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Smart Street Lighting, Smart Buildings, Smart City, Smart Grid

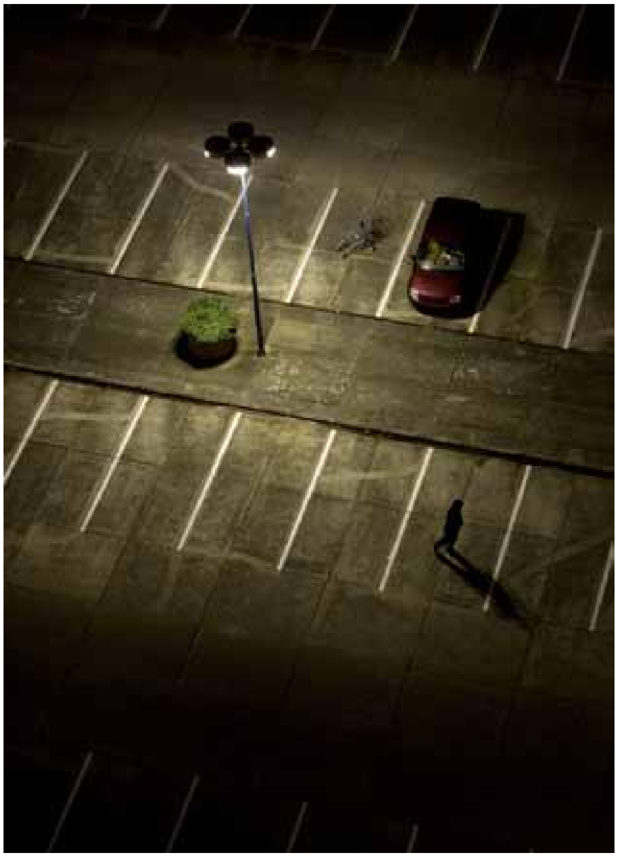
THE PROGRESSIVE REVOLUTION
EFFICIENT FOR A NEW ERA

SAFE. SECURE. EFFICIENT. RELIABLE.

Smart Street Lighting, Smart Buildings, Smart City, Smart Grid

Smart Street Lighting

The definition of SMART reflects technology that is intelligent, adaptable, energy efficient, and has the potential for interoperability between and among devices and systems. This technology also has the capacity to allow for advanced layers of computerized programmable platforms designed to address the specific needs of the operator, to allow for remote management and control, to improve information communication for the reduction of wasted energy and resources, and to develop specific responses that meet a community's expectation of a secure, safe living environment. Can this all be achieved with the use of lighting? At what price and from what funding source? Smart Street Lighting can answer those questions.



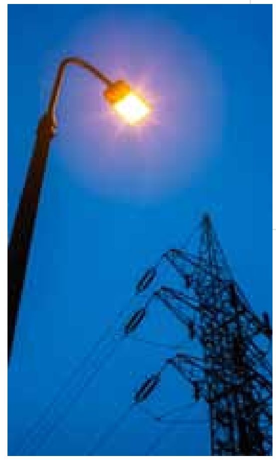
Picture this scenario: You are driving alone in an urban business section late at night. You are lost and all of the retail and business establishments are closed. Your cell phone is dying and you forgot your car phone charger. Your vehicle's engine acts in a peculiar manner, disrupting your travels. You quickly leave the roadway to pull over and find help. The car has just come to a stop for no reason. Thankfully, you chose to pull into a lighted parking lot near the roadway, so you are not stranded on the road itself. You analyze your present situation to choose the most immediate response. There is no one around. The temperature is dropping, and you only have a light jacket with you. Your gasoline is low, so you cannot keep the car on for long. You hope the cell power in your phone lasts until you can secure a tow truck or call someone to come get you. Your sleeping child in the back car-seat starts to stir from stopping and the temperature change drop. You search your phone for a help connection, but you really do not know exactly where you are…

Now picture this scenario: You are driving alone in an urban business section late at night. Your GPS is not working and you are lost. All of the retail and business establishments are closed. Your cell phone is dying and you forgot the car phone charger. Your vehicle's engine acts in a peculiar manner, disrupting your travels. You quickly leave the roadway to pull over and find help. The car stops for no reason. Thankfully, you pulled into a lighted parking lot near the road and are glad to be off the roadway. As you analyze your present situation, you notice the lighted pole lamps near your vehicle have grown brighter. You can see the immediate area better. You may be alone, but you feel a bit safer in the brighter illumination. The temperature outside of the car is dropping and you only have a jacket. You exit the vehicle to check the car, and you notice at a nearby intersection, a red alert arrow pointing in your direction. It is blinking continually. One of the pole lights in the lot near your vehicle has a small red beacon that begins to blink in concert with the arrow across the intersection.

