missouri invested in an Archibus CAFM and Space Planning software system to manage leases, perform condition assessment (conditions, deferred maintenance, asset inventory, and so on), create a project outline with a budget forecast, and manage energy consumption. The CAFM system was implemented to set standards and ensure consistency in maintenance operations and to manage work orders, predict maintenance orders, on demand work orders, and combine them with the purchase order system.

Before these parameters where employed, the State's utility bills went sent directly to the accounting department. Facility managers were unable to measure how much energy they were consuming. The new system enables this level of visibility by providing facility managers and other decision makers with access to information necessary to make changes to lower energy consumption and reduce the carbon footprint. This information further enabled facility managers to take corrective action on large inefficiencies such as air handling units (AHU) running all the time.

The enterprise asset management system, connected to the work order system, allows remote control from a centralized location, making it easier to analyze all sites across the state and to perform building analysis, identify maintenance needs and capital applications, as well as more effectively manage the activities of facility managers for thousands of sites. The goal was to provide executives, managers, and staff with information to make correct decisions depending on their individual roles and needs on a real time basis. With utility bills integrated into the enterprise asset management system, the facility managers can further provide diagnostic information and present it to staff in the organization, enabling them to take immediate action instead of waiting until the end of the month before realizing the bill is too high.

The ability to mine data automatically and present it not only at the 'C' level but also at the facility level and equips them to take some immediate action to reduce the energy consumption. In order to conserve energy, it is imperative to have proper information management architecture in place, in order to make the information actionable and definable:

- Computer rated facility management system for on-demand and preventative work orders and space management
- Capital planning condition assessment
- Building information management system
- Business process management tool for automating capital planning process
- Middleware software integrating existing disparate system and different control systems
- Gateway portal that enables external vendors such as JCI to manipulate the building controlsystem remotely

INTEGRATION APPROACH

As the program manager and project manager, Johnson Controls Inc. (JCI) was responsible for selecting and leveraging the cooperative efforts of companies involved in delivering the technology solutions to the State of Missouri. TEAM CO-OP alliance was formed to deliver a complete building information management system. As a result, no company singularly contributed all the savings, but rather, the savings were the result of the combination of many technology contributors.

There were four key architectural partners at the beginning in the bid process for the State of Missouri project that formed Team CO-OP alliance, namely:

- ISCO International
- Gridlogix
- Johnson Controls, Inc.
- Talisen Technologies

The TEAM CO-OP solution, ESCO 2.0 (Energy Services Contract Organization), is a visionary approach to managing a portfolio of facilities from a global and total cost of ownership perspective. The integration of technologies and solutions allowed for a high level of connectivity for a variety of products from multiple manufacturers, such as:

- Talisen Secure Portal
- VFA Condition Assessment and Capital Planning software.
- IDS Energy Witness software
- Archibus CAFM and Space Planning software
- Appian Process Management and Orchestration software
- Armstrong SteamStar
- Microsoft SQL Server
- Cisco Systems IPICs
- Gridlogix EnNet Framework
- Dell Servers
- Sprint PCS Broadband
- Johnson Controls Metasys

Integrating intelligence is not only desirable but is also becoming a mandatory requirement to provide clients the best automation solutions with the simplest connections to real-time data, Web-based data, and the corporate enterprise. Jointly, Johnson Controls, Gridlogix, ISCO International, and Talisen Technologies delivered an integrated energy and maintenance management systems covering 17 million square feet of existing state facilities that include as many as 1,000 buildings.

Although the team of integrators experienced management and technical challenges typical to any project of this size, the end result is proof that the collaboration was a success. This approach also demonstrates that customers can assemble teams from best in class and are not dependant on a provider to deliver optimal results.

JOHNSON CONTROLS, INC.

As the program manager and project manager, Johnson Controls was responsible for selecting and leveraging the cooperative efforts of companies involved in delivering the technology solutions to the State of Missouri. Under performance contracting with guaranteed savings, Johnson Controls also played the role of the energy service company (ESCO) and accepted the performance risk to achieve the sustainable goals set forth by the State of Missouri.

On the field, Johnson Controls orchestrated the connection of software to the building controls system, which, while sometimes simple upgrades, was often more complex. Johnson Controls' main focus was on the integration between building automation systems and a wireless communications backbone to help deliver a complete building information management system.

GRIDLOGIX

GridLogix is a leading creator of XML Web Services based integration solutions for remote control and automation systems. Their solutions provided industry standard (open) interfaces to automation platforms so they can be integrated into the rest of an enterprise information network.

Gridlogix provided the core software architecture and data normalization technology as the interoperability layer. The software solution provided enabled the State of Missouri to integrate with existing control systems and applications to communicate together and help reduce energy, maintenance, compliance, and physical security cost.

In using this open technology provider, the State did not need to remove existing building controls systems. Instead, the solution allowed for fine tuning to extract the data needed from existing controls. The open system made it possible for multiple partners to work together instead of relying on one vendor, despite the different subordinate control systems.

Gridlogix agnostic middleware layer allowed the project to remove significant cost barriers to access the proprietary and legacy data from all the different systems that measure, monitor, and consume energy within a facility. Proprietary systems found in facilities often limit a customer's ability to pick the best and most affordable technologies. Gridlogix's open system architecture allowed the state and Team Coop to choose amongst best in class vendors, resulting in as much as an 80 percent reduction in total program cost when compared to a standard ESCO process. Gridlogix information management systems are optimized and used by customers aiming at almost up to 80 cents to a dollar per square foot of savings.

TALISEN TECHNOLOGIES

Talisen is partnered with Appian, a provider of business process management (BPM) software. Talisen offers business process consulting and enablement of Appian's enterprise solution as well as its Web-based, hosted solution, Appian Anywhere™. The company addressed the issues pertaining to IT network, security, and wiring that enabled systems to interact over a reliable network architecture.

Talisen managed the deployment of PC's responsibility which typically required one connectivity or PC per site that which can have multiple buildings and networks connected through the local LAN or using a data center depending on reliability considerations.

ISCO INTERNATIONAL

ISCO physically implemented the boxes and provided wireless systems solutions for subsystems and components for all wireless technology platforms. ISCO enabled seamless integration of technologies, and condition and enhance the radio frequency management and interference-control systems to provide the ultimate end-user wireless experience.

MEASURED RESULTS

The State of Missouri is considered by many as the most comprehensive North American green and intelligent project in the industry, at present, in terms of scope, size, depth, and results. The project is proof that with the required level of commitment and strategy, significant cost savings and other benefits can be realized.

- Annual savings from real estate, operations, construction, utilities budgets $35.6 million
- Total JCI project cost $18.5 million
- Missouri's ESCO 2.0 Project had a return on investment of about one year.
- Reduction in Carbon footprint:
    - 205,210,232 pounds of carbon dioxide
    - 307, 933 pounds of nitrogen oxide
    - 583,539 pounds of sulfur oxide

With approximately 32 million square feet of facilities in its real estate portfolio, Missouri spends some $300 million annually to operate and maintain existing buildings. JCI guaranteed to save the State of Missouri $9.5 and facilitated savings of $35.6 million by reducing energy usage, process improvements in facility automation, monitoring and management, and more efficient real estate portfolio management.

PILOT 1

Truman State Office Building, Jefferson City, Missouri

775,000 square feet - the State's biggest office building

31 percent energy savings after two years - almost double the guarantee

In the base line year (the year before the ESCO), annual energy consumption for the Truman building was 26.9 Kilowatt hours per square foot or $1.3 million in total energy costs. The first year after ESCO, the annual energy consumption dropped to 21.2 Kilowatt hours per square foot or $986,220 in total energy costs, generating savings of $313,780.

In the second year, annual energy consumption was down to 20 Kilowatt hours per square foot and generated accumulated savings of $402,612, almost twice the guaranteed energy savings. Due to the savings and efficiency accomplishments, the Truman State office building is currently an Energy Star building.

Chart 1 – Truman State Office Building reduction in energy consumption after two years

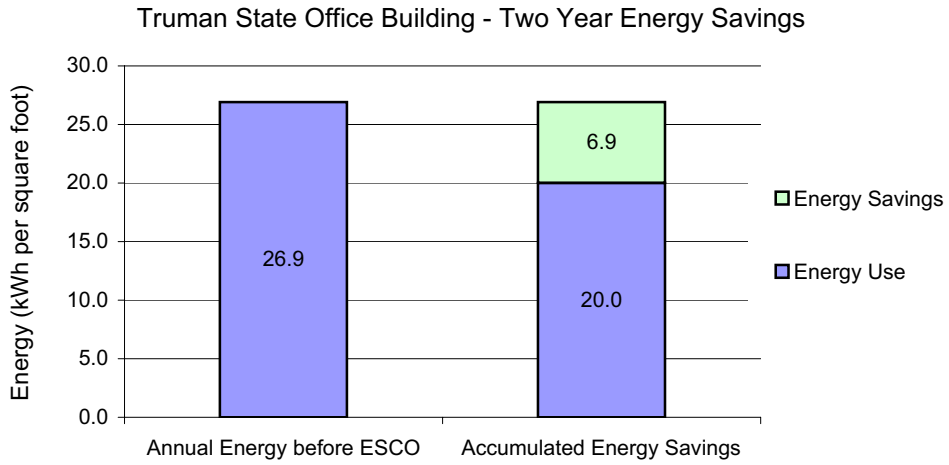
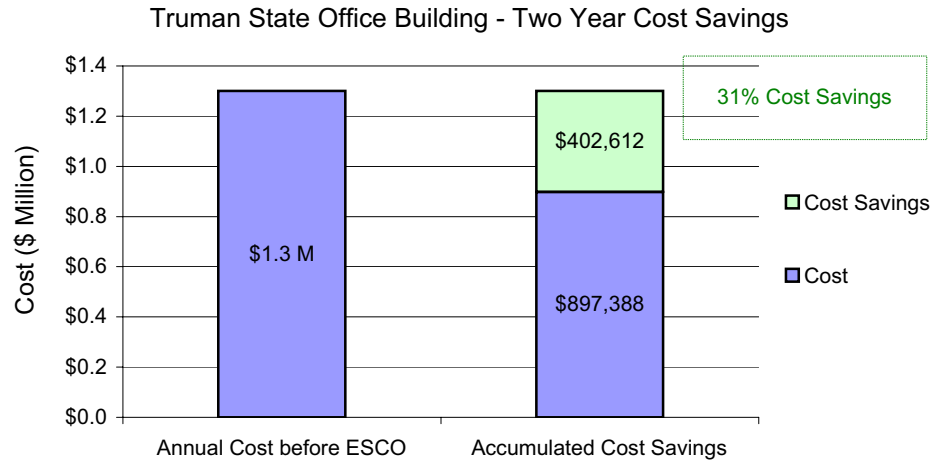


Chart 2 – Truman State Office Building cost savings after two years



PILOT 2

Wainwright Office Building, Downtown St. Louis, Missouri

234,000 square feet

40 percent energy savings after two years

In the base line year (the year before the ESCO), annual energy consumption for Wainwright office building was 33 Kilowatt hours per square foot or $620.301 in total energy costs. Two years after ESCO, the annual energy consumption dropped to 19.7 Kilowatt hours per square foot and saved $250,000 in energy costs, which was $45,000 more than the guaranteed savings.

