Prepared Testimony of

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President, ImbuTec Inc.

Hearing on Business Opportunities and Climate Policy

Before the U.S. Senate Committee on Environment and Public Works

May 19th, 2009

Madame Chair and Members of the Committee:

It is an honor to appear before the Committee today to shed light on the significant business opportunities presented by the proposed climate change legislation for the Light Emitting Diode ("LED") lighting industry. My name is Richard W. Taylor, CEO of Imbue Technology Solutions, Inc. ("ImbuTec"), headquartered in Pittsburgh, Pennsylvania. ImbuTec provides energy-efficient lighting technology products and services to commercial, industrial, and municipal customers.

As a distributor and installer of energy-efficient lighting solutions, I can share the perspective of both the manufacturer who supplies our products, and the end-users who purchase them. As lighting technology continues to evolve, we are always in search of the most cost-effective lighting solutions for our customers. At this point in the technological evolution, it is clear that LED lighting provides the best return on investment to our customers who are seeking to replace High Intensity Discharge ("HID") lighting sources like high pressure sodium or metal halide lighting fixtures. This is because LED lighting sources yield dramatic reductions in energy consumption, and last much longer than HID light sources.

At the outset, I think it will be helpful to give context as to why a policy shift that encourages reductions in carbon emissions will positively impact the market for LED lighting technology, as well as many other energy-efficient products. One of the simplest and most effective ways to reduce carbon emissions is to reduce the demand for electricity. As I will discuss in more detail later, the LED

lighting products ImbuTec markets require, on average, 80% less energy to produce the same level of light as conventional HID lighting sources. By dramatically reducing the amount of energy needed to accomplish the same task, there is less demand for electric power generators to meet. The electricity that is required to power lighting is the most constant energy load in commercial buildings, often greater than heating, ventilation and cooling demands ("HVAC"), and reducing that energy load with LED lighting sources will have a significant impact on overall demand for electricity. Consequently, expanded use of energy-efficient lighting technology is one of the most immediate and cost-effective solutions for reducing energy consumption, and, therefore, carbon emissions.

Technology

There are a growing number of manufacturers who are entering the market to produce LED lighting products. In order to provide a reliable solution for our customers, however, ImbuTec has chosen to market exclusively the LED products produced by Appalachian Lighting Systems, Inc. ("ALSI"), which is also, coincidentally, headquartered in Western Pennsylvania. We have found ALSI's products to be superior to other LED manufacturers for several reasons that are important for the Committee to consider, including their technological superiority and their higher quality domestic production.

First, ALSI holds or has pending several cutting-edge patented innovations in LED lighting that provide a useful life of their products of at least twenty years. Among ALSI's key, patented design innovations are those that allow for dissipation of heat within the core fixture, how the LEDs are

electronically “driven”, and how a multiplier effect of light output occurs by use of reflectors, rather than use of lenses. By significantly reducing the operating temperature of the fixture, very efficiently driving the LEDs, and providing for efficient heat dissipation from the core unit (separate from the outer enclosure skin), the integrated fixture design has a dramatically longer operating life. This is a critical point that bears further examination. As with all electronic products, heat within the unit shortens the operating life. The failure rate for most electronic components will *double* for every 10°C increase in temperature. This is true for both the LEDs and for the power supply. LED chip manufacturers have demonstrated that at a junction temperature of 125°C, one can expect to get 50,000 hours of operation life and the light output will have *degraded by 30%.* Conversely, for every 10°C reduction in operating temperature below 125°C at the junction, one can expect to double the operating life.

ALSI’s products are designed to take advantage of this fundamental, temperature-related characteristic of electronic components. For example, the ALSI Type III streetlight design, at an ambient temperature of 25°C, the LED junction temperature is approximately 85°C. As such, these fixtures will see only a 1-3% light degradation over a 50,000 hour period as compared to upwards of 30% for other LED lighting manufacturers, and they will easily attain a useful life in excess of 100,000 hours.

Another key consideration is that at least 75% of the components of ALSI’s products are made in the United States. Although it is well-known that American components provide superior quality, most LED manufacturers are

based in China or Taiwan, or they primarily utilize cheaper components produced in Asia. By using higher-quality domestic components, ALSI's products provide a much greater level of reliability and consistency in their performance.