Before you can even make a phone connection with your dying cell phone, an emergency vehicle pulls into the parking lot and drives towards you. You are very grateful to see help arrive and the occupants provide assistance and directions to allow you to continue safely and warmly on your journey. Your child sleeping soundly in the back car-seat never stirs. You are able to drive on, get fuel, and keep the car warm. The sensors in the street lights alerted central command station that there was a presence in an otherwise unoccupied area. Therefore, the illumination in the programmable light emitting diode (LED) lights automatically increased. The remote viewer installed on the pole pictured a stranded motorist with a disabled vehicle. The networked street lighting system in the roadway activated the emergency directional assistance modality built into the system to identify exact emergency locations. Help was dispatched to your exact location immediately. There was no wasted time or immediate danger. The problems were addressed accordingly and you are happy to continue safely on your journey. This is one probable resultant scenario from a Smart Street Lighting installation.

Traditional Street Lighting

Waste tremendous amount of energy and are incredibly inefficient



Those tall lonely street lights that run for miles across a town, a city, and a nation attached by power lines are for lack of a better term, at the present time, dumb. They are programmed to come on at a certain time of day and stay on at the same full power for an average of about twelve hours over the dusk, into the night, and into the early morning hours despite the time of year, light span during the day, weather changes, or night time visibility or need. Some more modern lights have photocells that activate when the sunlight is gone or when it arrives, thus turning the bulbs on and off. In either case, the lights have no way to relate their status, whether they are truly on or burned out, or if they are wasting energy by continually burning all through the daylight hours. They all waste tremendous amounts of energy and are incredibly inefficient.

The lamp bulbs used for conventional lighting systems are mercury based or high pressure sodium (HPS) and metal halide (MH). The former emit toxic gasses and all are expensive to replace, have low life spans of approximately five years or less, offer no insight for maintenance, and contribute a limited range of light that can only be turned on or off. Further, some of these older lights can take minutes to hours to fully come to optimum lighting power. Studies estimate that using these forms of street lighting are a municipality's highest expense ranging from 19% to 40% or more of the overall electricity usage cost. In average situations, there is a yearly 20% replacement need for these traditional bulbs. Replacements are costly and this expense does not include the maintenance operation costs.

Each of these legacy or traditional lighting systems is expensive to operate. The lights themselves use intensive and excessive energy whose cost is increasing yearly. Use and disposal of the mercury based lamps is hazardous to the environment. These lights have no alert system for replacement. Typically, the municipality's light center is alerted by a phone call from a citizen or a full time road crew patrolling areas at night for bulbs that have burned out to record a maintenance need for the day crew to replace that bulb. These routine checks and repair responses are expensive in man hours and equipment use. If the street lights are not maintained adequately, a municipality can experience increased crime due to low or no lighting, traffic accidents due to bad visibility, and

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increased liability exposure due to irresponsible or untimely lighting replacement. None of the preceding is advantageous for municipalities wanting to reduce energy use for environmental reasons and for energy savings cost. All of the preceding can be rectified by the use of LED lighting and an integrated networking system.

Intelligent LED Street Lighting

Changing to the use of LED bulbs reduces a municipality's expense from a 30% to an 80% decrease for electricity consumption just due to changing the bulbs alone. Many places in the world are still using the lighting solutions from the 1960's. These systems are energy wasting, electricity intensive, and contribute nothing but light to community life. Artificial lighting, especially at night, is an essential aspect of city life and a safe assurance for smaller municipalities. The use of such light impacts the sense of community safety and greatly influences business and tourism flow. Studies indicate that the current use of LED lighting worldwide is at 10% and that this figure will increase to 80% by the year 2020. Municipalities world wide are looking to reduce their energy costs, decrease environmental pollution, protect resources, and obtain more savings within their budgets. They are also looking for alternative ways to use energy in smarter, better ways. Using LED lighting moves consumption and cost into the direction of more efficient effective intelligent lighting solutions.

Lower power consumption and immediate cost savings

LED lights have many advantages over traditional lighting. They can be switched on without a pre-heat or dim-to-full light capacity wait. LEDs turn on instantly. They can also be turned off many times and not have their on/off capacity compromised or fail. They have a very high lighting capacity and efficiency. The exceptional quality of LED lighting can be dimmed without a noticeable difference in the overall lighting. LEDs have lower wattage and still have enhanced lighting better than traditional bulbs. Combine this with their lower power consumption and immediate cost savings occurs. LEDs are hardy in that they are less sensitive to transient phenomena like weather changes. Finally, LEDs have a superior life span and in some applications can last twenty or more years thus saving on replacement costs, hardware, and maintenance related expenses. SunView LEDs have the highest lumens and the lowest wattage in the lighting market industry.