Chart 3 – Wainwright Office Building reduction in energy savings after two years

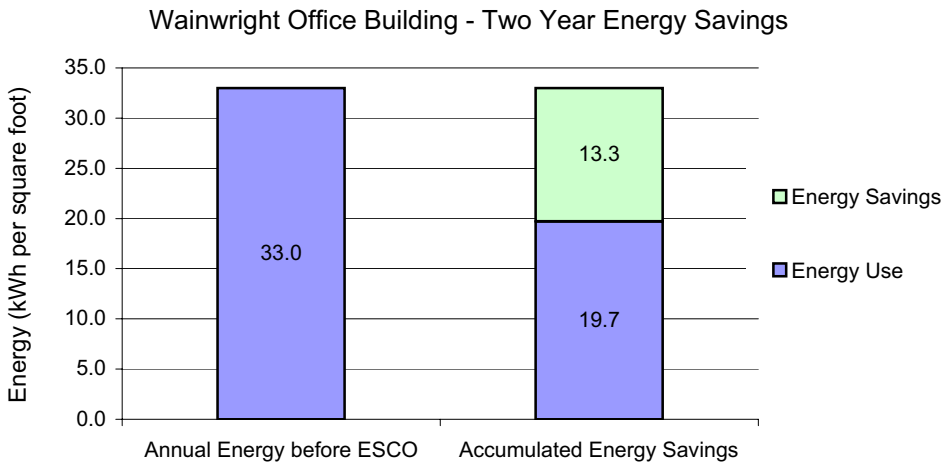
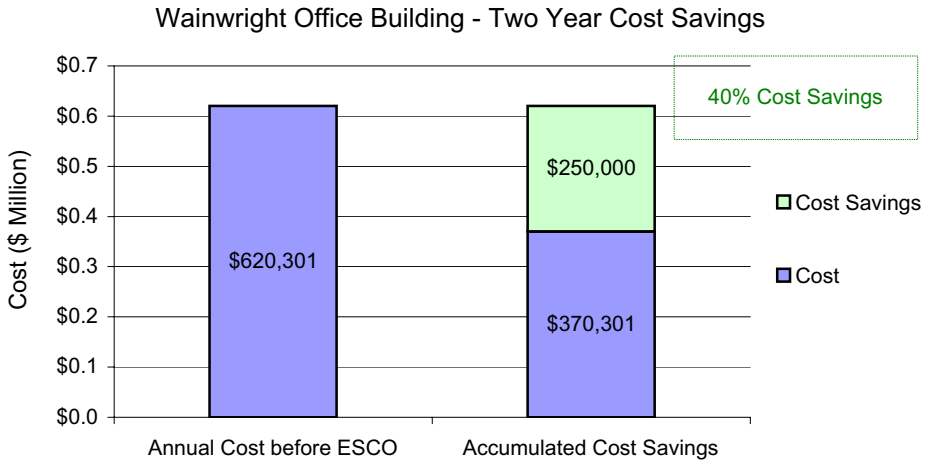


Chart 4 – Wainwright Office Building cost savings after two years



These technologies, in conjunction with some traditional energy conservation measures, have resulted in more savings than expected. The integrated solution approach enabled the State of Missouri to reduce energy and maintenance costs by as much as 40 percent with a payback period of less than two years.

The project was started in December of 2006 and was deployed through 2007. Using middleware software to connect existing building controls systems rather than replacing them enabled the project to significantly speed up the deployment time by about 30 percent to reduced the cost of implementation. The integration and interoperability features of middleware reduced the time for completion from three to four years to one to two years, and provided the data feed that allowed some of the other partners on the team to perform their jobs. As the traditional building automation systems were closed systems, using middleware enabled the content and interaction of building systems to move to the network and remove significant cost barriers to access the proprietary and legacy data from all the different systems that measure, monitor, and consume energy within a facility.

With one unified approach to monitoring facilities, the State can change the underlying infrastructure without changing the enterprise level reporting mechanisms. This allows the State of Missouri to have a heterogeneous infrastructure that creates more competition between vendors, begins to generate savings more quickly, and achieved an ROI payback in one year rather than over the course of a decade.

FUTURE OPPORTUNITIES/COMMISSIONING

The aim was to integrate all these systems into an intelligent system that can provide operational excellence as well as ease in maintaining the functionality of individual system by continuously monitoring, diagnosing, and taking preventive actions with scheduled maintenance. Integrating intelligence is not only desirable, but is becoming a mandatory requirement to provide clients the best automation solutions with the simplest connections to real-time data, Web-based data, and the real estate enterprise.

With the advent of technology in the independent systems of a building, building control feasibility will continue to develop and refine applications and implementation. Advances in networking technologies and the Internet have opened the door to a network-enabled world. Automated diagnostics supported by the latest sensors and control technologies can further lead to efficient building operation as well as to an increased life span for the structure. As this information is also available at remote locations, there are possibilities of achieving predictive fault detection, timely diagnosis, and prognosis. This makes it possible to produce an Intelligent Building, which provides virtual control of every system from a central location.

The Verve – High Rise Condominiums a project by Tridel

CASE STUDY OBJECTIVES

In examining the technologies and features of Tridel's high rise condominium building, this case study will demonstrate how energy modelling and new technologies such as individual suite sub metering supports the goal of developing an intelligent and green building. With additional time and effort going into designing, specifying and constructing a green building, the payoff comes with buildings that achieve substantially better performance with regard to the environment, but also in terms of reduced operating costs.

The case study will showcase information from a financial viability standpoint, both in terms of start-up and life cycle costs, and the impact of the chosen technologies on other less tangible factors including overall productivity and comfort for the suite owners and improved property value.

PROJECT OVERVIEW

Tridel develops and builds condominiums carrying a long history of innovation in construction and design. Tridel combines the knowledge and resources of different disciplines including architecture, engineering, interior design, and landscape design in an integrated team approach to ensure the most cost effective "green" solutions.

The Verve provides enhanced metering solutions including thermal, gas, electricity and water metering. The metering systems are designed to fairly proportion all of the in-suite energy consumption to enable significantly lower energy expenses. Sub-metering can separate individual zones using their own meter to measure the amount of energy consumed in an individual suite. This allows the billing contractors to collect data and provide billing services for individual meters and encourage suite residents to pro actively lower their utility bills.

Finding technologies that compliment Tridel's sustainable building design has been challenging as most high technology systems are typically designed for commercial applications. For example, to offer BTU sub metering for space heating and cooling, the meters had to be imported from Europe. Further, in designing for LEED, the challenge was that LEED is written more for office buildings than residential buildings, creating interpretation issues for systems and designs applicable to a high rise residential building.

Using an energy model was critical in this project to enable Tridel to match the benefits of an intelligent green building with the capital costs incurred. Tridel's past experience demonstrates that most mechanical plants are significantly over designed, therefore with

more accurate modeling these capital costs can be minimized by "right-sizing" the mechanical equipment. The other objective of energy modeling is to identify the energy saving opportunities, obtain an accurate idea of the cost to operate the building, and to predict savings for a green loan.

THE FACILITY

- Location: Downtown Toronto, Ontario, Canada
- 39 storey, 359 suite tower
- 7 storey, 86 suite loft building
- Suite size range 522sf to 1600sf
- Average suite size 790sf
- Move-in-Date: July 2008
- LEED Silver Candidate

KEY TECHNOLOGIES AND/OR FEATURES

- Advanced computer-based energy simulation models to determine costs and benefits of building design treatments
- Energy Management Systems (EMS)
- Enhanced metering solutions including thermal, gas, electricity and water metering with sub-metering technology for individual suite consumption
- Central mechanical equipment energy management controls and monitors
- LEED Best Practices Commissioning Agent services
- Overcome cost premiums with a green loan

RESULTS

- Annual greenhouse gas reductions due to energy efficiency measures: 805 metric tonnes (887 US tons)
- Annual energy savings compared to local energy code (similar to ASHRAE 90.1): 35 percent

- LEED premiums payback 7 years or less

- Residents can expect lower energy bills, good value-add at the point of sale, and a higher degree of satisfaction

- Marketing differentiation via green image enhanced the sales program success and created increased value for the purchasers

PROVIDENT ENERGY MANAGEMENT

Under Tridel's group of companies, Provident Energy Management is a leading Energy Services Company (ESCO) in the Greater Toronto Area. Provident specializes in the multi-residential market with an emphasis on high rise condominiums. Provident generates energy savings through energy management systems & monitoring, measurement and verification (M&C), and individual metering & billing. Provident is also providing the services of Commissioning Agent for all mechanical systems to ensure the engineers design intent is functioning properly. Provident ensures the ongoing accountability and optimization of the Verve's energy consumption and provides suite owners and the property manager with the data necessary to identify systems that may not be functioning as expected.

UNIQUE METERING SOLUTIONS

The Verve provides enhanced metering solutions including thermal, gas, electricity and water metering. The metering systems are designed to separate and accurately proportion the in-suite energy costs from common area elements that will in turn enable significantly lower energy expenses. Sub-metering can separate individual zones using their own meter. For example, the main electrical meter will measure the amount of electricity used for an entire building, while sub-meters will measure the amount of electricity used in an individual suite. This allows Provident to collect data and provide billing services for individual meters.

IN SUITE HEATING AND COOLING METERING

Gas and electrical consumption is separately sub-metered for the operation of the central equipment to provide the total costs for space heating and cooling, which can then be proportionally charged to each resident. Each fan coil is installed with a BTU meter which measures the volume of water flow through the fan coil as well as the temperature drop before and after the coil. From this information the heating or cooling energy used in the fan coil can be calculated and hence a cost attributed for that suite's consumption. The BTU meter transmits this measured information via the internet for interpretation and preparation of the monthly invoices.

The Verve offers residents metering of their use of heating and cooling energy in each suite based on their consumption even though it's a central system. In suite heating and cooling is provided by two pipe fan coils connected to a central hydronic plant of boilers and chillers.

In all other projects with this type of central system, residents pay their energy bill based on the size of their suite and not based on their consumption. It's a prorated solution based on the total square footage in the building and the total energy consumed. Tridel has developed with Provident a sub metering method of metering the actual energy consumed to heat and cool each suite.

FLOW SUB-METER TO MEASURE DOMESTIC HOT WATER BY EACH SUITE

In the main mechanical room there is a gas check meter which measures all gas consumed by the domestic hot water boilers, therefore separating the cost to produce domestic hot water. The domestic hot water consumption in each suite is measured in volume only with a flow meter since the hot water supply temperature in the central system is essentially constant. From this volume of water a proportionate share of the cost of the water and its inherent heating cost can be determined and billed to the customer. Data is likewise transmitted through the internet for interpretation and invoicing.

ADVANTAGES OF SUB-METERING

Sub-metering allows energy costs to be allocated to those who are actually using it, rather than being arbitrarily charged on a per square foot basis. This encourages residents to be accountable for the energy they use. This will encourage conservation through the "user pays" principle. Also, by still using a central or main meter, individual residents are still benefiting from lower bulk rates offered by various utilities and electricity retailers, rather than the more costly residential rates. By putting the control of suite energy consumption in the hands of the resident Tridel expects that the use of these sophisticated sub-metering systems will help curtail energy consumption by a further 10-15 percent above that which they conservatively modeled.

By accurately separating in-suite consumption, common area consumption can be isolated and energy management measures taken. In addition building operating budget estimates will be more accurate since a building has less financial exposure to uncontrollable energy factors, such as weather, occupancy patterns and non-energy conscientious residents.

CENTRAL MECHANICAL EQUIPMENT AND CONTROLS

Using central mechanical equipment energy management controls and monitors, Provident can remote control and monitor all central mechanical equipment including:

- Fully modulating boilers (for variable loads)
- Variable frequency chiller (for variable loads)
- Variable frequency drive pumps
- Variable frequency drive corridor fresh air supply units

As continuous lighting is mandated in areas such as hallways and stairwells, it was important to select the most efficient lighting sources to ensure the lowest electrical consumption possible. In the parking garage 60 percent of the lighting is above the emergency lighting needs hence can be turned off when there is no one around. There are motion sensors in the garage to control this lighting. In addition motion sensors have been utilized in other common area rooms which are not always occupied. The Verve also utilizes photo sensors for "daylight harvesting", which will automatically turn off the lights when they detect sufficient amount of daylight in some common areas. By installing these systems, the building can reduce lighting energy costs by as much as 20-50% without compromising lighting quality. The cost premiums for these controls will be recovered in less than three years.

Key benefits associated with lighting controls:

- Energy Savings
- Maintenance Savings
- Longer equipment life

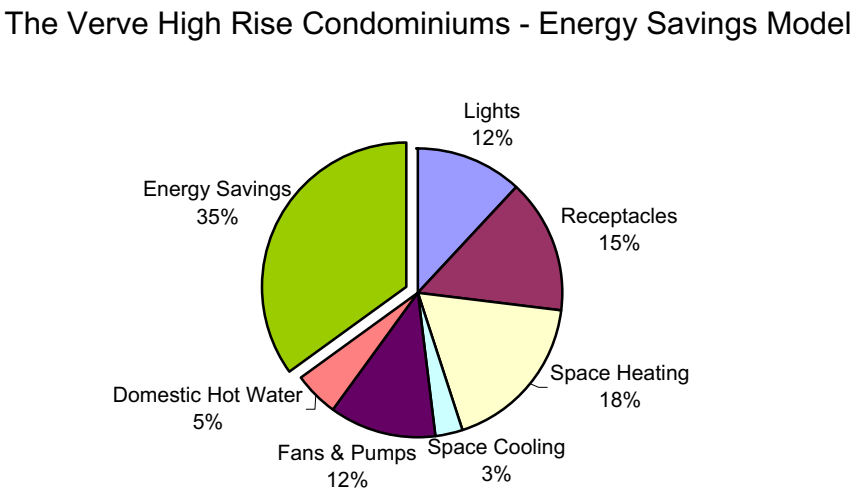
MODELING FOR GREEN AND ENERGY SAVINGS

Energy modelling is utilized during the design concept stage and involves the use of sophisticated computer software to better predict the building loads and annual energy consumption of a proposed building. The model is used to analyze the cost and energy impacts of various energy efficiency upgrades (such as high efficiency boilers, low-e windows, and low-flow showerheads). The model becomes a powerful tool so that the owner can choose which energy efficiency measures make the best financial sense. Life cycle financial benefits of adopting green technologies significantly outweigh the additional initial cost associated with green buildings.