Another advantage of LED lighting generally is its overall environmental impact. LED products do *not* contain mercury, as is the case with Metal Halide, Induction and fluorescent lighting products. Therefore, when LED products are disposed of, they do not have to be treated as a hazardous waste and comply with the expensive, complex regulations that govern hazardous disposals. As concern mounts about increasing levels of mercury in the environment, the Obama Administration has begun calling for even greater limitations on the use of mercury across-the-board.

Besides its technical performance, ALSI's fixtures also offer important operating features that help further reduce their cost of operation. The street light fixtures contain a computer chip that can be programmed to reduce the amount of energy consumption at a designated time. For example, the street lights can be programmed to reduce power by an additional 20-80% at some point in the late evening or early morning when the reduction in light levels is deemed acceptable to the community. Also, ALSI has patented a rapid change out process. In the unlikely event that there is a defective strip of LEDs, this allows them to be replaced in the field, as opposed to replacing the entire fixture, or sending the fixture to the factory. These two features combined yield additional savings in both energy and operating expenses.

Savings

The combination of ALSI's technology and workmanship results in products that reduce energy consumption, on average, by 80% as compared to conventional HID lighting sources. I have attached a chart titled "LED Lighting Energy Savings" that shows the reduction in energy consumption a customer can expect to realize by converting to LED technology. In addition to significant energy savings, these products also yield significant operational savings to our customers, because they don't have to stock and/or replace light bulbs or ballasts for twenty years, or expend the labor to do it. By providing substantial energy and operational savings, a customer will generally realize a return on their investment in five years or less, even though LED products are more expensive than the technology they replace. Long after the payback period, however, the customer will continue to realize dramatic cost reductions.

Applications

There are a number of applications for which LED lighting is appropriate. They include parking lot lighting, street lighting, parking garage lighting, tunnel lighting, warehouse lighting, and exterior, wall-mounted fixtures.

Customer Testimonials

In order to demonstrate how this technology benefits our customers, I will share just two examples. The first is the Allegheny County Jail in Pittsburgh, Pennsylvania. Like all corrections facilities, the Allegheny County Jail incurs significant energy expense, because its facilities must be lit 24 hours/day. Faced

with rising fiscal challenges, County officials were looking for ways to reduce operating expenses at the jail, and ImbuTec proposed converting the lighting in the prison pods, the parking garage, and the recreational areas to LED lighting. As a result of the conversion, which was completed in March of 2009, the jail realized an 83% reduction in energy consumption to light those areas, and the fixtures have a maintenance-free expected life of 20-25 years. In addition, light levels actually increased by 20%. The total cost of the project was $954,700, but the County will realize savings of at least $178,000 per year, thereby realizing a return on its investment in just over 5 years. As the attached press release from Allegheny County Executive Dan Onorato demonstrates, this project helped advance the goal of "greening" the County's facilities, operating facilities more efficiently, and providing a sound return on the investment of public dollars. This is believed to be the largest installation of interior LED lighting in the United States.

Another example comes from the municipality of Ellwood City, Pennsylvania, which is north of Pittsburgh. In 2007, Ellwood City began converting 135 street lights to ALSI's LED street light fixtures, and they completed the conversions in 2008. Like most municipal governments, Ellwood City was looking for ways to operate more efficiently so as to avoid having to raise tax rates. In order to monitor the savings, Ellwood City placed special meters on two of the LED fixtures. Dom Vicari, Ellwood City's Borough Manager, reports that, "our two metered LED lights were using 7 and 13 KW range per month, respectively, compared to: 175 watt mercury vapor, 39 KW, and 250

[watt] HPS using 61 KW - all in that range, month after month, dating back to when they were first metered on January 28, 2008." This reflects a savings of 82% and 79%, respectively.