Although the price of a LED bulb is still more than a traditional street light bulb, the inherent benefits in using LEDs, overtime, enable a municipality to save money in several important ways. Lower electricity usage cost, better management, less maintenance costs, and longer life spans offer a municipality a savings that could never be seen with traditional lighting. The small to vast amount of light bulbs needed for street light systems that waste energy at high electricity costs can be adjusted to environmentally clean and lower cost lighting solutions. The decision to simple change the type of light bulb used in a street lighting situation can save any municipality money and conserve energy. However, there is more to this street lighting ability. The change to LED lighting is the first step to reducing energy cost and increasing energy conservation. It is also the first step to future interoperable applications.

A municipality can save money by changing their street lights to cost effective LED bulbs. Many municipalities are doing this primarily to gain these energy use savings and to eliminate toxic greenhouse emissions from traditional lighting. Because LED bulbs contain computer program ability, they can be used for much more than mere energy effective lighting. More efficient cost savings can be realized from utilizing a street lighting system with network systems that add alternative and additional energy cost savings, maintenance savings, and operation costs savings while improving the sustainable lifestyle and safety of the community it serves. The future of public lighting, the networking of street lights, and the use of existing power line communication (PLC) as the connective system for a totally new adaptable network that links street lighting to many other beneficial resources for the community at an affordable cost is now within the ability and budget of many municipalities small or large.

> The life span of an LED bulb averages twenty years

Because the life span of an LED bulb averages twenty years, network systems built using this technology can be assured of savings in years to come. This allows full advantage to that technology use dictated by a municiplaity's needs and desires. Studies show that networked LED street lighting can save an additional 10% to 20% beyond the savings of replacing traditional bulbs to LEDs. This percentage is further increased by related savings in operational and maintenance costs associated with the networked management system. Welcome to Smart Street Lighting! We have come far from dumb lights on isolated poles connected by power line wires. Now, the ability to have intelligent computer programmable lights that can supply not just varying forms of light, but can contain and maintain other programmable abilities, on two way communication network systems enabled by interconnected poles that reach across a community collecting data and distributing it back for analysis and response is here to stay. The focus from simply lighting streets to keeping streets safe, keeping maintenance and operation costs down, and keeping data specific information directed for specific community cost saving use is the focus for Smart Street Lighting.

Traditional lighting systems need visual inspection by night workers who must be paid for the hours of searching for damaged or burned out bulbs. Smart Street Lighting (SSL) automatically reports problems with bulbs and targets exact location for immediate maintenance. Traditional lighting systems require mappings and paper files of work orders plus a system for management of replacement stock. SSL keeps an ongoing record of bulb usage, replacement time, bulbs available or needed to be ordered for replacement, proactive maintenance schedules, and plans for route repair directives. Traditional lighting burns at the same intensity for a set number of hours. SSL can be programmed to adjust to weather conditions, enhanced for problem areas or

circumstances, set to blinking, adjusted for color, and dimmed according to traffic flow or night time activity. SSL can also have the potential to optimize emergency directive alerts at selected and necessary times.

Traditional lighting cost is usually controlled and estimated by a utility company and specific breakdowns of individual usage are not easy to render. SSL accurately calculates every aspect of consumption including the details of time, amount, varying rates, and individual users. Bills can also be automatically generated and sent based on that information. These abilities, and more, are directed by the operations center which is able to see into the workings of the system to predict problems, calculate usage, and avoid system failures. There are also alert check systems that activate when an individual lamp is tampered with or altered without authorization. Because of this feature, electric energy theft, an expensive and difficult to identify energy waste concern, can be virtually eliminated.

The most fascinating part of the Smart Street Lighting systems is remote management. These intelligent light lamp posts send their data information to a central command system, or operations center, constantly. There, this information can be controlled, adjusted, analyzed, manipulated, and researched which simplifies management overall, provides more comprehensive information, and makes maintenance more effective and less costly. These abilities enable the development of a total comprehensive interoperable system able to enter further into the SMART world stepping into Smart City applications and eventual alignment with Smart Grid systems. One of the other exciting aspects of the development of Smart Street Lighting is financial assistance in forms of local and national rebates and incentives to replace old energy wasting technology and encourage movement into the efficient internet based network.

SunView LED Lighting has designed the finest, updated, most efficient, energy effective bulb in the industry. APANET Green Systems Technology has devised the most energy efficient, cost effective networking system utilizing power line communication (PLC) worldwide. Combining these two products and services offers tremendous savings now and into the future while simultaneously building a platform for network connections that can adapt as consumer needs change.