The 3 main objectives of energy modeling was to identify and select the most cost effective energy saving opportunities; obtain an accurate operating budget for the building; and to model the green loan. In this market the developers are responsible for the first year operating budgets, such that if there is a shortfall, then the developers are obliged to make up the difference. The model helps to identify areas of the building that are large consumers of energy. The biggest target on this building was HVAC and Lighting. A pressurized high-rise residential building pumps huge volumes of fresh air into the corridor on a 24/7 basis, requiring a lot of energy to heat or cool it. The single largest energy conservation measure in this design was the provision of energy recovery on the exhaust air to temper the incoming fresh air.

Using an energy model to benchmark against the model national energy code for buildings (MNECB), Canadian equivalent of American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1, Tridel calculates that the Verve will save 35 percent in energy based on the enhanced building features and design. In addition it is anticipated a further 10-15 percent savings may be achieved through the individual control of consumption and metering in the suites.

Chart 1 – The Verve Energy Savings Model compared to conventional buildings



Source: Provident Energy Management

In Toronto, a large portion of the electricity is produced from coal in the summer, generating substantial CO2 emissions. The total energy consumption in this type of building is approximately a 50-50 split in dollar terms for gas and electricity. Annual greenhouse gas reductions due to energy efficiency measures at the Verve were calculated at 887 tons.

LEED SILVER

The Verve high rise condominium building is expected to earn enough points to qualify for a LEED Silver building. To achieve these higher standards Tridel had to spend more in terms of the LEED premiums, which the owner expects to have a payback with 7 years or less. Tridel is using Provident Energy Management as their LEED best practices Commissioning Agents in the start up and during the first year for all equipment and control systems, to ensure that the objectives of the system design are met in the building operation.

The challenge with designing for LEED was that it was written more for commercial and institutional buildings whereas systems and designs in a high rise residential building are different which created interpretation issues. Fear of change and the unknown were the biggest constraints for the developer's team of project managers and design consultants. In addition there were financial burdens related to the administrative needs for the LEED certification. An example of interpretation issues was zone controllability of ventilation systems perimeter exterior and interior was written more for an office environment rather than condominiums.

Measurement and verification offers a credit under LEED for new buildings, as it offers a means to ensure that claimed energy savings are being achieved.

"GREEN" LOAN

To overcome some of the cost premiums for this building's enhanced performance, a green loan was attached to the condos common elements for $700,000. The loan amount was paid back to the developer to assist in keeping his costs competitive. A portion of the buildings energy savings (approximately 60%) will be used to pay off the "green loan" in 7 years. This loan was structured so that it only consumes 60 percent of the building's energy savings to pay off the loan, therefore the residents still enjoy low energy bills right from day one with 40 percent of the savings accruing to the residents benefit. In year 8 and beyond the loan will be paid off and 100% of the energy savings will accrue to the resident's benefit.

Building Connectivity and Physical Support by Ortronics Legrand, Inc.

CASE STUDY OBJECTIVES

With commercial enterprises and industry relying heavily on capabilities and solutions provided by information technology, the network infrastructure is more critical than ever. The cost to businesses for the installation and maintenance of the network is a large investment. Enabling productivity no longer requires the use of proprietary networks or technologies.

Currently IT and facility managers are facing numerous challenges including increasing bandwidth and performance requirements, the need to utilize network electronics for as long as possible, to move to new technologies and applications with the most minimal possible downtime and disruptions, and addressing the continuous requests for moves, adds, and changes (MAC) to equipment and the environment. These challenges arise as buildings integrate more sophisticated voice, data, and video equipment into converged or networked building control applications.

The large amount of cabling for HVAC, fire and life safety, security, lighting control, voice and data, contribute a great deal of complexity to a building's cabling infrastructure and must co-exist with IP based voice, data, and video technologies. At present, intelligent buildings demand the integration and convergence of a range of applications requiring a robust and flexible data infrastructure, typically delivered by a standards based structured cabling system (SCS). The SCS industry is being challenged to develop new and less costly network solution sets for systems supporting a wide range of building applications. End users are demanding suitably designed cabling infrastructures, which are reliable, interoperable, scalable over time, and support the entire building's communications.

ZONE CABLING NETWORK ARCHITECTURE

Users seeking data communications architectures that support a wide range of network applications can use a standards based solution, Fiber-to-the-Telecom-Enclosure (FTTE) or Zone cabling. This relatively new architecture was added to the TIA/EIA 568-B building communications standard in 2005, and is currently used in an estimated 10 percent of buildings.

The FTTE architecture extends the fiber optic backbone to a telecom enclosure closer to workstations throughout a building. The telecom enclosure can then distribute a flexible topology of mixed media to the devices using copper category cable, fiber optics, coaxial cable, and A/V cable. The FTTE architecture can be deployed to support a wide range of workstations in high density and low density configurations, while at the same time

providing the user an array of benefits and various savings. Apart from this, using the FTTE architecture will enable the network designer to build an efficient and robust communication system as the backbone for the integration of all building systems. Zone cabling architecture differs from the traditional 'hierarchical star' design more frequently used in building systems, in which each workstation or edge device connects directly through a dedicated cable run to the Telecom Room. Savings are possible using the FTTE architecture depending on the specific building and network design due to on average shorter cable runs, and potential savings through more efficient moves, adds and changes.

The areas of potential savings associated with the FTTE architecture are:

1) Space savings, from downsizing or eliminating the Telecom Room (TR) vs hierarchical star topology

2) Materials savings from shorter and fewer horizontal cable runs to work stations and edge devices from the TE vs 'home runs' from TR to each end point

3) Potentially faster, more efficient moves, adds and changes as horizontal runs could be (on average) shorter using the FTTE architecture

4) Material savings using a structured cabling system vs. application specific cables

Zone cabling solutions address the emerging needs of IT managers, facility managers, and building owners. Zone cabling architectures are able to deliver increasing bandwidth and performance requirements as demanded by the users, as additional applications strain existing infrastructure due to growing convergence to network based applications. The FTTE design benefits an intelligent building by providing additional needed bandwidth closer to the edge devices and allowing easy addition of new edge devices as building applications are converged onto the network. The high bandwidth fiber optic backbone cables enable effective integration and automation of the building control systems as have less of a chance of being over saturated as new applications are added to the network. Alternative network designs include the popular Hierarchical Star design, which was standardized in1991, and used in 85 percent of buildings today. Centralized Fiber Optic Cabling, which was standardized in 2001, is used in 5 percent of buildings today. These traditional cablings systems are less than optimal in addressing the various challenges faced by IT and facility managers in the future. Traditional building network systems include multiple diverged networks, which are expensive to integrate, inefficient to maintain and require multiple contractors for each network.

Image 1 - Traditional hierarchical Star Network Architecture "Backbone"

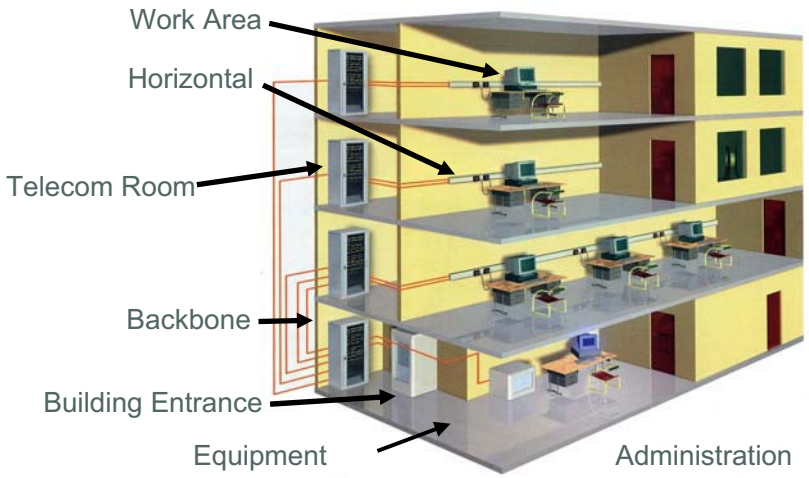
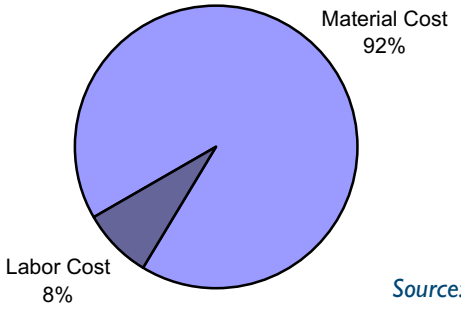


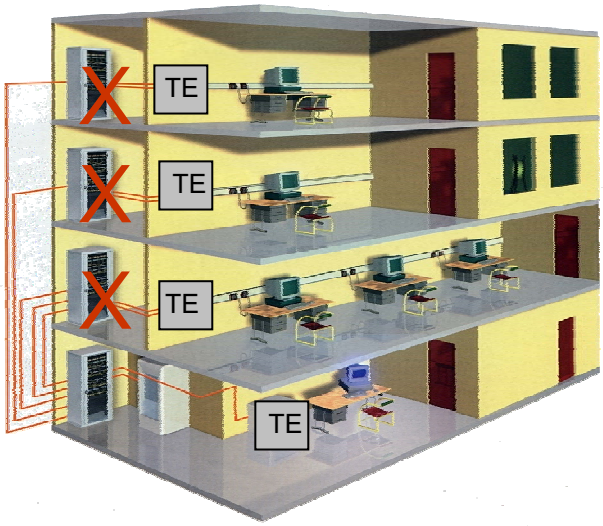
Chart 1 - Traditional hierarchical Star Network Cabling Cost Structure



Source: Ortronics Legrand Inc. & FOLS

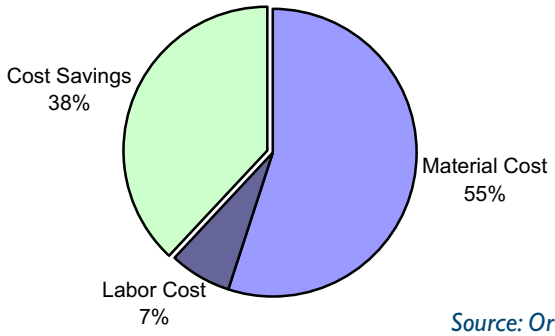
By using the Zone cabling design, the fiber optic backbone cabling passes through the telecommunications room (TR), directly to the telecom enclosure, allowing the building owner or tenant to use the space formerly dedicated to the TR. This results in significant space savings. This architecture also provides greater flexibility for adding capabilities with minimal disruption to existing operations or infrastructure. When a fiber backbone is used the cabling architecture is known as Fiber-to-the-Telecom-Enclosure (FTTE). From the TE, one can connect a wide range of users – workstations or edge devices using copper category cable, single-mode or multi-mode fiber. As part of the TE cabling standards, telecom enclosures with integrated advanced cable management provide flexibility and security to protect networks from physical threats. These various benefits are inherent in both the low density FTTE and high density FTTE

Image 2 - FTTE Network Architecture



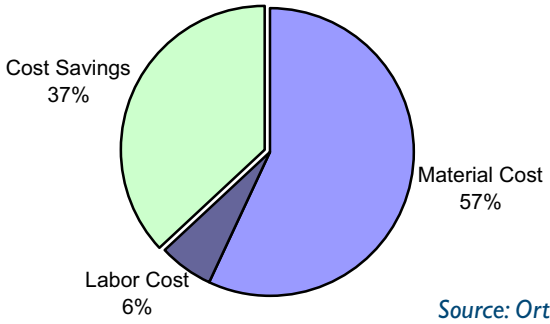
In an FTTE architecture the fiber only passes through the TR, without requiring any electronics, splice or interconnects. There can be one or more telecom enclosures per floor, each serving eight or more work areas using copper, fiber, or wireless connectivity. Telecom enclosures can be located in or on modular furniture, which can be on the wall, above the ceiling, or under raised floors.

Chart 2 - FTTE-L Structured Cabling Cost Structure



Source: Ortronics Legrand Inc. & FOLS

Chart 3 - High Density FTTE Network Architecture Cost Model Comparison to a Traditional Hierarchical Star Network Architecture



Source: Ortronics Legrand Inc. & FOLS

CONNECTIVITY AND PHYSICAL SUPPORT

Seamless access to the corporate network is necessary for today's new commercial buildings, and this inevitably makes various demands on the network, including:

- More bandwidth requirements
- Moves, adds & changes (MAC)
- More applications - from multimedia AV to VoIP to CCTV security, and building automation systems
- Wider range of user policies and regulations
- More demands for flexibility
- Ubiquitous networking

Delivering a highly reliable LAN in the present collaborative, information-rich enterprise remains a challenge. The challenge includes supporting both wired and wireless access for users who demand immediate up-time services.