Jobs

One of the most noteworthy impacts of the expanding market for LED lighting is the increase in domestic employment throughout the supply chain. As the attached list of supply chain vendors demonstrates, ALSI purchases supplies from ten companies in six states, including Illinois, Minnesota, New York, North Carolina, Oregon, and Pennsylvania. As demand for ALSI's products grows so will the need for ALSI, as well as its suppliers, to hire more skilled workers to produce the components, and assemble the finished product. In addition, companies like ImbuTec will have greater demand for installing these products, necessitating us to hire the skilled electricians and electrical subcontractors needed to ensure that the work is done properly. This expanded employment across the LED product's supply chain has a positive impact on the local economies in each of these communities. This impact is not only limited to ALSI's manufacturing/assembly facility in Pennsylvania. It extends to the companies that provide the LED chips, circuit boards, power supplies, transformers, gaskets, housings, lenses, and control boards. All these jobs are "clean energy" jobs. And I see a bright future for these companies that are able to produce superior products which can be sold into the global stream of commerce.

Conclusion

For many years now, policy makers have been struggling to find the spark to reignite the industrial core of America. At the same time, debates have raged about how advances in environmental policy result in greater domestic job losses. As it relates to energy-efficient LED lighting technology, this old construct does not hold. Limits on carbon emissions will create additional demand for energy-efficient technology solutions, and will create more customers for Imbutec and ALSI. This will spur investment and job creation in the manufacturing supply chains for our products, as well as in the skilled trades that deploy them. Finally, in addition to adopting policies to limit carbon emissions, the federal government ought to consider becoming a customer as well.

Appendix I:

Appalachian Lighting Systems Inc. suppliers

Appalachian Lighting Systems, Inc.
101 Randolph Street
Ellwood City, PA 16117

	US Vendors/Manufacturers		**Component(s)**		**Purchased Through**
1	A.L.P Lighting Components, Inc. PO Box 95023 Palatine, IL 60095-0023		Housings & Lenses		Direct
2	The Bergquist Company SDS 12-1021 PO Box 86 Minneapolis, MN 55486-1021		Circuit boards		Direct
3	Jamestown Plastics 8806 Highland Ave PO Box U Brocton, NY 14716-0680		Lenses		Direct
4	Lumax Industries, Inc. PO Box 991 Altoona, PA 16603-0991		Housings & Lenses		Direct
5	Lytech Solutions 3915 Fairview Industrial Dr. SE Salem, Oregon 97302		Drivers, Control Boards, LED Chip Mounting Services		Direct
6	MCI Transformers 411 Manhattan Avenue Babylon, NY 11704		Transformers		Direct
7	Peres Pattern 1502 Cherry St Erie, PA 16502		Castings		Direct
8	Stockwell Elastomerics, Inc. 4749 Tolbut Street Philadelphia, PA 19136		Gaskets		Direct
9	The Warren Company		Housings, Reflectors,		Direct

	PO Box 8440 Erie, PA 16505		Lenses		
10	Cree 4600 Silicon Drive Durham, NC 27703		LED Chips		Arrow Electronics

Appendix II:

LED Savings Chart

LED Lighting Energy Savings

IMBUTEC
Phone 412.322.8832 . Fax 412.322.1130
920 North Lincoln Avenue . Pittsburgh PA 15233

Contact us at: Sales@imbutec.com
Or visit us at: www.imbutec.com

Application	Replaces Current Fixture	LED Wattage	% Savings
Parking Lot Light	250 Watt HID Fixtures (+45W ballast)=295 400 Watt HID Fixtures (+65W ballast)=465	35 70	***88*** ***85***
Canopy/Parking Garage Light	70 Watt HID Fixtures (+20W ballast)=90 100 Watt HID Fixtures (+29W ballast)=129 150 Watt HID Fixtures (+35W ballast)=185	24 24 24	***74*** ***82*** ***87***
Decorative Acorn Post Top	70 Watt HID Fixtures (+20W ballast)=90 100 Watt HID Fixtures (+29W ballast)=129 150 Watt HID Fixtures (+35W ballast)=185 175 Watt HID Fixtures (+35W ballast)= 210	32 32 32 32	***64*** ***75*** ***83*** ***85***
Street Light ††	250 Watt HID Fixtures (+45W ballast)=295 400 Watt HID Fixtures (+65W ballast)=465	70 91	***76*** ***80***
Warehouse Light	250 Watt HID Fixtures (+45W ballast)=295 400 Watt HID Fixtures (+65W ballast)=465	70 91	***76*** ***80***
LED Wall Pack	70 Watt HID Fixtures (+20W ballast)=90 100 Watt HID Fixtures (+29W ballast)=129 150 Watt HID Fixtures (+35W ballast)=185	24 24 24	***74*** ***82*** ***87***
LED Vertical Wall Pack	50 Watt HID Fixtures (+19W ballast)=69 70 Watt HID Fixtures (+20W ballast)=90	9 9	***87*** ***90***

†† Additional energy savings can be achieved by utilizing the power down chip to lower light output during off-peak periods, e.g. 2 am–dawn.