Please Note: For more detailed information please download our Smart Lighting Technology and Interoperability brochures.

Smart Buildings

Globally, human history begins with common categories: food, sleep, companionship, work relations, worship, and protection. The protection category involves an environment into which occupants gather, exchange ideas and sustenance, keep comfortable, perform essential daily tasks, and sleep in safety. These features are fundamental to the concept of a building and have not altered much since the dawn of civilization. Where humans gather to live, to work, to enjoy, or to worship, a building represents humans working with and/or against a natural environment that either supports their needs or must be managed to supply those needs.

Modern building architecture can astound us with its complexity and dazzle us with the technologies necessary to provide comfortable occupancy. However, the truly amazing ability of buildings is still to be demonstrated in the ongoing development of Smart Building concepts. Common features like lighting, heating, air conditioning, security, and ventilation are all being threaded together into compatible information sharing intelligent system networks. These networks are built on applications that can be layered onto one another over time, and eventually lead to interaction with the Smart Grid.

How do you define 'Smart Buildings?' Because each building is different and each owner requires a definition that explains their particular need, defining a smart building can only be accomplished by citing what application capacities can be used in a building. The foundations of these capacities are intelligent automation, analytics, and integration. Automation is programmed into the building function for more efficient building operation and management. Analytics that include sensors and controls that can be remotely managed are used to improve energy efficiency, lower operating and maintenance costs, and provide asset reliability. Integration of the building with current connection to smart energy systems within and beyond the building completes a general definition.

Smart Building technology can be installed during building planning and construction or retrofitted to address existing building needs. Intelligent technology (IT) can provide intelligent control to manage connected devices, equipment, or groups of equipment with networked systems and an overall supervisory system. Many of these systems involve machine-to-machine (M2M) communication. This communication requires open system responses to accommodate connectivity between all of the equipment and the systems in the building. Applications can be designed for intelligent control of electricity to manage lighting and general electric use, heating and air conditioning systems, security systems, telecommunication systems, loading dock delivery areas, parking garages, exterior parking and building campus areas, and architectural lighting. The list is defined by the building owner's needs.

Quick detection of any system malfunction is another asset of Smart Buildings. Maintenance response is exacting and no labor time is wasted for necessary replacements or repairs. Maintenance can be proactively planned and not reactively performed. Fundamentally, smart buildings will provide services that make all occupants and visitors comfortable and productive. Lighting, thermal comfort, air quality, safety, security, refuse removal, sanitation, and bridging to the world beyond the building walls will allow integration of data gleaned from many sources to provide energy efficient and cost effective building management through systems that share information and optimize building performance.

In 2015, the US Government Services Administration (GSA) plans to cut the energy level use in all government buildings by 30%. This reduction can not happen with technology alone, but must involve human understanding, acceptance, and participation. Building occupant's responses and suggestions to these changes add to the information data used to improved efficiency into the future. The ideal approach to Smart Building functions contains the following connected components:

- Integrated building systems
- Technological and human intelligence
- Addressing bottom line expenses
- Awareness of global environmental issues
- Connection to the Smart Grid
- Development of future enabled intelligence solutions

The practical approach to Smart Building contains elements that work with the people using the facility, facility owners, and considerations beyond the facility. Using an office building as an example of the interconnection of the three aforesaid elements, the intelligent use of office light can be analyzed and redefined. The small electron voltage in the sensitized coating of electromagnetic windows will allow those windows to darken or to lighten in direct response to the outside sunlight. These windows darken when the sun is brilliant upon the outside of the window and reduce the solar heat within the room. Conversely, if the sun is setting or the day cloudy, the windows react to become transparent to allow maximum light into the room. These features, automatically and remotely controlled, alleviate light and room temperature fluctuations, thus reducing costs. Automatic controlled shading can be combined to contribute to balanced room temperatures and cost free lighting.

LED Lighting and Smart Building Efficiency

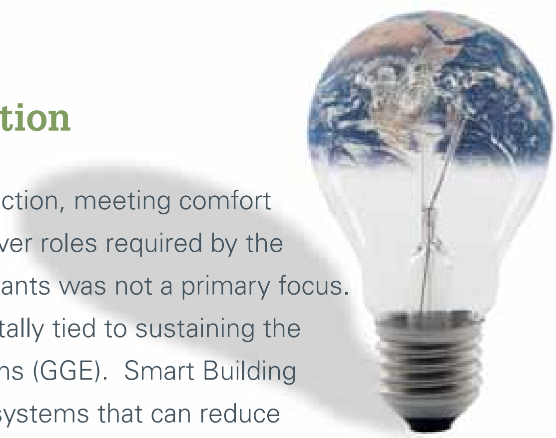
LED lighting can provide dimmable light fixtures that use efficient electronic ballasts and allow for sensor control. SunView LEDs are the finest bulbs on the market with the highest lumens and the lowest wattage. Using these LEDs will further reduce electricity power consumption and lower electricity costs. Rooms can be fitted with occupancy sensors that reduce lighting, heating, or air conditioning needs as a room is filling or emptying of occupants. These sensors can also be integrated to security systems.