The various features of FTTE cabling provide benefits by substantially reducing the initial cost of installation, which includes network electronics, cable, and connectivity products, labor, and TR space savings. The zone enclosures also act as the common demarcation point for this segment of building networks, which provides easy accessibility for the contractor. Once the fiber is attached to the building network electronics inside the enclosure, it can be used with various media such as UTP copper, single-mode or multi-mode fiber, and even wireless to integrate with other building control systems or devices, as well as providing device power such as Power over Ethernet (PoE).

FTTE cabling can utilize existing copper electronics for the rest of its lifetime. The TE cabling can lead to more efficient use of limited space for the tenant by reducing the number of TRs and the size of the remaining rooms. This reduction in the size and number of TRs can simplify and lower the cost of MACs allowing greater flexibility for adding capabilities to the network without disrupting the TRs. As a result, these benefits provide a smooth migration, while still maintaining reliability. The ultimate result of the implementation of TE cabling is improved building network efficiencies allowing buildings to respond and adapt to the changing needs of its occupants.

LOW AND HIGH DENSITY FTTE

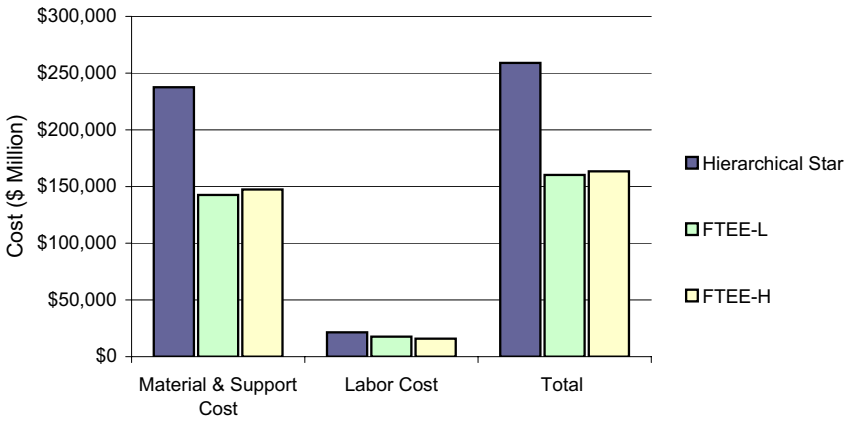
Low density FTTE (FTTE-L) models can be installed in an office architecture column or office furniture panel. The FTTE-L typically uses eight-port mini-switches, which are small enough to be mounted in a furniture wall panel, yet with the capacity for other active and passive equipment. Overall, FTTE-L is considerably lower in cost than a Hierarchical Star architecture offering higher performance at the lowest possible cost.

A high density FTTE (FTTE-H) model carries more features when compared to FTTE-L.

FTTE-H can connect to backbone, cable, switches, and up to 48 ports of high performance connectivity, compared to only eight with the FTTE-L. The enclosure can be installed under the floor, in the ceiling or in the wall. Compared to traditional Hierarchical Star Topology, both FTTE-L and FTTE-H provide cost savings of 28 to 38 percent, as estimated by the "premise cost model" available from the TIA Fiber Optics LAN section (at http://www.fols.org/resources/costmodel_links.cfm).

The potential for improved cabling costs, energy savings, and space savings as a result of using one of these two TE cabling systems benefit an intelligent building because of the increased efficiency of communication enabled by the FTTE design as shown in Chart 4. The fiber optic cables allow efficient integration and automation of the building control systems by providing the necessary bandwidth, security, and network efficiencies.

Chart 4 – Network Architecture Cost Model Comparison



Source: Ortronics Legrand Inc. & FOLS

Chart 5 – Interactive FOLS Cost Model on the Use of Fiber in Customer-owned Networks

Installation	Hierarchical Star ($)	FTEE-L ($)	FTTE-H ($)
Desk Support Equip/NIC	6,273	6,273	6,273
Horizontal Cabling	29,225	7,970	7,970
TR Support Equipment	86,325	21,003	15,571
Workgroup Switches/GBIC	48,557	26,811	48,557
Vertical Cabling	1,262	4,368	2,922
MC Support Equipment	3,120	3,663	3,120
Core Switches/GBIC/Blades	62,653	72,285	62,653
Misc.	130	195	390
Labor	21,504	17,612	15,904
Total	259,049	160,180	163,361

Note: Floors: 8, Total Ports: 432

Source: Ortronics Legrand Inc. & FOLS

OPEN-OFFICE ARCHITECTURE

Commercially successful intelligent buildings require adapting to the changing needs of the business and its occupants more efficiently than traditionally designed buildings. The open-office architecture model can be enabled by utilizing the standards-based FTTE topology and bringing the benefits of fiber's high bandwidth and long transmission distances closer to the user or building management device with less traditional cabling. The open-office brings the fiber backbone to smaller TEs serving up to 48 users/devices throughout the office area. The TR is simplified, with reduced space requirements, cooling needs, and complexity. The major advantages of the TE-based open office approach are:

- Zero-footprint implementation with ceiling, floor, or wall-mounting TEs
- Reduced cooling requirements
- Potentially lower equipment costs for network workgroup switches
- Easier, incremental migration to new technologies with minimal disruption
- Simplified management of MACs
- More potential bandwidth to each user or device
- Potential savings of 30 to 40 percent over traditional Hierarchical Star topologies

While fiber runs from the main equipment room to the TE, individual or "horizontal" runs to users or devices can be with copper, fiber, or wireless connections through wireless access points. The TE is designed to accommodate both the network equipment and cabling management hardware to serve users. Cooling is as easy as adding fans in the enclosure for ventilation. Deploying FTTE allows for an open-office architecture that significantly reduces the space and costs of TRs on each floor.

Fiber optic cabling offers green benefits as well. The fiber cabling is smaller in diameter, thus reducing the cable profile. While providing higher bandwidth capabilities, the smaller fiber bundles can increase airflow and cooling efficiencies in congested areas. Many redundant cabling types can be eliminated by deploying one fiber-based converged network from the main equipment room to a far-end location.

AN INTELLIGENT INFRASTRUCTURE SOLUTION

FTTE/Zone cabling systems benefit an intelligent building by enabling more effective integration and convergence of building control systems. Using high bandwidth optical fiber closer to users and edge devices increases the data communication capacity by two or three times compared to legacy cable, thereby saving cable installation costs. Fiber optic cables also provide protection against EMI, RFI, and other external electrical noises or disturbances.

In addition, optical fiber can be more secure and less prone to unauthorized access than traditional copper cabling. Since copper runs are limited with respect to distance, fiber optic technology is often the choice for large installations such as a campus facility, factories, multi-dwelling units (MDUs) or across multiple buildings.

Effective communication and integration through the thoughtful choices of cabling systems can lead to more efficient building network applications. A by product of such choices may include improved space usage. Reducing operating costs by combining products and technologies to better suit the demands of a business, is a core competency of an Intelligent Building infrastructure.

An earlier adopted standard specific to commercial buildings was the TIA/EIA-862 Building Automation Systems (BAS) Cabling Standard. This standard specifies a horizontal connection point (HCP) for BAS to help in the planning and installation of a building communication network. Using a zone-cabling topology such as FTTE, BAS devices can be connected to the zone HCP for easier maintenance and logical placement. When new BAS devices are added to an area, only a short cable run is needed to connect to the network, saving on material and installation costs.

CONCLUSION

Since the TIA/EIA 568-B standard for zone cabling implementations were ratified, there has been a growing interest in the FTTE architecture. The FTTE architecture will allow the adoption of new technologies within a building – specifically convergence of previously proprietary stand-alone systems to an IP-based platform. Advances in technology are demanding an infrastructure that will support all of a building's communications. The cost of re-cabling and/or installing disparate networks in terms of both capital dollar investment and associated network downtime is not always an option; building owners and end users are looking for alternatives to the traditional cabling system. It is difficult to dispute the long term benefits of investing in and implementing an innovative zone cabling solution.

The benefits include:

- More useable real estate resulting from eliminating or reducing the size of the telecommunications room on each floor.
- Potentially 20 – 30 percent cost reduction on cabling installation due to consolidation and removal of single purpose proprietary networks.
- Reduced pathway size within the office area and more efficient installation. 20 – 30 percent cost savings on cable pathways.
- Substantial reduction in cost and disruption to staff when making changes within work areas.
- Universal, converged, and fully integrated solutions which are able to support:
    - Voice & Data
    - Video
    - Security
    - Access control
    - Lighting
    - HVAC
    - Energy management
    - Fire & Life safety

- Integrated system works across all vertical markets:
    - Commercial Real Estate
    - Education
    - Government
    - Healthcare
    - Hospital
    - Industrial
- Improved network performance by increasing the bandwidth available to the users and edge devices
- Single contractor/integrator responsible for installation vs. need to coordinate several specialists for disparate systems
- Installed system is easy to change and has capacity to integrate additional applications as needs of businesses and occupants evolve
- Zone cabling can provide the highest bandwidth option, at the lowest installed cost, for the greatest distance and number of devices

Electrical Architecture by Convia – A Herman Miller Company

INTRODUCTION

There is a growing global emphasis on environmental protection, energy efficiency, and sustainable resource management. This emphasis is leading to more focus on applications designed to minimize power consumption, reduce waste and scrap generation, and minimize the downtime when problems arise in a building. The National Institute of Building Sciences estimated that buildings utilize 40 percent of the world's raw materials and 40 percent of the world's energy.

In the United States, 55,000 obsolete commercial buildings are demolished each year, generating 150 million tons of construction and demolition waste. According to the United States Department of Energy, commercial buildings account for nearly 18 percent of energy consumption and 66 percent of the electrical energy consumption in the United States. This electric consumption has doubled between 1989 and 2005 and by 2030 is expected increase by 150 percent at the current growth rate, unless remedial measures are taken.

PRODUCT SHOWCASE

To meet the needs of more flexible and integrated infrastructures, Convia delivers electrical infrastructures that are flexible, adaptable, and are able to serve as the integrated center for lighting, energy, and control systems. This new programmable environment combines a new electrical infrastructure that replaces the traditional pipe and wire systems with embedded lighting controls that are connected together through nodes on a network.

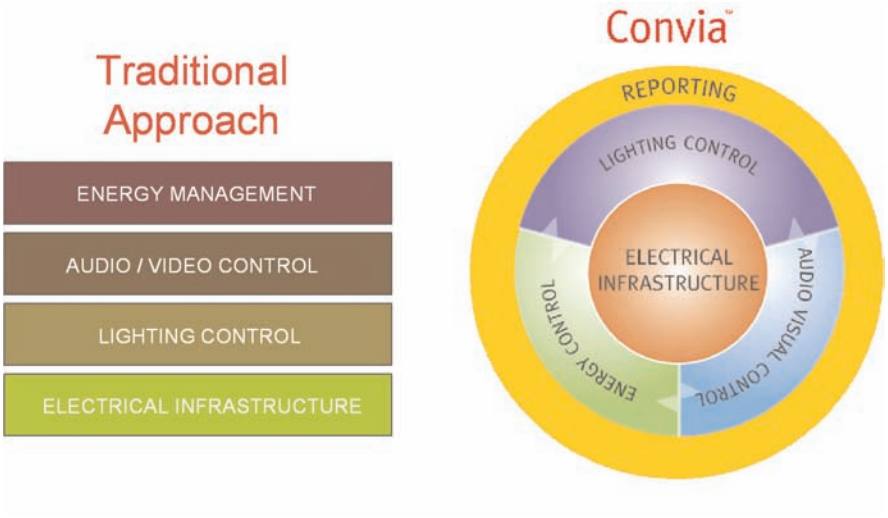
The Convia system creates either a horizontal or vertical framework structure that can employ control, communication, and power technologies in an integrated system that can be placed anywhere with a plug and play approach. This allows for virtual rewiring without having to tear down walls or rip out wires.

This new system has different architecture requirements: an open ceiling with a grid may be used to set up the infrastructure, or the system may be placed behind traditional, finished ceilings and walls. This allows building owners and managers to retrofit existing buildings without any noticable disruption. Tenants and users can easily access the infrastructure to adapt the system to their environment and needs.

Compared to traditional systems which require separate control elements to be installed after hardwiring the electrical structure, Convia offers an integrated system control making additional installs obsolete. This enables the Convia system to integrate the lighting controls,

building controls, and device controls with the electrical infrastructure at the center of the integrated system.