****** Life expectancy of our LED fixtures is 20+ years and they are maintenance FREE. ******
The actual return on investment is significantly higher when operational savings are taken into account.

Appendix III:

Examples of LED Lighting Products

LED Lamp Post

LED Parking Lot Light

Appendix IV:

Press Release From Allegheny County Jail Lighting Project

DAN ONORATO
COUNTY EXECUTIVE

COUNTY OF ALLEGHENY

OFFICE OF THE COUNTY EXECUTIVE

101 COURTHOUSE · 436 GRANT STREET
PITTSBURGH, PA 15219
PHONE (412) 350-6500 · FAX (412) 350-6512
WWW.ALLEGHENYCOUNTY.US

FOR IMMEDIATE RELEASE:
March 2, 2009

CONTACT: Kevin Evanto
412-350-3171 office
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Onorato Unveils "Green" Lighting Project at County Jail

County pursuing federal stimulus money for similar energy-saving projects at other facilities

PITTSBURGH — Allegheny County Executive Dan Onorato today unveiled new "green" lighting at the County Jail. More than 805 light fixtures were replaced with high-efficiency LED lights, which will consume 83 percent less energy, the equivalent of reducing the County's energy consumption by 184 kilowatts.

"The green lighting project at the jail is a win-win for Allegheny County," said Onorato. "We're increasing energy efficiency while decreasing costs to taxpayers. When I launched Allegheny Green, I promised that Allegheny County would lead by example, and we're doing just that. We will continue to look for ways to operate government more efficiently and environmentally friendly."

The cutting-edge, patented LED fixtures were installed in the pod areas of the jail where lights are required to remain on 24 hours a day. The LED lights are expected to last 20 to 25 years with a projected savings of more than $178,000 in the first year.

"In addition to the energy and cost savings, we're also looking forward to being more efficient with staff time," said Warden Ramon Rustin. "The life expectancy of the LEDs means we no longer have to purchase and store extra bulbs, and we'll cut down on the time spent changing bulbs as well."

The LED fixtures are manufactured by Appalachian Lighting Systems in Ellwood City, and 75 percent of the fixture components are produced in the United States. Pittsburgh-based ImbuTec Inc., an energy solutions company and minority business enterprise, served as project manager.

"Everything we do at ImbuTec is focused on saving money for our commercial, industrial and municipal customers, and we are pleased to bring this cutting-edge, locally-produced green technology to the market," said ImbuTec Chief Executive Officer Richard Taylor. "As the

– more –

County seeks to achieve greater energy savings, our LED products can address many interior and exterior lighting applications, such as parking garages, parking lots, street lights and warehouse lighting."

"Allegheny County will pursue federal stimulus money for similar energy-saving projects in our other facilities," added Onorato. "With these cutting-edge companies right here in Southwestern Pennsylvania, we will be stimulating our economy by putting local people to work."

The lights were installed by Sargent Electric. The total cost of the project was $954,000.

# # #

Allegheny Green is a comprehensive initiative to promote sustainable practices within County government and through countywide policies and programs. The key elements of the plan are the hiring of a sustainability manager reporting directly to the County Executive and creation of the Allegheny Green Action Team, a group of experts and stakeholders who will help the County to meet its green objectives and goals.

Appalachian Lighting Systems Inc. (ALSI) specializes in the development and manufacture of high-powered, ultra energy-efficient light emitting diode (LED) lighting fixtures. With research, development and production facilities located in Ellwood City, Pennsylvania, ALSI has developed several products using cutting-edge, patented technology. ALSI products include next generation streetlights, warehouse lighting, sign illumination, parking lot, parking garage lighting, tunnel lighting, indoor office lighting, and other specialty lighting applications. For additional information, visit www.appalachianlightingsystems.com.