These same practical principles can be applied to residential Smart Building use. Smart Electric Meters will be a critical link between the intelligent home network and the Smart Grid. These meters will calculate energy use in 15 minute or less intervals and record usage over time periods. Customers will be able to view their energy and time use and compare this to the peak and off-peak energy use rates. This will allow them to choose using electricity at a lower cost time period. In cases of power outages or malfunctions, the necessary repair location information can be exactly pinpointed thereby alleviating excessive downtime or wasted maintenance detection time. This 'Smart Building' function will give home owners more efficient, effective electricity service and allow them to chart and choose their price points for service. In certain applications, a home owner will be able to collect energy, share it, or sell it back to the utility company for discounts, refund, and/or payment directly to the home owner.

Just as an office building intelligently connects its systems and equipment for remote control and efficient management, a homeowner will be able to perform similar tasks through use of their 'Smart Appliances.' These appliances are already on the consumer market. They contain computerized programmable chips with wireless and remote capabilities that will allow an owner to remotely switch on/off their appliances to take advantage of peak and low energy use rates. Plug in switches at a residence that are connected to the Smart Grid will allow an owner to plug in their electric vehicle to charge batteries at optimum times. The goal of residential

Smart Building is essentially the same for any other building. The end user can monitor energy consumption, in-place or remotely, adjust their energy use for personal preferences or needs, and save on electricity power costs. Distribution operators will be able to program a customer's devices, limit peak hour consumption, and, if necessary, switch a device to off. A consumer becomes proactive with the energy distributor and can decide how their energy will be consumed. Through this dynamic power consumption, a consumer's role changes from one who merely receives energy, to one who is able to choose the lowest energy cost and and the possibility to become a 'prosumer' or one who can sell excess energy back to the utility grid.

Intelligent network systems must be created with the interoperability of open systems in order to accommodate the multiplicity of devices, the maximum choices, and the full functional integration of the system. Because APANET Green Technology Systems utilizes only LonWorks technology, we can offer the interoperability that will allow a customer to develop layers of programs that will adapt and allow future technological upgrades. Financial budgets require technology that people who use, operate, and manage a building can understand and utilize with ease. LonWorks technology is that choice. Many people learning to use LonWorks technology become easily proficient as the technology is designed with people in mind. A building may be smart, but it is the people managing the intelligence who really define the level of intelligence.



Global Environment and Functional Connection

Building management systems have historically focused only on function, meeting comfort and safety standards, and providing security for occupants in whatever roles required by the building's activity. Until recently, the tracking and reduction of pollutants was not a primary focus. The sustainability for buildings, cities, and nations is now fundamentally tied to sustaining the environment by the reduction of CO2 and Greenhouse Gas Emissions (GGE). Smart Building intelligence systems can capture this data and develop operational systems that can reduce environmental pollution and decrease energy power use. These systems allow an organization to participate actively in global environmental sustainability efforts and mange their own carbon footprints for the future. The Smart Building will ultimately connect to the informational data and knowledge base beyond the building complex walls and into the Smart Grid. This connection will allow building owners and managers dynamic participation in their own electricity consumption. It will also provide occupants and the public with information on a variety of levels to create a future sustainable environment.

On a functional level, Smart Buildings are able to impact the security and safety of both human and capital resources. Equipment can be maintained more efficiently and effectively. Humans can experience better health and safety. The building itself becomes a source of accessible information that can be utilized for public welfare. With large building complexes, connection to the Smart Grid allows that building the potential to become a virtual power generator by which owners are able to sell excess electricity back into the market. This process can assist the electric grid to offset electrical outages due to malfunctions, brown or blackouts, or natural disasters. Smart Buildings become contributors to social well being and not simply consumers of energy.

These real benefits for the building and for society are not temporary solutions, but are resources that extend over the building's lifetime. Therefore, the building is not just a structure of concrete, stone, and metal. It becomes animated with intelligent purpose and able to provide an information infrastructure that is connected to the intelligent system network of the future.