Chart 1 – Comparison between a traditional buiulding infrastructure solution and Convia's integrated solution



INTEGRATED ELECTRICAL ARCHITECTURE SOLUTION

The building industry continues to move toward more intelligent and green buildings. This move requires interoperable, flexible, and open systems to ensure ease of operability in a building. A single platform that can control all these systems can propel growth in intelligent buildings while also enhancing energy efficiency, ensuring minimum energy waste as it is able to manage the occupied spaces.

The days of pipe and wire electrical installations with different installers for electricity, HVAC, and AV may become a thing of the past. These systems can be integrated by Convia with a simple, sleek system that integrates the various controls in a building into one "plug and play" solution. Pipes and wires are disappearing in favor of nodes on a network which are easier to change and restructure. This allows Convia to integrate lighting control, building control, device control, and the electrical infrastructure into one system, allowing for better energy efficiency as well as cost saving.

Convia can address the following three major needs of building owners and tenants:

1. Facilitate people using the building to become active agents in the utilization, creation, and evolution of spaces that support their activities.

2. Preserve and improve the investment and ROI for the building owners and managers.

3. Reduce the impact on the environment by the building, from its initial construction stage through its lifecycle.

An embedded, central, and integrated control system can help create energy efficiency within a building by reducing electrical consumption through controlling energy sources in more efficient ways. Buildings now require systems that can control various equipments like HVAC, lighting control systems, fire and life safety, AV, security, and elevators. A system like this would produce a more intelligent building, and significantly reduce energy consumption once all functionas are coordinated.

The centralized control of a building can be achieved through the advent of new technologies. The addition of embedded control and wired or wireless standard connectivity options can help promote productivity by enabling efficient data flow to centralized control points. The use of standard internet protocols like Ethernet generates a smoother interoperability within the building's centralized management. Ethernet installation are expected to grow along with the demand for Ethernet nodes creating a need for technologies that can be connected and integrated into a centralized control system.

CONVIA COMPONENTS

A number of components are employed in the construction of the Convia system infrastructure, which lead to a full system integration. The seven components involved in Convia's programming of the lighting system are:

- Convia Switch: This is used when a person manually pushes the switch to turn the lights on or off.
- Single Switch: This switch controls dimming, and it can be programmed to control a configuration of light fixtures.
- Multiscene Controller: This controller establishes multiple existing lighting settings in one unit.
- Smart Connector: These connectors come in a variety of shapes and sizes, and they control the load to a light fixture.
- Remote IR (Infrared): A Remote IR can control a Smart Connector from one hundred feet away, thus allowing the user to place the Remote IR wherever it is most convenient for the user.
- Convia IR Interface: This is activated by the wand when programming, and it becomes the target of the Convia Switches, Smart Connectors, and Remote IR controls.
- Wand: The wand is used in programming the switches and Smart Connectors.

HOW CONVIA WORKS

Within the integrated Convia system, there is a low voltage communication network and protocol that allows unlimited connectivity between these multiple devices to form the heart of the Convia system intelligence. The core of the Convia system is the unlimited connectivity between multiple devices through its flexible system, which allows for it to be utilized at or above the ceiling, beneath the floors, or within the modular or traditional wall construction.

The Convia system is a node based multi-cast system. This system allows for all the nodes to have embedded control intelligence, and they can all communicate with one another. This allows the nodes to be reprogrammed as needed, and the nodes have the ability to react to the other nodes on the network. This system allows the user to plug and play into the electrical infrastructure and easily install, upgrade, or relocate a lighting fixture, security camera, electronic display, thermostats, speakers, switches, or sensors at any moment because these devices can be placed and activated anywhere. Besides the lighting and AV, Convia can control the HVAC through this integrated system. Now, the facility managers can control HVAC zones to respond to and correct hot and cold spots.

HOW TO CONTROL THE CONVIA SYSTEM

Once Convia's system is set up, users may then control the switches and Smart Connector light fixtures through either the wand or the Convia Global Gateway web portal. The wand is a secure, remote control device that uses infrared technology. All the user has to do is simply point the wand at a fixture and then to a switch, which connects the fixture and switch. Similarly, another button on the wand, can disconnect a fixture and a switch without making any wiring changes. The wand allows the user to personalize space by pointing and clicking the two buttons.

Using Convia Global Gateway, an internet based system, allows for the user to control the Convia system along with all the other building subsystems using a PC. This web portal allows all the building subsystems to communicate with and react to each other, and all protocols and systems to interoperate, which provides control of lighting, power, and AV equipment simultaneously. Convia Gateway can act as either the master controller or servant to the other BAS systems. This system supports event programming, which can be used to turn off or dim lights, at certain times, or triggered by other events.

Convia Gateway monitors in real time the energy consumption in the space, while also calculating the dollar impact on the bottom line of dimming and other energy strategies. The portal can prioritize the load-shedding to different power zones. The web portal can give building occupants the ability to control their overhead light levels and personal thermostat.

DESIGNING FOR EFFICIENCY AND SUSTAINABILITY

Convia's approach considers several different methods to achieve these goals, with the first method starting literally from the top down. By starting with the ceiling, a builder is able to use gravity rather than fight gravity, which allows them to use lighter, cheaper materials to divide space. There are variations of articulating ceilings that can define space or contain videoconferencing.

The use of lights can create effects on the ceilings and walls, and spot lighting can be replaced with fully illuminated LED lights. There are prototype textile walls that can be moved to change a space to create either a lobby or meeting room. To accomplish their goal of combining these different elements into a building, there is the Convia platform with its three systems:

- Open grid system
- Modular system
- Hybrid system

The open grid system delivers power every ten inches on the grid, and it is ideal for spaces where total flexibility is required. Additional infrastructure units may be hung from the grid. The open system is ideal for highly dynamic areas. The modular system is the most economical solution. The modular system is best utilized in situations where there is a closed ceiling, which allows for a more finished look while retaining the ability to rewire within in minutes. The modular system is a good fit for areas where changes are infrequent. The hybrid system has the ability to accommodate the full spectrum of flexibility.

HOW CONVIA REDUCES COST

There are several major challenges in the building industry today involving labor, retrofitting, energy, and integration. Convia's integrated solution with electrical architecture can reduce time and cost of labor with plug-and-play components and enable design and spatial changes at a marginal cost. Convia provides the ability to customize tenants own environments through their integrated system and web portal creating a higher level of habitat customization for tenants through programmable environments.

Convia's technology also offers other economic benefits to the users of their system. For example, the modular system can be installed at a cost that is comparable to the cost of a traditional electric system that includes lighting control. Despite the benefits offered, the open grid and modular Convia Systems can be depreciated over seven years, rather than the thirty year period for the fixed systems, providing significant lifetime savings.

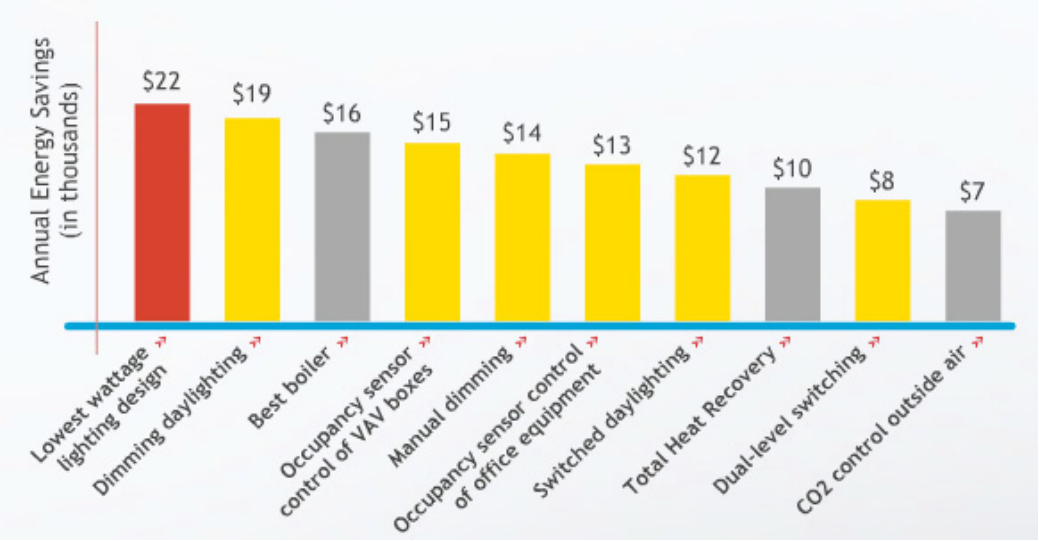
Convia reduces labor costs by 40 to 60 percent over the life of the building as it requires less labor during the initial installation and requires less labor to maintain the building. The system uses 100 percent reusable components, which reduces the substantial landfill waste of traditional electric infrastructure. Convia's ability to save money extends to energy savings also as Convia can reduce the energy costs in a building by making it more energy efficient.

HOW CONVIA SAVES ENERGY

The Convia System starts saving energy during its installation. Convia provides a 32 percent reduction in energy costs compared to pipe and wire systems. The Convia system saves energy because it requires less expensive adjustments and can more easily implement strategies like daylight harvesting and occupancy sensors.

An independent study conducted by the Weidt Group, showes that Convia solutions can recoup 20 to 60 percent energy savings that would otherwise have been lost by traditional electrical infrastructure. The study, conducted in a Denver 194,000 square foot office building, explores the relative opportunity of control strategies possible. As shown in Chart 2, Convia enabled 7 out of 10 of the leading energy saving strategies, (these combination of controls can account for the largest savings of up to 30 percent).

Chart 2 – Convia's Energy Savings Potential



Source: Weidt Group, Nov 8, 2006

CONVIA'S APPROACH TO LEED AND AHSRAE

The ability to reduce energy consumption and increase savings is unique in today's building environment because traditional electric infrastructures can not reconfigure new components. Convia is able to capture these savings through its ability to be flexible, which allows the system to use hierarchical switching, zoning control, and load shedding.

Convia's flexibility is especially useful with lighting controls. The Convia system provides personalized and cost-efficient control of lighting, power, and HVAC by optimizing daylight, occupancy, temperature, and time sensors. The daylight harvesting and occupancy sensors programs can be implemented at a much lower cost than with traditional wiring. The Convia system works with sensors that can be embedded into the furniture and walls. The presence of these sensors means that when an employee leaves their desk the occupancy sensor will shut down or dim the lights.

The Convia system can contribute up to eight Leadership in Energy and Environmental Design (LEED) points to a building. When a building gives 50 percent of direct control of energy to its occupants then that is worth one LEED point, and when it gives 75 percent, it receives two points toward certification. These points can be very helpful in reaching the twenty one points needed for LEED certification, twenty seven for Silver, thirty two for Gold, and forty two for Platinum.

In addition to the benefits toward LEED paints, reduced energy consumption can be used to meet other green building standards, as well as reduce operating costs of buildings. Convia can help qualify for federal and municipal tax energy credits of $1.80 per square foot of a building, of which $0.60 is attributed to lighting. These savings match up with other energy benchmarks such as ASHRAE 90.1 and Title 24 in California.

Against the stringent ASHRAE 2004 standard, the Convia system can result in energy savings from 6 to 30 percent according to the study by Weidt Group. Overall, based on an independent study by the Weidt Group, the Convia system meets seven out of the ten leading energy savings strategies examined:

- Lowest wattage lighting design
- Dimming daylighting
- Occupancy sensors control of VAV boxes
- Manual dimming
- Occupancy sensor control of office equipment

- Switched daylighting

- Dual level switching

The system is beneficial to anyone looking to develop a green building because of its fully integrated capabilities, and its ability to reconfigure. What makes the Convia system valuable are the many ways that it can provide benefits to the end user: it is a programmable, integrated system that allows a facilities manager to control the lighting, energy, and HVAC of a building through one system. This integration allows occupants to control their own lighting and temperature from their desks.

Restroom Monitoring Systems by Sloan Valve Company

INTRODUCTION

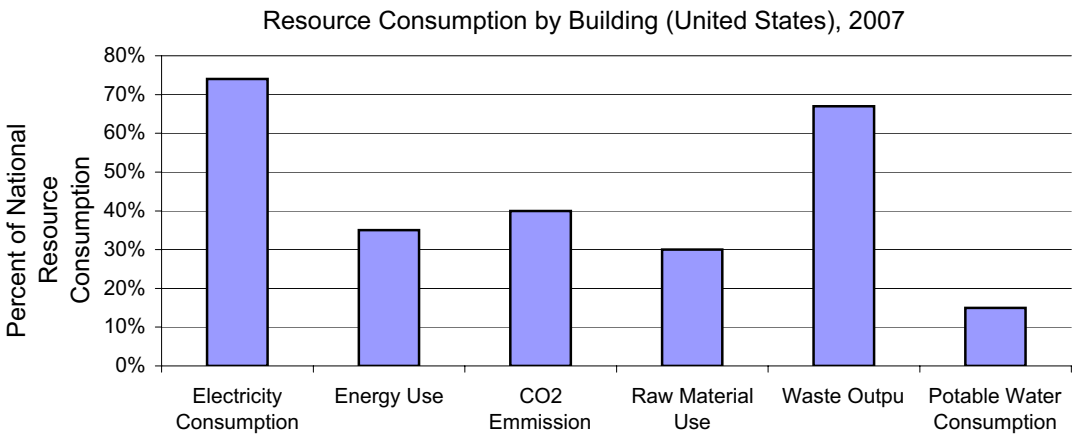
Water shortages are expected to be an ever-present challenge, and offers tremendous market potential for water conservation technologies and products. One such option that has been displaying growing potential is the application of integrated monitoring and control of water use. Sloan Valve Company has introduced Sloan® Monitored Systems (SMS), a water conservation technology that monitors and controls water usage in potable waters systems. By networking sensor operated faucets and flushometers in conjunction with supplemental water meters and sensors allows an owner to monitor the entire restroom environment.