Imbue Technology Solutions Inc. (ImbuTec) is an energy solutions company focused on helping commercial and institutional customers reduce operating expenses. ImbuTec operates through three divisions: lighting and energy solutions; public utility solutions; and electrical supplies. In addition, ImbuTec is actively involved in the development and deployment of energy-efficient lighting technologies that dramatically reduce energy consumption, as well as operating expenses in commercial, industrial and institutional applications. For additional information, visit www.imbutec.com.

Appendix V:

LED Lighting FAQ

Frequently Asked Questions

What is an LED?

LED is short for Light-Emitting Diode. An LED is a semiconductor diode that emits light when current is passed through it. LEDs have been used since the 1970's as indicator lights on electronic products. Recently the efficiency, reliability, and light output of LEDs have improved to the point where they are not only useful for general lighting applications but are becoming a long term and 'green' alternative to most other forms of lighting applications.

Where are LEDs used to provide lighting?

LEDs are used for general illumination, aesthetic, effect, or specialty lighting applications, including architectural highlighting. Traffic lights and exit signs also now use red, yellow, green or blue LEDs. ALSI has focused its LED lighting technology into commercial applications where long lasting, efficient, and generally maintenance free lighting is needed to illuminate streets, highways, parking areas, building exteriors, signs, warehousing, and office or other interior areas.

Have LEDs always been used in general illumination lighting?

No. Only now has LED technology advanced to the point where using LEDs is a viable option for general illumination. ALSI has applied this LED technology to an engineered product line via a series of patent pending innovations.

Why have past attempts to create general-illumination LEDs failed?

People started by trying to *retrofit existing fixtures*, working from a flawed principle of "lowest initial cost" as the primary design criteria, and then claiming such fixtures would last much longer than the existing fixtures they were seeking to replace. Further, existing 'non LED' light fixtures are generally very low cost, typically have a high operating temperature, and have little or no suitable fixture design to thermally dissipate the heat that is built up. LED companies made the fundamental error of designing general illumination product around a premise of 'form over function' so that the fixture had the *appearance* of the existing 'non LED' fixtures, without addressing the fundamental enemy of the LED - heat. We will address in more detail the issue of heat and LEDs later. Critically, the companies failed to understand and respect the nature of an LED, and as a result applied flawed engineering principles. In most cases, early designers failed to make the distinction regarding temperature and current control, and their affects on LED performance and longevity.

ALSI has built its entire product design around a 'function, then form' principle, and to be able keep the LED operating at a temperature and efficiency level that will provide for many years of maintenance free performance.

Why don't LEDs function correctly in traditional fixture housings?

One of the design criteria for a conventional housing is to prevent injury to the user or to prevent starting a fire. Traditionally, only enough cooling is provided to keep the body of the housing at a user-safe level. Therefore, high internal temperatures are common with such fixtures.

To operate at a temperature that supports LED longevity, *an LED fixture must provide a direct thermal path to conduct the generated heat efficiently to the surrounding ambient air.* This is accomplished by designing a large cooling surface area for heat radiation and conduction. This approach is fundamental to ALSI fixture designs, as will be addressed later.

What are the advantages of using LED lights?

With a correctly designed fixture:

- LEDs yield very high energy-efficiency, ruggedness, and superior life, as compared to other light sources.
- Required maintenance on such correctly designed fixtures is greatly reduced.
- Energy savings and maintenance savings combine to yield an overall reduction in cost of ownership, as compared to other light sources.
- LED lights are 'green' in that they utilize no hazardous materials. Mercury is a bi-product of a significant number of non LED lights on the market today. Disposal of such fixtures has become a significant environmental problem.

How does one evaluate LED products?

To fully evaluate an LED product *one must understand the individual components as well as overall system efficiency, from the power input to the light output.* That is the overall *efficacy* of the luminaire. We must also understand the difference between catastrophic failure, as experienced with conventional light sources, and the *slow depreciation of light output over time,* as it applies to LED light sources.

The US Department of Energy concluded in its Solid-State Lighting Commercial Product Testing Program that: "Until the field of SSL (solid state lighting) technologies and supporting knowledge matures, any claims regarding performance of SSL luminaires should be based on overall luminaire efficacy (i.e., from testing of the entire luminaire, including LEDs, drivers, heat sinks, optical lenses and housing), to avoid misleading buyers and causing long-term damage to the SSL market."