Smart City

The basis of the Smart City system is a well functioning infrastructure with data coverage of the entire city that allows integration of new services and functionality in the future. The aim of the Smart City is to reduce CO2 emissions and reduce the level of noise and air pollution, as well as to gain experience and knowledge on how to integrate elements of public space with new logistical applications. The concept and development of the Smart City is so new that finding a fully working city system is difficult.

The Smart Metering of electricity consumption and data gleaned from media recording devices from public buildings can be combined to create a city database. This information can be enlarged to include data derived from the monitoring of school buildings and other municipal facilities. This infrastructural information can be the basis for carrying out retrofitting work for LED lighting and improving the energy costs for many properties. Entire Smart City systems will eventually be integrated to the Information and Control Technologies (ICT) networks of public buildings, which will allow for remote management of facilities, and, in concept designs, will be part of the Smart Grid, the modernized electricity network of the future. Many cities worldwide are working to implement intelligent energy power systems combined with intelligent logistics to develop intelligent resource efficiency. This is the idea behind what is called Smart City or Smart Region. One of the first implementation examples for a Smart City is in Boulder, Colorado, USA. This particular Smart City concept consists of four main components: Power Smart Grid Infrastructure, Smart Electric Meters, Smart Home Devices, and a Public Website.

> By the year 2050, two-thirds of the world's population will live in cities.

One of the driving concepts behind Smart City is to create a sustainable way of life, work, mobility, and public space that utilizes new cost effective technologies and supplies more efficient, less expensive, energy use. However, implementing technology alone will not bring about these sustainable changes. The real motivation for the change will come from adjusting the behavior of the residents and promote partnerships among multiple entities like companies, manufacturers, municipalities, and other urban organizations to achieve a common goal. Not only will citizens from all walks of life be asked to change and to do more to implement these technological advances, but non-entities like simple outdoor street lights will be required to do more.

Along with their capacity to provide lighting for roadways, residential, business, and public space areas, outdoor lighting is increasingly being targeted for the implementation of smart technology. This smart technology includes the reduction of energy consumption, improved citizen safety, and interfacing with the expanding Internet of Things (IoT) for an ultimate connection to the Smart Grid. Some of these changes will include connecting Smart Street Lighting with the facades of buildings that have photovoltaic panels to collect energy and sensor panels to gather data to broadcast selected information to the public. Other concepts include urban planning that engages electric vehicles on programmed runs for automated refuse disposal aligned with distribution of goods to centralized city locations. This eliminates polluting and unnecessary vehicle presence on roadways, reduces traffic congestion, and integrates mandatory city maintenance like water runs for street cleaning. Even towering skyscrapers will be used in this process. They will be equipped with methods to measure and analyze energy consumption and evaluate CO2 emission. Intelligent Tower Offices (ITO) will provide a testing ground from which information will be used to develop future efficient energy solutions citywide.

By the year 2050, two-thirds of the world's population will live in cities. As a result of this increasing population and the resultant demands upon the urban environment, Smart City is a solution that addresses the need to provide a livable, safe, and comfortable future urban environment. Creating a resilient city plan that provides a decrease in energy consumption, the efficient use of resources, improved citizen safety, a reinvigorated urban area, an ensured healthy future environment, and integration with the growing connectivity of regional and national Smart Grids is the basis of the Smart City concept. Each city has the opportunity to design its own Smart City plan. Eventually, all cities will be connected to the ultimate system of systems, the Smart Grid.

Please Note: For more detailed information please download our Smart Lighting Technology and Interoperability brochures.

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The Smart Grid

The US Dept of Energy is charged under the Energy Independence and Security Act of 2007 (EISA 2007) with modernizing the nation's electricity grid to improve its reliability and efficiency. The act mandates modernization of the electricity grid policy of the United States to support effective, efficient, and reliable upgrading of the nation's electricity transmission and distribution systems to maintain a secure electricity infrastructure than can meet future demand growth and achieve the ultimate goals that define a Smart Grid (Title XIII Sec 1301).

> Affordable Electricity,
> Efficient Distribution,
> Protected Environment

This Smart Grid will become the main platform for the nation's future energy grid. It will be the backbone of power nationwide. This Smart Grid must ensure resilience, identify and prevent cyber attacks, and incorporate innovations and controls to provide affordable, safe, reliable power for all citizens. Reaching these goals requires new business models, regulatory models, and new responsibilities, as well as obligations, for grid operators, consumers, and new providers who will all help develop further innovative solutions.