STATISTICS ON WATER DEMANDS

The population growth in the U.S. has significantly increased the demand for water; while the U.S. population nearly doubled from 1950 to 2000, the demand for water more than tripled. The U.S. population is estimated to reach 420 million by 2050; the increasing demand is expected to put additional strains on existing water supplies and distribution systems. Because of this, significant efforts are being made to conserve water and protect our water resources. Given the current water consumption, the government expects at least 36 states will experience local, regional, or statewide water shortages by 2013. Water conservation efforts are thus required to ensure the well being of future generations and the protection of the environment.

Every year, trillions of gallons of water are consumed in the U.S. for personal, industrial, and agricultural use. According to the U.S. Geological Survey, Americans consumed in excess of 400 billion gallons of water daily in 2000. In many Southwestern and Plain states, water stress has been a longstanding challenge. Inefficient water use places an immense burden on municipal water treatment systems in many major cosmopolitan areas. In major urban centers in North America, the average volume of water consumed by each person often reaches 150 gallons or more per day.

Chart 1 – Resource consumption by building



Source: US Green Building Council

Commercial properties and institutional establishments are major users of water. At the present time, there are an estimated 5 million buildings in the U.S., with an estimated daily water consumption rate that exceeds 10 billion gallons per day. Together these buildings may consume up to 3.5 trillion gallons of water annually-enough to provide water to meet the basic survival need (4-5 gallons per day) for 730 billion people for an entire year! In addition to actual water use, water leaks in toilets result in substantial water loss. For small leaks up to 7 gallons of water per toilet could be lost per day, whereas extensive toilet leaks could result in over 100 gallons of water loss per day. In fact, up to 40 percent of water use in a commercial building can be attributed to sanitary use such as toilet flushing.

PRODUCT SHOWCASE

To drive the nation's water conservation efforts, the Sloan Valve Company introduced Sloan Monitored Systems. This approach is designed to help building owners increase the overall water efficiency of the building by allowing them to manage, monitor and control water usage. Sloan Monitored Systems is envisioned to be the next level in building automation; adding the restroom as a fully monitored sub-system permitting a variety of monitoring and control functions, on-site or remotely.

Some perceived benefits that will be delivered by this system are:

- Increased patron satisfaction
- Reduced maintenance cost
- Reduced housekeeping effort
- Continuous commissioning

These benefits will be achieved by networking automated plumbing fixtures (urinals, water closets, faucets) in conjunction with discretely monitoring water usage at strategic locations throughout the facility. Some of the features of this system that would deliver said benefits:

- Predictive, usage-based, maintenance
- Proactive supply replenishment
- Automatic alarm notification via e-mail, text, or voice mail

In addition to promoting water conservation, the Sloan Monitored System also provides building managers with a valuable tool to manage potential liabilities related to water leakage and flooding.

SLOAN'S SUSTAINABLE WATER CONSERVATION SYSTEMS

The Sloan Monitored System incorporates advanced microprocessor technology to achieve maximum control of the plumbing fixtures. The system functions by monitoring the sensor signal supplied to the electronic flushometer and records that an attempt to activate was made. A water meter enables this system to measure that water use is in line with expectations. If the amount of water use differs from the established baseline, the system sends an alarm to a control center, building owner, or any other designated party, to alert them that there is a problem in the restroom. The message is sent over the internet and is delivered on a PDA, pager or any other device regardless of location. This empowers the facilities group to resolve the issue in a timely manner, preventing further water waste and restroom damage.

In addition to sending alerts, the system can be set up to send a signal to an automated ball valve installed upstream of the restroom to turn off the water in that zone. Since the system can automatically shut off the water, this feature can be particularly important in the event that the failure occurs when the person responsible for fixing the problem is unavailable; such as during off hours, weekends, holidays, etc. Event schedules can be established to designate working and non-working times routing alarms accordingly.

This system can also be used to monitor the water usage of other plumbing fixtures such as faucets. This is achieved similar to the flushometer by monitoring the sensor signal supplied to the electronic faucet. If the system identifies that water is running and, no faucets or flushometers have been activated, the system will again send an alarm. Considering that more than 3,000 gallons of water can be wasted each year from a single faucet leak, this system is a clear example of the efforts made by Sloan to increase water efficiency.

Depending on the level of monitoring employed; being able to identify which specific valve is not working properly makes this system a great solution for many industries. For example, in the hospitality industry, the system can identify the specific room that has an

issue so it can be addressed immediately. This technology can be especially effective in a hotel setting because the possibility of a toilet leak or a running faucet is more likely to go unnoticed for an extended period of time. This is also the case in large commercial buildings, where the restroom might be on a vacant floor or not used over a weekend or holiday.

The number two complaint in public facilities is restrooms. These complaints typically include the following

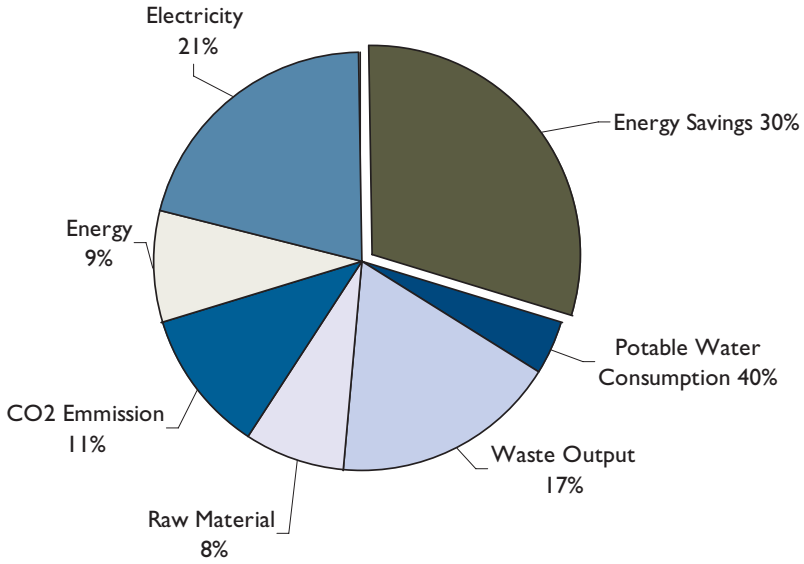
- No toilet paper
- No soap
- No paper towels
- Overflowing toilet or faucet
- Lack of cleanliness

Sloan Monitored Systems can be used to monitor consumable items in the restroom. If a soap dispenser is set to provide a certain number of dispenses of soap, the system will send a signal to alert housekeeping or facilities staff when supply is low, ensuring a continuous supply of soap. Sloan is continually working to offer solutions for other replenishable items in the restroom.

Sloan is concentrating their efforts on providing more detailed information to better allow building owners to control their water consumption. Sloan is looking to provide information to show how often and at what times of the day the fixtures are used, and how the fixtures are used in different seasons. In terms of Waterfree urinals, Sloan is developing modules to monitor the number of times the fixture was used so the system can notify the building manager that the cartridge needs to be replaced. Over time this will help forecast the usage trend, facilitate preventative maintenance and ensure the fixture is always in service.

A large percent of the water consumed can be attributed to toilet flushing, bathing, and other amenities. At this rate of consumption, many municipalities are challenged with insufficient potable water production capabilities to meet the demands of the growing population. Since infrastructure expansion to increase water supply is extremely costly, more cost-effective water efficient conservation methods are being implemented to manage water demand. In regions where water shortage is already a prevalent challenge, water conservation becomes imperative as there are few alternatives available to meet the growing demand for water.

Chart 2 - Potential Resource Consumption Savings from Green Buildings



Source: U.S. Green Building Council (USGBC) and Frost & Sullivan

THE MONITORING PHASE

Establishing that water usage can in fact be measured involves being able to monitor a series of variables such as flow rate, fixture use, traffic patterns, occupancy, and others around facilities that have restrooms. In a Sloan-sponsored study at a major university involving lavatory water consumption, a method to measure the frequency of use and calculate the amount of water consumed by plumbing fixtures in a public restroom was developed and used. In that study (2005), the following conclusion was put forth by the researchers:

"We were surprised at how much water lavatories use overall. That made the savings much more noteworthy [in the experiment], especially with the automatic valves ("auto" phase). . . Predictably, during the second phase ("low con" with 0.5 gpm aerators) that used low consumption manual faucets, there was a significant decrease in consumption. The last phase – Automatic — incorporated the use of Sloan Optima low-consumption, sensor-operated faucets with 0.5 gpm aerators. This phase represents the least amount of overall consumption while occupancy remained steady..." (NOTE: for a complete copy of this report, e-mail engineer@sloanadministration.com)

Sloan took this data and then advanced the approach at a major retail establishment by installing usage monitors on all plumbing fixtures in addition to installing a traffic counter on the primary ladies restroom. Over the course of a couple of months, using a limited data set, Sloan was able to correlate fixture use to restroom traffic and accurately predict subsequent week-to-week usage patterns. Additionally, when creating the LEED® paperwork, the client estimated the number of female patrons using all the restrooms in

any one given day to be 204 and the number of men to be 102. The actual measured usage at the main women's room averaged 300 per day, a 50 percent increase in traffic-and nearly double the original estimate for all restrooms in the store; highlighting that the demand was significantly underestimated, not only on the plumbing system, but the consumable items such as soap, paper towels, and toilet tissue. Higher traffic levels also dictate additional cleaning activities that were otherwise un-anticipated. Additionally, they were able to correlate spikes and dips in usage to the time leading up to and including the back to school Labor Day holiday.

THE CONTROL PHASE

Sloan has been active in the control of water at prison systems for over a decade with the Programmed Water Technologies (PWT) product line. Through that, deepened their understanding of networking fixtures. Prisons typically install plumbing control products to keep inmates from abusing fixtures, which can result in fixture or water damage. Before the installation of the PWT control system at one California prison, the facility was discharging 42,000 gallons of wastewater each day. Today, after retrofitting the facility, consumption averages just 8,300 gallons of wastewater each day – 80 percent less than before!

The next phase in Sloan's development plan was automating that calculation process, and presenting the information in real time.

THE INTEGRATED PHASE

Sloan Monitored Systems is the next generation monitoring and control system, focusing more on the commercial environment. Sloan Monitored Systems is currently optimizing the maintenance processes at a major facility in the Chicago area to achieve increased efficiency and sustainability. Where the monitoring of plumbing fixtures, restroom occupancy, soap dispensing and even the monitoring of a greywater system will be taking place.

This facility was planning a major renovation to the original restrooms, as well as, adding new restrooms throughout increasing capacity by 50 percent. This change would increase the amount of area the maintenance and facility personnel would need to monitor and service. Similar to the retail store, they had no idea of fixture or water usage in the existing restrooms, let alone the amount of activity to expect in the new restrooms. Sloan worked with the owner, architect, electrical engineers, and plumbing engineers to design a system that would not only monitor discrete fixture usage, but measure actual water usage of all the restrooms – in real time. This facility is undergoing significant design changes; replacing manual 3.5-gallon per flush water closets with sensor operated 1.6-gallon per flush water closets, manual 1.5-gpf urinals with Waterfree urinals, and replacing manual metering faucets (0.25 gallon per dispense) with 0.5-gpm "on demand" hands free faucets. "On-demand" means that the faucet runs only as long as the user needs water, which is frequently a much shorter time than that of a metering faucet.

The tables below were constructed using information collected from this site over a 90-day period. For comparison, the actual usage data is used to calculate water savings based on the lower efficiency products in the original restroom.

While the reality is that current regulations would prevent the installation of such water wasters as 3.5-gpf water closets, this provides a visual impact of the amount of water saved due to this multi-million dollar renovation and expansion. It shows the potential to fund additional savings by converting the water closets to 1.28-gallons per flush; which would reduce water use another 20%.