Most LED lighting companies have designed product that has poor *longer term* efficacy. Initially, the product may operate relatively efficiently, but because the designs have not correctly addressed the long term impact of heat in depreciating the LED light output and LED life, such designs clearly run the risk of adversely impacting the migration from conventional lighting product to LED general illumination product.

ALSI believes its patent pending designs and innovations have correctly addressed efficacy to allow its product to outlast its competitors with a generally maintenance free life of up to 100,000 hours or more.

What is the distinction between efficacy and efficiency?

Efficacy is a term used when the input and output units of measurement differ. In lighting, the light produced in lumens is compared to the electricity input in watts. The resulting measure of performance is expressed in Lumens per Watt.

Efficiency is a dimensionless term used when input and output units of measure are the same. Lighting fixture optical efficiency is the ratio of the total lumens exiting the fixture to the total lumens produced by the light source. Power supply efficiency is the ratio of power delivered to the load to the power taken from the electricity source

What happens if LED fixtures fail?

Most of the fixtures now being offered for sale must be removed from service and repaired by the manufacturer, or (more than likely) discarded. ALSI has designed their fixtures with the intent of *preserving the value of the customer's investment over the very long term.*

ALSI's patented *Rapid Change* capability offers unparalleled ability for the customer to be able to remove individual components, replace failed components, and put the fixture back in service in rapid fashion. ALSI also provides failure analysis of fixture components to determine the cause of failure and allow design improvement to occur based on the data collected.

Repair kits, tool kits, and repair training classes are offered to ALSI customers who wish to be responsible for maintaining their light fixtures without returning them to the factory.

Can LED fixtures impact radio or television reception in their area of operation?

Yes, that is possible with a poorly designed power supply or current control regulator circuit in LED lighting fixtures. ALSI's light fixtures pass the most stringent of FCC (Part 15 Level B) and international regulations. (CISPR22). When evaluating LED product being offered by other manufacturers, any potential buyer should be very careful to evaluate whether such product passes these standards.

How does lightning or other transient spikes impact operation of an LED fixture?

If a typical power supply is used for outdoor lighting, transients on the power line will cause instant failure. Most commercially available power supplies are tested to withstand typical indoor transients of 1000 volts. This is a minimal level needed to get past a short warranty period operation in a well protected building environment. It is grossly insufficient for outdoor applications.

ALSI's power supplies are designed to withstand transient events up to 6000 volts, in accordance with the specification ANSI / IEEE C62.41 level B3. This gives a very high probability of survival for up to 30 years in outdoor environments.

Why is the power supply for an LED fixture critical to the long operating life of the fixture?

The power supply *and* LED current regulators must create a precise electrical environment to assure LED longevity. An LED does not typically fail like an incandescent bulb, suddenly leaving no light. An LED fails by slowly diminishing light output over time. Protecting the LED from damaging electrical events and controlling its operating conditions is the primary purpose of the power supply.

If we were to compare the life expectancy of a well designed power supply to the life expectancy of an LED we will find that the power supply is between 100 and 500 times more likely to fail, for example, within a 10-year period. ALSI power supplies are designed to operate in difficult environments and last as long (or longer) than the LED.

Why are ALSI's patented reflector designs critical to efficient use of its fixtures?

The intention of a light fixture is to put light where you want it. This can be accomplished with lenses or reflectors, or both.

During ALSI's initial design and development efforts we discovered that we could get *more* light, and *better control* of the light, at the working surfaces, by using carefully designed reflectors. It also became clear that we needed to modify the light patterns depending on the application of the light fixture. This is very evident if you consider the difference between a sidewalk light and a parking lot light. One requires directing a narrow beam of light from side to side, and the other requires flooding a large area.

ALSI has evolved and patented a selection of reflectors for different applications and techniques for creating new reflector designs, based on customer requirements.

What is "junction temperature"?

Junction temperature is the temperature internal to the LED chip. Junction temperature is a critical measure for evaluating an LED lighting product's ability to deliver long life.

