Lighting the future

Designing the energy-efficient illumination systems of tomorrow
With the vital need to save energy, the power industry has permanently innovated numerous ways to increase efficiency including by the way we convert electron to electron. Power conversion ratios are approaching physical limits, energizing researches and inventions and enabling applications that were heretofore impossible or at least not cost effectively viable. In lighting, new applications are requiring power designers to explore a new dimension, the efficient conversion from electron to photon which has created the lighting of the future.

Since 1860, when the English inventor Sir Joseph Wilson Swan created the first electric light bulb concept, followed by Thomas Edison and his team in 1879 patenting and perfecting the carbon-thread incandescent lamp after many, many attempts and the subsequent and rather ubiquitous "Edison bulb" used around the world, the lighting industry has been continually evolving. Fortunately for those of us in the electronic design industry we have also evolved from Edison's brute force design methods where he famously quipped "I have not failed 10,000 times. I have not failed once. I have succeeded in proving that those 10,000 ways will not work. When I have eliminated the ways that will not work, I will find the way that will work."

In 1932, sodium lamps were first produced commercially by Philips in Holland Although very efficient, due to their relatively poor light quality, these lamps are mostly used for street lighting as well as large lighting area applications.

In 1938, General Electric announced the introduction of fluorescent lamps as a regular line and they were placed on public sale. A story in the Magazine of Light at that time stated “Lighting would be changed forever, and for the better!” While the incandescent light bulb dominates the housing market, fluorescent lights still dominate the commercial office and building markets.

The introduction of “energy saving in lighting” and power electronics into these segment with “electronic ballasts” and SLL, made lighting change for the better. They also enabled an amazing flood of lighting innovations, contributing to making our lives better while reducing energy consumption.

A diverse industry
The lighting market segment is very diversified, but Solid State Lighting (SSL) based on LEDs have popped the conventional light bubble making the Edison bulb effectively obsolete and they are now infringing on fluorescent lighting. as well. The possibilities offered by SSL are also bringing lighting advantages in industrial applications such as for roads and parking lots, stadiums and stages (Figure 01), urban farming, horticulture, water purification, and medical lighting and light therapy.

Figure 01 – Stadium and Stage LED lighting quickly deploying.

Where electrons meet photons, it requires power designers to work very close with LED manufacturers. One example is so-called “GaN (Gallium Nitride) lighting,” using GaN transistors in the power stage, and GaN-on-Silicon in the LED element. Although anecdotic, it reflects the industrial maturity of the usage of GaN in the power and lighting industries. As power designer it is very interesting to follow both technologies and I foresee huge benefits in that association.

SSL lighting currently dominates some segments of the lighting market where the cost of replacing a light bulb is inordinately expensive and could cost the end user more than the light itself. Lights on tall poles where a lift truck is required to even reach the lighting fixture would be an example. Having to stop or reroute traffic on a bridge or in a tunnel is another example. These type of applications benefit from having very long lasting SSLs Additionally, the SSLs are much more efficient than the typical high pressure light that they are replacing so the power consumption for providing the same level of light is notably reduced, often resulting in a very good ROI for the end user.

In America, the last “Super Bowl” was held in a stadium that was lighted by SSLs. The individual SSLs on a roadway are typically in the 100-150 watt range. Stadium lights are typically 500-1,000 watts.

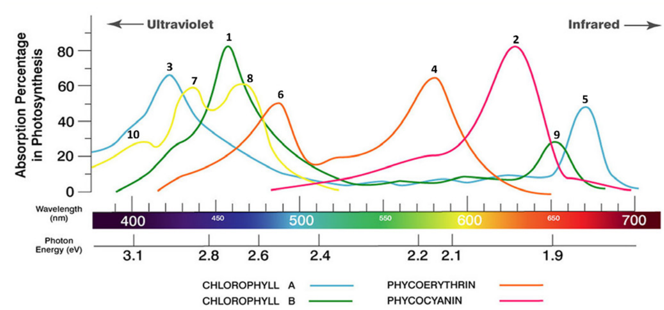

Figure 02 - Light spectrum to grow plants and vegetables typically starts at 450 nm (blue light) and goes through 730 nm (far red).

A power designer has to be very creative to bring power solutions to applications that our society might depend on in the future. For example, urban farming requires very specialized lighting solutions. The specific light spectrum to grow plants and vegetables typically starts at 450 nm (blue light) and goes through 730 nm (far red) (Figure 02).

The light energy required ranges from 50 micromoles (μmol) for mushrooms up to 2,000 μmol for light intensive plants like tomatoes and some flowers that thrive in full summer light (Figure 03). Horticultural experts tell us that for optimal results different plants types may require different light spectra as well as differing light balance and intensities between the seedling to harvesting stage. This often results in a requirement for the artificial light to have a number of different spectra channels that are individually adjustable for intensity.

Figure 03 - Light energy required ranges from 50 micromoles (μmol) for mushrooms up to 2.000 μmol for light intensive plants.

Urban farms are increasingly moving to modern SSL lighting, especially as the amount of light energy per watt of power steadily increases. This increased efficacy also lowers the cooling costs as the produce yield is negatively impacted by too high of air or soil temperatures. LED lighting allows the grower to use lights that only consume energy in just the spectra that the plants require, generally red and blue, thus saving energy over having to deliver full spectrum lighting where the majority of the light is not used by the plants. This goes back to your days in elementary school when you asked your teacher "Why are plants green?" (In case you never asked, the answer is because most plants don't absorb (use) green light and thus it is reflected back to your eyes making the plant look green.).

Today multiple LED lamps are commonly used to energy efficiently grow vegetables though more progresses can be achieved by integrating intelligent power sources in LED modules. One of the research area is to create micro-LED panel with growth index monitoring, able to modulate the light locally (1/2 square meter area). That will require a very efficient distributed power solution able to adjust all parameters to "vegetable growth." Here the electrons and the photons meet a new dimension, "feeding the population with sustainability for future generations."

Who said that lighting industry was ugly and the power industry boring? Both will usher in new and even better ways of lighting the future.

About Powerbox
Founded in 1974, with headquarters in Sweden and operations in 15 countries across four continents, Powerbox serves customers all around the globe. The company focuses on four major markets - industrial, medical, transportation/railway and defense - for which it designs and markets premium quality power conversion systems for demanding applications. Powerbox's mission is to use its expertise to increase customers' competitiveness by meeting all of their power needs. Every aspect of the company's business is focused on that goal, from the design of advanced components that go into products, through to high levels of customer service. Powerbox is recognized for technical innovations that reduce energy consumption and its ability to manage full product lifecycles while minimizing environmental impact.

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