90-day activity Water Closets

Water Closet usage	Pre-renovation 3.5-gpf Flushometers (gallons)	Post-renovation 1.6-gpf Flushometers (gallons)	Savings (gallons)	Percent Reduction	**HET *Projections*** 1.28-gpf Flushometers (gallons used)	Additional Percent Reduction
28,867	101,034.5	46,187.2	54,847.3	54.3%	26,323	52%

90-day activity Urinals

Urinal usage	Pre-renovation 1.5-gpf Flushometers (gallons)	Post-renovation 0.0-gpf Waterfree Urinals (gallons)	Savings (gallons)	Percent reduction
10,732	16,098	0.0	16,098	100%

90-day activity Lavatory Faucets

Lavatory Faucet usage	Pre-renovation metering faucets 0.25 gallons per activation (gallons)	Post-renovation "On-Demand" hands free faucets water usage (gallons)	Savings (gallons)	Percent reduction
64,801	16,200	3,671	12,529	77%

Over the course of this project Sloan played the role of systems integrator, and no specialty contractors were used. Sloan worked closely with the facility's IT department to ensure the network was installed according to their security policies. A computer in the central control room is used to monitor the usage activities and system alarms, providing the ability to dispatch work orders to address any issues from low soap to non-functioning fixtures. Sloan also has a virtual private network access to permit remote access to update software as required.

Usage-based alarms are set to signal the following:

- Water meters-water use of any fixtures in off-hours, percent above established baseline
- Soap Dispensers-low soap level
- Water Closets-service time approaching
- Lavatories-service time approaching
- Occupancy-over or under utilized

- Entrance traffic counters-over or under utilized, time for general cleaning
- Indoor air quality-time for general cleaning

From original datasets developed from multiple monitoring points, predictability outcomes can be developed. For example, monitoring the occupancy sensors located in the lighting controls in the family rooms would indicate that someone entered but no activations registered. A frequent occurrence of this, may point to a problem with one or more fixtures, such as a clogged toilet, leading the user to look elsewhere. This would trigger a "soft" alarm such that a facilities person is dispatched to physically check on conditions. The appropriate work orders can be automatically generated and logged.

Since most service life suggestions are time based (typically occurring at the time of failure) the system is initialized with preset threshold values that can be adjusted up or down based on the actual activity and experience at the facility. The highest cost component of service is not generally the part, but the labor required to service the part. By monitoring, recording and reporting activities, the most valuable assets in the organization (people) can be better scheduled and utilized.

For example, the predictability outcomes of the monitoring are occurring around the Waterfree urinal. The life of these cartridges is actually being extended due to the ages of the primary users of this restroom (children), and gives administrators another factor in assessing maintenance strategies. In other words, the "life" of the cartridge is related to the age of the user – something that never entered maintenance equations for predictability until this study took place.

As the remainder of the restrooms are brought on-line this picture will be updated and expanded.

Further excitement is surrounding the project because some of the restrooms at this facility are also tied into a greywater system. In the greywater system, water is collected from faucets, treated, and re-circulated to the water closets. Sloan Monitored Systems monitors this process with seven points of reference:

- Ultraviolet (Light Disinfection – "UV") Lamp Failure Alarm
- UV Lamp Low Life
- Sump Basin Low Level
- Low Booster System Pressure
- High Booster System Pressure

- Booster Shutdown Alarm
- Filter Switch (indicates time to change filter)

These alarms are important for many reasons,. Among them the fact that while Ultraviolet light disinfection of greywater has a number of advantages, the efficacy of the UV disinfection can be impeded by high levels of particulates and chemicals in the greywater, micro-organism aggregation, and the geometry between the UV lamp and surrounding sleeve, leading to suboptimal flow paths through the lamp assembly. Thus, setting off alarms at appropriate points ensures the stability and performance of the system itself. As the history is developed the case for adopting greywater will be quantifiable and verifiable.

SOLUTIONS TO WATER CONSERVATION FOR BUILDING OWNERS

Typically, building owners and water managers have been reluctant to spend funds on water efficiency upgrades due to concerns about payback, and to avoid issues related to the budget dichotomy of purchasing a capital asset that benefits operating expenses. Building energy managers, who achieve energy savings via lighting, HVAC and other high energy-performance measures, can seek additional methods of saving on energy costs in water fixtures. Saving water from high-performance systems would be favorable to the environment, favorable to water managers and beneficial to owners as energy costs will be mitigated; e.g. less water required to be pumped to restrooms. Additionally, where performance contracts are in place, the savings earned from energy efficiency can be employed to support costs for water efficient technologies.

Energy Performance Contracting is a financing method that allows a facility to complete energy-saving improvements within an existing budget by financing with money saved through reduced utility expenditures. Building or facility owners make no up-front investments and instead finance projects through guaranteed annual energy savings. Similar arrangements are already commonplace to address water saving upgrades in a building. Municipal water rebate programs have also proven effective at getting the public and private entities to adopt water efficient conserving products and technologies. Providing rebates for approved products significantly reduces or even negates the cost to the end user.

Additionally, performance contracting can allow a manufacturer to pilot a technology where the customer (such as a city government) is risk averse to trying new technologies. Unlike universities, who seek to attract top students and faculty by use of innovation as a means of differentiation. In the absence of financial incentives or regulatory policies that mandate water management technologies, performance contracting can be a solution.

While water savings can be realized by installing stand-alone plumbing fixtures, only with Sloan Monitored Systems can the savings be documented and maintained over the life of the structure. Sloan Monitored Systems provides an owner the ability to monitor the "health" of the system and proactively address any issues before they become major problems.

LEED'S APPROACH TO WATER CONSERVATION

A significant industry driver for adoption of energy management practices is the Leadership in Energy and Environmental Design® (LEED®), a tool developed by the U.S. Green Building Council for green building design, benchmarking, performance improvement, certification, and recognition. LEED points are awarded for the following water consumption rate changes: reducing landscape irrigation by 50 percent; avoiding potable use in irrigation (by using rainwater or reclaiming greywater) or avoiding irrigation altogether; reducing non-irrigation water use by 20 to 30 percent; and another point is given for innovative wastewater technologies. LEED for Existing Buildings includes prerequisites for water management including minimum water efficiency which will drive 20-30 percent water efficiency for non-irrigation use.

A recent Executive Order in the State of California mandates all state buildings to reduce their energy consumption by 20 percent by 2015. Additionally, all existing buildings in California must be LEED-EB benchmarked by 2015. These together require a system-wide transition from a supply-based to a demand-based system for water and wastewater management. Non-governmental organizations encouraging voluntary initiatives for energy efficiency impact water management insofar as water management is related to energy use. Sloan believes that while the building will be eligible for the water credit due to high efficiency fixtures, Sloan Monitored Systems will provide extra points in the area of Measurement and Verification.

WATER DEMAND MANAGEMENT PROCESS AND PRACTICES

Municipalities are using water conservation strategies aimed at changing customer behavior and encouraging adoption of water efficient technologies, as means of engendering sufficient savings as to provide for infrastructure costs or slow the need for infrastructure growth. In an effort to measure and control water volumes utilized, and to direct conservation education to appropriate target areas, municipalities have been metering consumption. Metering motivates change to a water fee system based on time-of-use and per unit volume, as low-users expect others to behave similarly.

When costs directly related to consumption volumes and peak times of use are introduced, consumers in all sectors will have had time and some support to implement necessary changes. Fee-based and other financial and educational incentives for facilitating water conservation management are on the rise. For example, Seattle utilities spend about 2 percent of their income on programs to promote water efficiency and peak demand management.

Increasing tier pricing, time-of-day pricing, water surcharges (for extreme use) and seasonal rates (depending on demand and weather) mitigate water use. The most effective means of transitioning from supply management to demand management seems to be the route of awareness building, education, metering, incentivizing conservation habits and technologies, combined with voluntary and/or regulated initiatives.

The regional municipality of Durham in alliance with the Canadian Water and Wastewater Association, the American Water and Wastewater Association, and other supporting bodies, have implemented a system of field-testing high-efficiency fixtures, such as toilets, and other water efficient technologies. Given the concerns around available water supply; as well as source, building, and effluent water quality it would seem that the industry will increasingly use controls that monitor these factors.

Because of Sloan Monitored Systems, total realistic life-cycle costs of the restroom are, for the first time, within the grasp of owners and developers. This new level of integration will help companies establish a single source of water knowledge while increasing both the overall sustainability of the restroom space and positive experience for the end user.

Integrated AV Systems by InfoComm International

OVERVIEW: WHAT IS GREEN AV?

Over the past several decades, audiovisual (AV) technology has evolved from simple, piecemeal loudspeakers and projectors used as presentation tools into integrated and networkable systems capable of linking organizations and their facilities in new and dynamic ways. The convergence of AV and IT technologies has raised the bar for usability and systems integration, especially in intelligent and green buildings where user comfort, energy efficiency, and asset management are key features.

Brought forth by rising energy prices and an increased awareness of issues related to global warming, the mainstream green movement and the increasing demand for energy efficient products has prompted the AV community to harness existing technology for use in new applications. The term "green AV" was coined in reference to projects where established AV technologies like videoconferencing, environmental controls via touch panel interfaces, digital asset management, and audio/video signal dissemination are designed not only for communications purposes or convenience, but also to conserve energy, reduce carbon emissions, decrease operational costs, and to maximize the operational efficiencies.

Other drivers of green AV include the Restriction of Hazardous Substances (RoHS) Directive, passed by the European Union and enacted on July 1, 2006, that restricts the use of certain hazardous substances in electrical and electronic equipment. Since most AV manufacturers sell their products in international markets, RoHS compliance meant that the levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) flame retardants were reduced on a global scale.

Advancing network technology and wireless networking systems, as well as advances in room control and smart automation using sensors and timers are other key drivers that are fueling the green AV movement toward sustainable and intelligent building goals.

Green AV benefits broad market segments – government, education, corporate, commercial, industrial, houses of worship, and multi-residential housing, to name a few. These markets share a common goal to increase efficiency in long-term use buildings without compromising performance. According to the U.S. Department of Energy, buildings consume nearly 40% of all energy and 70% of all electricity produced in the United States. The melding of green AV system integration and intelligent building design achieves the common goals of reduced carbon output, user comfort, and increased efficiency while enhancing normal daily operation.

GREEN AV IN AN INTELLIGENT APPLICATION

The combination of green AV and intelligent building design proves a powerful combination for building owners, occupants, and visitors. Studies have shown that students in day-lit rooms consistently score higher than students in windowless classrooms. In addition, studies of workers in green buildings report productivity improvements of up to 16%, reduced absenteeism, and improved work quality. In healthcare facilities, patients recover faster and have fewer complications when recuperating in rooms with outside views, controlled acoustical environments, and fresh air available to them.

A modern intelligent conference room with green AV features may include a networked projector and/or LCD displays, intelligent lighting and window shade systems, a digital audio system, and a high-definition videoconferencing system. Traditionally, an administrative assistant or AV technician would be assigned to prepare the room for the day's meeting by arriving early to turn the thermostat up/down, turn on the lights, warm up the projector, adjust the audio system, and perhaps turn on and connect with the remote videoconferencing site. However, proper design and integration with intelligent building systems takes the potential of intelligent and green AV to a whole new level.

The combination of green AV and intelligent building design can turn a complicated series of events into an experience so simple that everyone becomes a system user. For example, take this same scenario but add in the integrated building management piece. The administrative assistant would send out an invitation to the meeting and the room scheduling software would schedule the meeting to the nearest location that can accommodate that number of invitees or that minimizes participant travel. Based on requested capabilities in the meeting invite, the AV control system would take over the task of turning on the AV components, setting them to the proper operational mode, and adjusting the room temperature to a comfortable level prior to the meeting start time. Ambient light sensors installed in the room would measure the amount of incoming natural light (which is becoming more prevalent in green building), adjust window shades as appropriate for the function, and supplement the natural light with the interior lighting system to achieve the proper environment for a presentation or videoconference. The videoconference bridge can be dialed five minutes prior to the meeting so all attendees have to do is enter the room.

Figure 1 highlights the key differences between green AV and green AV in an intelligent building.

Green AV	Green AV in Intelligent Buildings
Motion sensors integrated into the lighting system automatically lights a room when a person enters for a meeting.	Room scheduling software will turn the lights on in a room 10 minutes prior to the scheduled meeting, as well as automatically adjust the room temperature to a comfortable level.
System components go into standby mode or power down when not in use.	A sequential power system integrated with the room scheduling software turns system on/off in proper order and at the proper time.
A building-wide digital signage system enhances communication but also saves paper and reduces the fire hazard created by bulletin boards.	The digital signage does multiple duties as room signage as well as an emergency communication system. If integrated into a control system with motion sensors and timers, the signage can be remotely turned off overnight to save energy or when there are no people near a display. Digital signage can also communicate green and intelligent building information to workers, students, and visitors about the building's energy and water conservation metrics and other green aspects of the facility such as wayfinding to the nearest recycling bins.
Videoconferencing is deployed to reduce an organization's carbon emissions	Intelligent scheduling software looks across an enterprise's room resources and finds videoconference spaces nearest to each participant to maximize meeting efficiency and further reduce carbon emissions.
The use of a touchpanel control system for audio, video, and lighting.	Additional programming to also ties in HVAC, motorized shades, security system, etc.