The details of the elements of Title XIII of the EISA 2007 are as follows:

- Increased use of digital information and control technology
- Optimization of grid operations and resources with full cyber security
- Deployment and integration of distributed resources and generation that include renewable resources
- Incorporation of demand response, demand-side resources, and energy-efficient resources
- Deployment of 'smart' technologies for metering, communications concerning grid operations and status, and distribution automation
- Integration of 'smart' appliances and consumer devices
- Deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning
- Provision to consumers of timely information and control options
- Development of standards for communication and interoperability of appliances and equipment connected to the electric grid
- The lowering of unreasonable or unnecessary barriers to adoption

The American Council for an Energy-Efficient Economy (ACEEE) defines the Smart Grid as an umbrella concept describing electricity transmission and distribution systems that employ a full array of advanced electronic metering, communications, and control technologies. These technologies provide detailed feed-back to customers and system operators on energy use and allow precise control of the entire energy flow in the nation's grid. Distribution networks and consumers will gradually switch from being passive managers and receivers, to active managers and empowered, engaged consumers. The changes the Smart Grid brings will affect everyone. Electricity will no longer merely be provided by professional energy suppliers, it will be controlled by end users. These end users will be connected to distribution networks which will replace simple electric reception through connection to transmission lines. Ultimately, state and local projects will be absorbed into the functional elements of the Smart Grid with emphasis on interoperability and cyber security.

In the absence of standards, the development of the Smart Grid technologies may produce diverse technological investments that will become prematurely obsolete or be implemented without adequate security measures. Therefore, the National Institute of Standards (NIST) has developed a series of standards that form the roadmap and framework to support state efforts in modernizing the nation's electricity grid. Interoperability is one of the key objectives in these standards. SunView LED Lighting and APANET Green Technology Systems are compliant with these standards.

Reasons for the Smart Grid

There are several important reasons for the need to develop a national Smart Grid. The nation's current electricity grid is not equipped to meet the collective demands of current or future needs with the efficiency required to maintain citizen comfort and national security. Some studies claim that the present electricity generation and

Outages cost America $150 billion each year

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transmission system of the United States is ineffectual and wastes approximately two-thirds of the energy used to meet national electricity demands. With the current inefficient and often unreliable electricity system, the national economy loses approximately $250 billion annually. Outages alone cost America $150 billion each year. The price for electricity is rising steadily and in ten years it is predicted to increase over 30% of its present cost. When the rate increases, so does the cost of the losses.

Globally, utility fraud is second only to credit card fraud and costs about $85 billion worldwide. Billions of dollars are stolen from national grids, because it is easy to do and difficult to detect. The United States loses $200 billion in electricity loss and theft due to inefficient monitoring and the arduous efforts required to pinpoint the exact cause of loss. Overlooked transformers, illegal by-passes, and metering errors, coupled with aging technological equipment, contribute to this inefficient loss.

Brownouts and blackouts occur due to the slow reset time of mechanical switches, lack of automated analytics, poor overall system visibility, and a lack of situational awareness on the part of grid operators. These outages move beyond simply waiting for lights to turn back on. Industrial production plants stop. Perishable food spoils. Traffic lights and credit card transactions become inoperable. These forms of outages cost American businesses on the average of $100 billion yearly. Anyone who has experienced a lengthy electricity outage due to a natural disaster understands the inconvenience, discomfort, and fear that results from an entire system breakdown. During recent national weather disasters, the fortunate, who still had homes, sat in the cold, wet, and dark waiting for the power to come back. Some had the comfort of kerosene generators as they waited. Teams of professional electricians were summoned from far away states to assist in finding and repairing the cause of the outages. We all remember their tired expressions of frustration as they toiled endless hours over massive lines searching for the source of the power damage in inhospitable weather. With the Smart Grid, malfunctions are noted immediately and locations pinpointed exactly. No time and expense is wasted.

Our current electric generation system annually produces 4.03 million tons of sulfur dioxide (SO2) and 2.1 million tons of mono-nitrogen oxide (NOx) which is transferred into our environment. These, coupled with other pollutants, add $125 billion to annual healthcare costs, cause 18,000 premature deaths, 27,000 cases of bronchitis, and 240,000 cases of respiratory distress. The noxious effects of rampant air pollution create approximately 2.3 million lost days of work nationwide due to illness. Adding to these dismal statistics are findings by the US Environmental Protection Agency (EPA). They state that nationwide there are 200,000 premature deaths per year due to combustion emissions especially from changes in particulate matter concentrations and 10,000 deaths occur per year due to changes in ozone concentration. From economic to environmental warnings, the development and implementation of the Smart Grid is critical to America.