The US Department of Energy advises: "Heat management and an awareness of the operating environment are critical considerations to the design and application of LED luminaires for general illumination. Successful products will use superior heat sink designs to dissipate heat, and minimize junction temperature. Keeping the junction temperature *as low as possible*, and within manufacturer specifications, is necessary to maximize the

performance potential of LEDs." That DOE statement is the Mission Statement for ALSI and is strictly incorporated into the design and engineering of its product.

How does ambient temperature affect LED efficiency?

As an LED's junction temperature gets hotter, its light output will be diminished. At a 135° C junction temperature, the LED will meet the manufacturer's specifications.

Operating an LED at high temperature results in lower initial light output *and a much shorter life*. ALSI's fixtures are designed with thermal properties and electronic components to minimize light loss and maximize life by *operating the LEDs at a consistently lower temperature*.

Why is the operating temperature critical to the life of the LED fixture?

The failure rate for most electronic components will *double* for every 10 °C increase in temperature. This is true for both the LEDs and of the power supply. LED manufacturers have demonstrated that at an LED junction temperature of 135 °C we can expect to get 50,000 hours of operation before the light output will have *degraded by approximately 30%.*

However, the above "10 °C" rule suggests that if we operate the LED at 85 °C we will *extend* the 30% light-degradation interval out to about 16 x 50,000 hours, or about 800,000 hours. As the LED manufacturers' accelerated life tests continue, we can expect this result to be verified by actual test data.

ALSI's light fixtures are designed to take advantage of this fundamental, temperature-related characteristic of electronic components. For a typical ALSI street light design, at an ambient temperature of 20 °C, the LED junction temperature is approximately 85 °C. As such, we believe we can project that ALSI fixtures will see only a

1 to 3 percent degradation over a 50,000 hour period as compared to upwards of 30 percent by other LED lighting companies

How are LEDs able to outperform HID?

Think of a simple source of light, like a traditional incandescent light bulb, surrounded by a sphere. Light is given off in all directions and illuminates the inside of the sphere almost equally. With an LED, the light is directional, and is given off predominantly in one direction. If the LED points downward, imagine that the top of the sphere will be quite dark. If our working surface is below the sphere we will get almost as much light on the working surface, by starting with a light source of half the intensity of a traditional light source.

This is not a fully accurate model but it does express the principle. In reality, the conventional source will probably have a reflector in an attempt to redirect some of the upward and sideways light downwards. However, the LED light may also have a lens or reflector to concentrate the light at the working surface.

One advantage of the LED light is that the side glare is significantly reduced compared to a conventional light source. Again, imagine the inside of the sphere. This is quite beneficial for cities with “Dark Sky" initiatives.

In an ALSI light fixture using reflectors, we can quite accurately direct light where it is needed. We have successfully replaced 200 Watt metal-halide lamps with 85 watts of LED light source, and yet put more light on the working surface at the same time.

Do I have to replace LED diodes?

Probably not. It is not really practical since the assembly process for the individual diode requires precision control of temperature and excellent process cleanliness. A more important question is to consider the arrangement of

LEDs within the fixture. Do you remember the old Christmas tree lights where one bulb goes out and all of the lights in the string go off? If all the LEDS are connected in series, one could get the same affect.

ALSI street lights are designed with multiple strings of LEDs to minimize this possibility. Each string has its' own current regulator, and if we were to lose one string the other strings would continue to function correctly. Further, because of ALSI's patented *Rapid Change* capability, should a string of LED's fail the LED board can be easily removed and replaced without losing the entire fixture.

Why is the life span of an LED measured as "lumen depreciation"?

The LED doesn't burn out in the conventional sense. To have a way of describing what happens, product life is measured as lumen depreciation. The life span of an LED is much longer than that of incandescent, fluorescent or HID lamps. Fluorescent or HID light sources also show a reduction in light output before they fail completely.

The concept of lumen depreciation is not new. The Illuminating Engineering Society of North America (IES) current standard for calculating the life of an LED is the operating time at which the LED light output is reduced by 30%.

If a fixture is rated for 100,000 hours how long will it last?

That is based on how long a fixture is illuminated per day.

Hours of Operation:	100,000 hours is:
24 hours per day	11.4 years
18 hours per day	14.8 years
12 hours per day	22.8 years
8 hours per day	34.2 years