Figure 1: A Comparison of Green AV versus Green AV in Intelligent Buildings

SPECIFIC TECHNOLOGIES

Video technology plays a prevalent role in green AV. Advancements that range from high-definition flat panel displays to videoconferencing systems have all had positive impacts on the environment. In the past few years, high-definition (HD) video has gone from a future, niche technology to broad-based adoption in the consumer marketplace at a lightening pace. Like the consumer market, the commercial marketplace has seen a growing demand for HD video quality in technology applications such as digital signage, conferencing technology, and large venue entertainment systems. The quality advances offered by HD technologies allow viewers to experience a more informative, richer experience.

LCD and plasma displays are more environmentally friendly than cathode ray tube (CRT) televisions. The higher efficiency of these technologies results in a lower heat load, which also means less HVAC and less overall power usage. In addition, some display manufacturers have released flat panel desktop displays that include its carbon footprint as a product specification. Once in use, these displays also provide the user with an on-screen calculator that educates him or her about how its carbon footprint changes in relation to power consumption as brightness and contrast settings are adjusted.

Video technology has also grown into a suitable alternative to transportation. Technologies like distance learning, telepresence, and videoconferencing systems connect people in similar fashion without the gas consumption to drive to the airport and the jet fuel burned to fly across the country not to mention taxi rides, hotel room energy use, and other travel-related energy costs. These technologies, spread across a national or multi-national corporation, can have a significant impact on a company's resource consumption and carbon footprint. The key to quick adoption and use of these technologies are proper facilities that encourage staff members, students or workers to request their use over traditional travel. In today's global economy, robust use of current conferencing technologies from desktop videoconferencing to telepresence should be a centerpiece of an intelligent organization's intelligent buildings.

AV control technology has also advanced and taken a prominent role in intelligent and green AV systems. Years ago, these control systems acted like a mega universal remote, replicating functions for each AV component's handheld remote. The advent of touchpanel technology has propelled AV control systems into compact, intuitive interfaces that can control AV, lighting, temperature, motorized window shades, as well as process information from and algorithms for occupancy sensors, ambient light sensors, and timers. Today's AV control system can serve as the human interface to the intelligent building.

Window shades also play an important role in creating the proper environment for green AV systems in intelligent buildings. With such an intense emphasis on daylight harvesting and temperature control, the proper selection of window shade materials and controls is essential for optimal operation. In an intelligent building, automated window shades used in conjunction with ambient light sensors and atomic clocks can adjust the correct amount of light for the time of day as well as the time of year.

Rich media capture and dissemination is the result of a combination of AV technologies such as the recording of audio, video, and presentation content. The goal is to offer a full presentation experience in an asynchronous, anytime-anywhere delivery method to enhance an organization's ability to communicate vital information regardless of geography and room size or availability. Rich media systems can reduce the operational headcount associated with training and teaching allowing core content to be stored and played on-demand to employees and students around the world. This type of information delivery allows real-time meetings and class sessions to be more effective since foundational information can be reviewed prior to a follow-up, interactive session.

In LEED 2009, a project can earn up to five "Innovation Points" on a LEED project for exemplary or innovative solutions to improving a building's sustainability. While there is no direct correlation with AV and LEED points, there are ways to address LEED requirements with innovative AV solutions.

Figure 2 illustrates how AV technology can help building owners attain LEED points.

LEED requirement: Pursue transportation alternatives to reduce carbon emissions.
AV solution: Demonstrate how AV conferencing technologies have reduced an organization's carbon emissions using an alternate compliance path to existing telecommuting credits.
LEED requirement: Daylighting using skylights, atriums, or window walls that lets in an abundance of daylight and offers outside views.
AV solution: Recess the LCD displays in alcoves so that performance and contrast ratio is preserved, or use automated shade control to achieve the best balance between daylight and performance. Choice of shade fabric that will reduce glare but still let in natural light.
LEED requirement: The use of recycled or rapidly renewable resources that were harvested with minimal impact on the environment.
AV solution: Use recycled denim as acoustical dampening material, or use acoustical ceiling tiles made from recycled newspapers.
LEED requirement: Contribute to the energy efficiency of the building.
AV solution: Use AV systems that are designed to power down automatically with power sequencers that will also address phantom power loads, and use of Energy Star-compliant products where possible. Using a mirror mount, install a projector that remains in the ceiling during operation to reduce heat load in the room.
LEED requirement: Improve indoor air quality.
AV solution: Specify AV products such as screens and millwork with low-emitting volatile organic compounds (VOCs).

Figure 2: Green AV and LEED Requirements

CURRENT BARRIERS AND OPPORTUNITIES

Historically, AV systems have been regarded for their essential functionality, such as the sound system in a house of worship, or for their wow factor, like a high definition LED display at a new ball park, rather than for their ROI or sustainable features. AV professionals, manufacturers, and buyers are beginning to look at AV technologies through this new sustainability paradigm, but the awakening is just beginning.

Power consumption of AV equipment has not traditionally been a product differentiator. The calculation of the carbon footprints for AV systems was rarely, if ever, requested. Even videoconference systems, the most obvious of green AV technologies, has been sold as more of a time-saving convenience for busy executives and cost-saver for faculty-constrained institutions of higher learning, than for carbon reductions.

Likewise, intelligent buildings have sought a unified user interface that can bridge the disparate technologies to make the whole greater than the sum of its parts. AV technologies can be that bridge bringing vital information to the occupants of intelligent and green buildings.

Education, information sharing, and experimentation are the keys to evolving how building owners view AV technologies. With the growing demand for greater competitiveness in a global economy marketplace and possible "cap and trade" legislation, AV solutions that not only appreciate but take center stage in the intelligent and green building will become ever more mission critical.

THE SOUTHFACE ECO OFFICE – A CASE STUDY

Southface, a 501(c)(3) non-profit organization based in Atlanta, GA, has a mission to promote the tenets of sustainable design by providing education to the construction industry—architects, engineers, contractors, developers and building owners—on LEED certification compliance and green building best practices. Southface's new Eco Office headquarters is a model for using sustainable and intelligent design practices in the design and construction of a commercial office. As such, the entire building is a teaching tool used as Southface's office, but is also open to the public for tours and educational seminars.

Southface's LEED-Platinum facility incorporates sustainability throughout. In drought-stricken Atlanta, water management features include rainwater harvesting, waterless and low-flow fixtures, a composting toilet system and a vegetated roof. Energy conservation is achieved through passive solar orientation, daylight harvesting, a continuous thermal envelope, intelligent lighting, an electromagnetic elevator and photovoltaic-integrated glazing. A rigorous recycling program greatly reduced construction waste to almost nothing.

Intelligent features of the building include motion and ambient light sensors tied to the lighting and interior shade systems and electrochromic tintable glazing and motorized sun control devices that adjust automatically to maximize daylighting and minimize solar heat gain.

How Intelligent and Green AV Solutions Promote Southface's Mission

AV technologies play a vital role in helping Southface disseminate their message. Given the organization's mission and purpose, AV solutions had to be sympathetic to the green and intelligent goals of the project. The heart of the building is a 1,200-square-foot, "paperless" classroom. This innovative classroom features a state-of-the-art AV system blending traditional presentation capabilities with a full-wall, interactive digital whiteboard system from PolyVision. The PolyVision Thunder™ system empowers real-time brainstorming for LEED charrettes, design reviews, and other interactive training sessions.

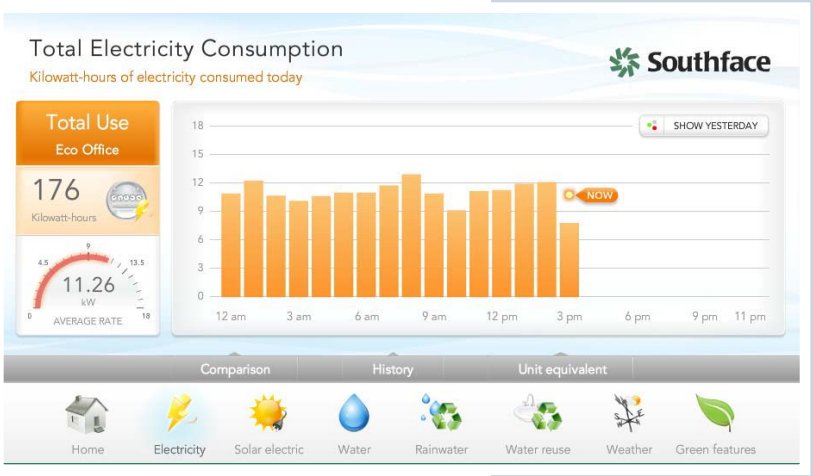
To start a session, a presenter begins writing on the digital easel. As virtual flip charts are filled, they are projected across four video projectors. Up to eight separate virtual flip chart

How Green AV can Affect LEED Ratings

The truth is that a project can get LEED Platinum certification (the highest level) without a particularly energy-efficient AV system. To date, the U.S. Green Buildings Council does not award direct LEED points for AV technology. That does not mean that AV is not an important element to consider within an intelligent building design. User comfort and convenience are intangible benefits to a properly designed and installed AV system. The AV community has actively worked to have AV technology formally recognized, especially given alternative transportation technology like videoconferencing.

pages are viewable simultaneously and information can be grabbed from one page and moved to another with the stroke of a pen. A conferencing audio system combined with the Thunder server allow remote participants to not only join the conversation and view the presentation from anywhere in the world, but they to can annotate on slides for all local participants to see. At the end of the meeting an email containing all meeting content is automatically sent to all attendees. Thus, no one has to take notes, copy handouts, or scan/transcribe flip charts.

Other sustainable features of the classroom include PolyVision's e3 environmental ceramic steel marker boards which are Cradle-to-Cradle certified, low-VOC finishes, and low power consumption AV equipment. Intelligent and green features of the classroom include intelligent lighting and shade controls to promote daylight harvesting and minimize the need for any supplemental illumination from the room's lighting system. Auto on/off features of the Thunder system minimize energy consumption and maximize projector lamp life. Sustainable features were contemplated even in the selection of microphones where RevoLabs Solo™ rechargeable microphones were specified not only for their audio quality, but also to eliminate the waste from dead batteries typically associated with traditional wireless lavalier microphones.



AV systems also play a prominent role in promoting the green and intelligent features of the building through interactive digital signage. Lucid Designs Building Dashboard software takes real-time information from the various building systems—HVAC, lighting, temperature sensors, etc.—and allows visitors to view the current power consumption of the building, amount of rainwater stored in rooftop cisterns, and other environmental data through user-friendly interactive touch screens.

In the end, world-class AV hardware and software have been integrated with information from the core building systems to allow Southface to take its educational message out of the textbooks and into a building environment that is a teaching tool in and of itself.

Notes

Notes

BRIGHT GREEN BUILDINGS

Convergence of Green and Intelligent Buildings

The intent of this research is to provide documented evidence and build tools that can be used to educate and influence end-users, building owners, architects, and contractors that a "greener building" can be achieved using intelligent technology, and will provide a tangible and significant return on investment. This concept — intelligent, green, and profitable — is what we call "Bright Green Buildings".

This research identifies the exciting developments taking place on the technology front and analyzes their implications for intelligent and green buildings, highlighting examples of "best in class" buildings employing green and intelligent technologies. These buildings are dynamic environments that respond to their occupants' changing needs and lifestyles.

Green Buildings

Air & Energy
Reduce GHG emissions
Improve IAQ
Improve Energy Efficiency
Waste to Energy

Water
Reduce wastewater discharge
Lower contaminant release

Waste & Remediation
Reuse and recycle products
Reduce waste disposal
More brown fields instead of green fields
Green architecture

Bright Green Buildings

Energy Management
Asset management
Space utilization
Integrated design process
Sustainability - easier to maintain and built to last
Renewable energy
Healthy and comfortable environment (IEQ)
"Green" loans
Higher resale or lease rates

Intelligent Buildings

Converged Networks
Data collection, measurement & verification, diagnostics, sensors, control, monitoring, remote monitoring etc.

Integrated Controls
HVAC, lighting, energy, AV security, energy, fire & life safety, etc.

Infrastructure
Structured cabling, solution, wireless systems, unified communication system

Water Management
Monitoring and metering

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