The Smart Grid is a Visible Network System

The Smart Grid technology will make clearly visible what has been up to now an invisible power producing and delivery network. It will improve the ability to predict overloads and avoid outages by distribution methods that include renewable, non-renewable, and distributed energy resources (DER). These systems include natural gas fueled generation, combined heat and power plants (CHP), electricity storage, solar photovoltaics (PV), solar-thermal energy, wind energy, hydropower, geothermal energy, biomass energy, fuel cells, municipal solid waste, waste coal, coal-mine methane, and other forms of distributed generation (DG). In using megabytes of data to move megawatts of electricity, the delivery of electricity will be more reliable, efficient, and affordable. This process will create an electric system for the United States that will move from a centralized producer controlled network to less centralization and a more proactive consumer response network.

The Smart Grid will empower consumers to participate and choose using a public two-way communication between utilities and consumers. This will enable consumers to accurately view the electricity they use, when they use it, and how much that use costs. Through a sort of social behavior modification, consumers will be able to self-manage their own electricity use by investing in intelligent, energy-saving end-user devices or selling energy back to the utility company as excess stored energy in exchange for discounts, rebates, incentives, or revenue. This social behavior modification applies to utilities as well. Due to proactive customer participation in electric consumption, utilities will be able to use consumer demand as another alternative to alleviating the need to search for additional power generation. For the first time, residential customers will be on the same playing field and have the same discount options and demand responses presently offered to commercial and manufacturing customers.

Studies have been made that report over the past twenty years if the Smart Grid already was in place, the nation would have saved from $46 billion to $117 billion dollars by not constructing obsolete power plants, inefficient transmission lines, and ineffective sub-stations. The goal of the Smart Grid is to reduce utility costs, maximize efficiency system-wide, and prevent outages from natural, human actions, and cyber attacks.

The Smart Grid Provides Affordable Energy Cost

What will matter most to the consumer is effective delivery of electricity at an affordable cost. This is the realm of dynamic pricing which reflects hourly variations in retail power costs and gives consumers timely information to choose low cost hours of use. Consumers will be able to refuse to use or reduce their use during peak electric use hours. Demand responses will be created to allow all electric consumers from industry to residential to use energy in a rational manner by cutting energy use at peak times or when power reliability is at risk. Advanced Metering Infrastructure (AMI) will provide real time monitoring of power usage to consistently inform all consumers of their use and options. Distributive energy generation will allow customers to use the generation of energy on their premises to offset their consumption costs by actually turning meters backward when they generate more electricity than they have demanded or simply providing them a credit for the excess energy in their next bill cycle.

For the reduction of toxic carbon, the Smart Grid's ranks the potential in providing cost effective clean energy using plug-in electric vehicles (PEVs), including plug-in hybrid electric vehicle (PHEVs), as the main response to this environmental threat. Although the vehicles by themselves will not produce the savings, the Smart Grid technology will allow them to generate their fundamental potential. The present idle production capacity of the nation's electric grid could supply 73% of the energy needs of the vehicles on the road with the use of existing power plants. Integrating idle production would put that power back into the national grid. The use of electric vehicles would reduce 52% of net oil imports or about 6.7 million barrels daily, reduce CO_2 emissions by 27%, and cut Greenhouse Gas Emission (GHG). To achieve this goal, vehicle charging must be done during off-peak hours. This

peak time considerations will apply to electronically controlled appliances including ranges, dishwashers, refrigerators, microwaves, washers, and dryers. The Smart Grid will allow remote control of these devices using compatible global interoperable standards to transmit signals to and receive signals from devices while away from home. The benefits to consumers include their ability to make choices that save money, improve their personalized energy convenience, and impact the environment in a positive way.

The Smart Grid is the Future of America

Up to the present time and for most of us, energy use has been a passive purchase, unclear in exact cost, and confusing to consider. We receive bills. We pay them and hope there is not an outage especially in extreme weather conditions. Controlling the consumption, distribution, and generation of electricity by using the technologies of the Smart Grid will contribute to national and global environmental protection. If we choose to do nothing, polluting emissions will rise, electric rates will increase substantially, consumers will be forced to pay excessively higher rates. We will have no choice or options. Brown/black outs will become a norm. This is not a future option for America.

When the nation implements fully the Smart Grid, it will change and hopefully enhance every aspect of the electric delivery system from generation, to transmission, to distribution, to storage. This implementation will create utility initiatives that will encourage and provoke consumers into new patterns of electricity usage. The modernization to the Smart Grid is central to national efforts to improve and increase the reliability of energy efficiency, transition to renewable sources for energy use, reduce greenhouse and carbon pollutants, and provide a sustainable, comfortable, safe environment for future generations. The Smart Grid will have requisite levels of interoperable standards that will enable innovative changes, some yet unknown. This interoperable system will exchange meaningful actionable information in a safe, efficient, and reliable manner. This System of systems will provide information sharing with flexibility, fidelity, and security to allow our nation to prosper and perform into the future.



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